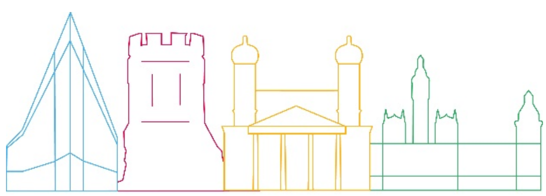
D7.1 State-of-the-Art Reports of concepts, approaches, standards and technologies

Deliverable of work package 7 of the ARCH project

29th of November, 2019



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Executive Summary and Table of Contents

The ARCH project aims to assess and improve the resilience of historic areas to climate-related and other natural hazards. Tools and methodologies will be designed for local authorities and practitioners as well as urban, national and international stakeholders.

This deliverable D7.1 of ARCH offers a series of six standalone State-of-the-Art Reports (SotA) addressing issues pertinent to the project and connected with other work packages within the project. Each report was written by different authors and is thus presented as a standalone document within this combined document. The individual reports present and analyse concepts, approaches, standards and technologies linked to the scope of the project. They serve as a basis for the development of the ARCH disaster risk management framework for historic areas in T7.2 and T7.3, for standardisation activities in T2.6, for the inventory of options for the four stages of the disaster risk management cycle in T6.1, and for funding opportunities in T6.3. A combined glossary holds all definitions mentioned in the reports as well as further definitions relevant for ARCH (provided as appendix to this D7.1).

Each of the six SotA reports has its own executive summary. At this point, we thus provide only a brief overview of the D7.1 content:

- **SotA 1: Historic areas, conservation practices, and relevant regulations / policies**

  Authors: A. Gondová M. Musilova; Co-Author: M. Zubiaga;
  Reviewer: C. Garzillo, E. Chapman; Contributors: Z. Zvarová, A. Albanesi, B. Paulowitz

  Identification and review of relevant definitions, practices, regulations, and policies related to the management and conservation of heritage assets.

- **SotA 2: Disaster risk management, emergency protocols, and post-disaster response**

  Authors: M. Mendizabal, S. Zorita, M. Musacchio, A. Costanzo;
  Reviewer: E. Rome, K. Milde

  Identification and review of existing disaster management policies / frameworks, emergency protocols, as well as post-disaster response techniques and identification of gaps with regard to the integration of heritage assets.

- **SotA 3: Building back better**

  Author: D. Lückerath, M. I. Pannaccione Apa;
  Reviewer: M. Musilova, A. Gondová

  Identification and review of existing policies / frameworks and technologies to enable implementing the principle of building back better.

- **SotA 4: Decision support frameworks and technologies**

  Authors: E. Rome, K. Milde, O. Ullrich; Co-Author: A. Krukowski;
  Reviewer: C. Bignami

  Identification and review of existing frameworks and technologies for decision-making processes and support systems, both generic as well as related to heritage conservation and climate change adaptation.

- **SotA 5: Gender aspects in conservation and regulation of historic areas, disaster risk management, emergency protocols, post-disaster response techniques, and techniques for building back better**

  Authors: V. Rebollo, T. Rangil-Escribano, E. Chapman;
  Reviewer: C. Garzillo, K. Herranz-Pascual

  Identification and review of how relevant frameworks, policies, and techniques (do not) address / influence issues related to gender roles and / or inequalities. This report should ensure that the work done throughout ARCH takes gender aspects into account and will build the basis for suggestions / improvements for the inclusion of gender aspects.

- **SotA 6: Existing standards and regulatory frameworks**

  Author: A. Schäfer, S. Maresch; Co-Author: V. Latinos;
  Reviewer: A. Gondová

  Analysis of both existing standards and ongoing standardisation activities in the field of resilient cities, heritage assets, and the given keywords will be performed and overview and assessment of existing formal and informal standards on National, European, and International level (CEN, ISO etc.) as well as regulatory frameworks.

- **Appendix: Combined Glossary of Definitions and Terms for ARCH**

  Editor: D. Lückerath

  This appendix contains the currently used definitions for ARCH plus all definitions provided in the six SotA reports. This extended set of definitions and terms constitutes the ARCH project glossary. It will also be provided as a separate stand-alone living document, to be extended and updated whenever necessary during the execution of the project.

ARCH

ARCH State-of-the-Art Report 1

Historic areas, conservation practices, and relevant regulations / policies

Deliverable No.	D7.1
Author(s)	Anna Gondová, Margaréta Musilová (MÚOP)
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Reviewed by (if applicable)	Cristina Garzillo, Eleanor Chapman (ICLEI)

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List of Abbreviations

Abbreviation	Meaning
BBB	Building Back Better
CC	Climate Change
CH	Cultural Heritage
CCHWG	Climate Change and Cultural Heritage Working Group
CURE	CUlture in city REconstruction and recovery
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
HULA	Historic Urban Landscape Approach
HV	Heritage Value
ICCROM	International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOM	International Council of Museums
ICOMOS	The International Council On Monuments and Sites
LA	Landscape Approach
SDGs	Sustainable Development Goals
SotA	State-of-the-Art
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHC	World Heritage Centre

Executive Summary

Aim of the report is to define and discuss state of art in terms of historic areas, current practices and regulations and policies relevant to the research subject of ARCH project and its further intersection with topics of cultural heritage and disaster risk management. ARCH is a European-funded research project that aims to enhance the resilience of areas of cultural heritage to climate change-related and other hazards. Tools and methodologies are developed with the pilot cities of Bratislava, Camerino, Hamburg, and Valencia, in a co-creative approach with local policy makers, practitioners, and community members. Therefore, the report is partially aimed to management and participatory governance of cultural heritage and implementation of disaster risk management methodology into existing frameworks.

At the beginning of the report we define key terms relating to the subject matter: cultural heritage conservation and management; typology of historic areas; fundamental conservationist principles of heritage value, authenticity and integrity; disaster risk management and climate change impacts and adaptation of relevance to the ARCH pilot cities as well, and whether/how they reflect certain regulatory frameworks.

The report further discusses other key topics and issues in the focus area. Firstly, we scope out the topic of managing cultural heritage at risk, covering its basic principles, related international frameworks and participatory governance. These are reviewed in relation to the typical cycle of Disaster Risk Management and climate change adaptation. Finally, the link between cultural heritage with sustainable urban development is explored more broadly, with respect to key frameworks for sustainable development and participatory governance.

The next subsection is dedicated to the analysis of regulatory frameworks at international, national, regional and local levels, considering the DRM cycle. Analysis is exploring substantial documents for cultural heritage conservation and management, as well as national or regional policies and legislation. This part of the report reflects on whether such policies address resilience against hazards (including those related to climate change) and if so, how this process evolved over the last decades.

The report concludes with a summary of the discussion, resulted in statement, that cultural heritage management and disaster risk management remain poorly integrated. Only some recognition has emerged in certain international and EU frameworks and guidance documents, but these are yet to be made operational. The improvement might be achieved via developed frameworks, engaging culture as cross-cutting discipline and participatory governance into cultural heritage management practices.

1. Introduction

ARCH is a European-funded research project that aims to enhance the resilience of areas of cultural heritage to climate change-related and other hazards. Tools and methodologies are developed with the pilot cities of Bratislava, Camerino, Hamburg, and Valencia, in a co-creative approach with local policy makers, practitioners, and community members. The results will be combined into a collaborative disaster risk management platform for local authorities and practitioners, the urban population, and international expert communities. A range of models and methods will be developed to support decision-making at appropriate stages of the management cycle. The results of the co-creation processes with the pilot cities will be disseminated to a broader circle of other European municipalities and practitioners and through European standardization.

1.1. Background information and aim of this report

The aim of the report is to indicate state of art in the topic focused on historic areas, conservation practices and regulation/policies, connected to climate change (CC) and other hazards related topics, within the scope of the ARCH project. Firstly, were on the basis of related literature search and survey of current discourse in the expert field, essential concepts and definitions described. Secondly, there was an objective stated, to follow whether/how is Disaster Risk Management cycle (DRM) reflected in the current practice (conservationist, legislative). Intention was to put emphasis on ARCH project pilot cities (Bratislava, Camerino, Hamburg, Valencia) and their issues related to the dealing with the impacts of CC and implementation of DRM tools.

1.2. Relation to other SotA reports and deliverables

Regarding the core topic - historic areas, as well reflected in the title of the project ARCH, the output of this report practically relates to all reports, considered in D7.1. *SotA 2: Disaster risk management, emergency protocols, and post-disaster response* elaborated DRM cycle and related frameworks and methodologies, that are followed within this report; *SotA 3: Building back better* is connected to current practices and policies, that are needed to be considered while implementing Building back better methodology into praxis in relation to cultural heritage (CH); output of this report provides useful data for the subject of *SotA 4: Decision support frameworks and technologies; SotA 5: Gender aspects in conservation and regulation of historic areas, disaster risk management, emergency protocols, postdisaster response techniques, and techniques for building back better* provides essential output for processes, considered within this report; *SotA 6: Existing standards and regulatory frameworks* complements the task of regulatory framework mapping, while focusing on standardisation processes.

The topic of this report is relevant to other ARCH deliverables, handling the issues of CH, DRM, conservation practice and regulatory framework, in particular: *D7.3: Mapping and characterisation of experiences and good practices; D7.4: ARCH disaster risk management framework; D4.2: Historic Area Information System (HArIS); D4.3: Threats and Hazard Information System (THIS); D4.4: Knowledge Information Management System for Decision Support; D5.1: Hazard models for impact assessment; D5.2: Handbook on Heritage Asset Vulnerability.*

1.3. Structure of this report

This report starts with an introduction of the topic, afterwards, the main definitions and terms are presented and explained. The main part of the report starts with the discussion over main topics, firstly historic areas, then conservationist and management practices and lastly relevant regulatory framework. The report concludes with a summary of the discussion and our most important findings.

2. Key concepts and definitions

This section provides an identification of the important concepts and definitions, further used within the paper. The aim is to focus on the topic of protection of CH, while addressing the scope of CC adaptation.

2.1. Conservation of cultural heritage

CH is very diverse, although limited and irretrievable resource. Authenticity, integrity and sustainability are essential components in today heritage practice, guiding its care and use and safeguarding the successful transitions to the future generations.

According to European standardization, **CH** is defined as: tangible and intangible entities of significance to present and future generations. [1] Considering the complexity of the topic and further need to detail the subject within the scope of ARCH project we would adopt the definition developed by ICOMOS Climate Change and Cultural Heritage Working Group (CCHWG) in 2019, when CH should be categorized into six following typologies (all covered within the ARCH project, in terms of issues characterized by ARCH pilot cities):

1. moveable heritage;
2. archaeological resources;
3. buildings and structures;
4. cultural landscapes;
5. associated and traditional communities;
6. intangible heritage.

There is also further need to explain closely the terms of and **tangible and intangible cultural heritage. Tangible cultural heritage** refers to physical artefacts produced, maintained and transmitted intergenerationally in a society. It includes artistic creations, built heritage and other physical or tangible products of human creativity, which are carriers of cultural significance within society and are considered to be worthy of preservation in the future. [2] **Intangible cultural heritage** "*means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity*." [2]

It is also called living cultural heritage, usually expressed in one of the following forms: oral traditions; performing arts; social practices, rituals and festive events; knowledge and practices concerning nature and the universe; and traditional craftsmanship.

2.2. Historic areas

In the context of ARCH we follow the UNESCO Recommendation concerning the Safeguarding and Contemporary Role of Historic Areas [3] of 1976, and subsume under the term **'heritage asset'** single buildings, structures, artefacts as well as whole **historic areas**. Those "shall be taken to mean any groups of buildings, structures and open spaces including archaeological and palaeontological sites, constituting human settlements in an urban or rural environment, the cohesion and value of which, from the archaeological, architectural, prehistoric, historic, aesthetic or sociocultural point of view are recognized," [3] and should be preserved unchanged. Among these is possible to distinguish: prehistoric sites, historic towns, old urban quarters, villages and hamlets as well as homogeneous monumental groups.

Among terminology both pertinent to the topic of historic areas and relevant to the ARCH project, we distinguish several expressions, differing in a several details. **Historic urban areas**, "large and small, include cities, towns and historic centres or quarters, together with their natural and human-made environments," [4] represent the embodiment of traditional urban values, within their role as historical documents. Text of the World Heritage Convention defines **Historic sites** as the "works of human or the combined works of nature and human, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view." [5] **Urban conservation** views architecture as but one element of the overall urban setting and is not limited to the preservation of single buildings, therefore it becomes complex and multilateral discipline and by this definition lies at the core of urban planning. [6] European Union research report No.16, SUIT: sustainable development of urban historical areas through an active integration within towns, from 2005 [7] settled three main categories of **urban heritage:**

- Monumental heritage of exceptional cultural value;
- Non-exceptional heritage elements but present in a coherent way with a relative abundance;
- New urban elements to be considered (for instance): The urban built form; The open space (streets, public open spaces), Urban infrastructures (material networks and mechanism).

The paper provides also an interesting discussion over defining built CH in terms of management, when two aspects are distinguished:

- **heritage by designation:** all cultural objects that are listed, institutionalised and labelled by experts.
- **heritage by appropriation:** the social, or ethnologic heritage that includes landscapes, townscapes, living places and non-exceptional building ensembles.

Concept of **historic urban landscape**, shall by *UNESCO Recommendation on the Historic Urban Landscape* from 2011 *"be understood as the urban area, the result of a historic layering of cultural and natural values and attributes, extending beyond the notion of "historic centre" or "ensemble" to include the broader urban context and its geographical setting. It also includes* *social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity*." [6] The document operates with terms landscape approach (LA) and historic urban landscape approach (HULA). LA is a framework for making landscape-level conservation decisions, developed by International Union for Conservation of Nature and the World Wildlife Fund. [6] Its aim is to help reaching decisions about the advisability of specific interventions1, and to facilitate the planning, negotiation and implementation of activities across a whole landscape. "HULA was developed by and within several adjoining disciplines, such as rural, cultural, urban and natural landscape management and territorial governance." [8] It integrates the goals of urban heritage conservation and social and economic development. Aim is to preserve the quality of the human environment, enhancing the productive and sustainable use of urban spaces, while recognizing their dynamics and promoting social and functional diversity. "It is rooted in a balanced and sustainable relationship between the urban and natural environment, between the needs of present and future generations and the legacy from the past. It considers cultural diversity and creativity as key assets for human, social and economic development, and provides tools to manage physical and social transformations and to ensure that contemporary interventions are harmoniously integrated with heritage in a historic setting and take into account regional contexts, while learning from the tradition s and perceptions of local communities and respecting the values of the national and international communities." [6]

2.3. Issues of value, authenticity and integrity

Clear understanding of the cultural significance of the place, the needs of its stakeholders is what stands at the beginning of a good heritage conservation practice. This includes the development of policies to both manage change and assess risks. To understand the history of the site development, is important to assess its associations, integrity and authenticity, therefore this understanding goes beyond a physical condition and fabric analysis. [9, p. 17]

Articulation of **heritage values** (HV) is used as a reference point for all conservation decisions. Assessment of values, that are attributed to heritage is a very important activity in any conservation effort, because of its eminent influence on the decisions that are made. HV are often called "**cultural significance**." This term is given a central role by *Australia ICOMOS Burra Charter, 2013*, [10] and means *aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups.* [10, p. 2]

Value can be defined as the relative social attribution of qualities to things, therefore is depending on society and can change over time. Certain values can be related more specifically to the intrinsic aspects of the monument or site (design, material, and workmanship), while other values can be associated with its location and its relationship to the setting. [11, p. 14] There are many types of values with complex interactions between them. A typology of HV would be an effective guide to characterization and would move conservation stakeholders closer to having common language, when all parties' values can be expressed

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[1] such as a new road or plantation

and discussed. The *Burra charter* devised HV into four groups as described above in the definition. *Research Report by The Getty Conservation Institute: Assessing the Values of Cultural Heritage* [12, pp. 5-31] developed provisional typology of HV, described in table 1. It is necessary to adopt a holistic approach to its evaluation, characterized by the integration of use and non-use values.

The European Commission's 2014 *Communication Towards an integrated approach to cultural heritage for Europe* [13] underlined the importance of maximising the intrinsic, economic, and societal value of CH, in order to promote inter-cultural dialogue. In the agenda for CH research and innovation *Getting Cultural Heritage to Work for Europe*, [14] CH is understood as a production factor and hereby an important resource for innovation, social inclusion and sustainability.

Table 1: Provisional typology of heritage values

Sociocultural Values	- Historical - Cultural/symbolic - Social - Spiritual/religious - Aesthetic
Economic Values	- Use (market) value, - Non-use (nonmarket) values: Existence Option Bequest

Authenticity is a crucial aspect in the assessment of heritage assets. Generally speaking, authenticity is ascribed to a heritage asset that is materially original or genuine as it was constructed and as it has aged and weathered in time. *The 1994 Nara Document on Authenticity* [15] stresses the credibility or truthfulness of the information sources for the assessment of authenticity, and notes that the diversity of cultures and heritage can be understood as an irreplaceable source of spiritual and intellectual richness for all humankind. Authenticity derives from the definition of the asset, and therefore may be understood in different ways depending on the context of its historical significance.

The heritage significance of a historic area, that results from gradual growth or development can be defined in terms of its historical **integrity**. Integrity generally refers to the material completeness and sound condition of an object or site. **'Historical integrity'** relates to the current form of a heritage asset as a result of growth and changes over time. The intrinsic qualities of a heritage asset include: quality of its design, materials, workmanship, setting and relationship to the setting. Over time, the original may be partially damaged, intentionally modified or even destroyed, while its original integrity caused to be diminished or lost. Historic asset may at different periods of its history, become part of a new whole, creating genuine part of its historical stratigraphy. Treatments aimed at the restoration of a heritage asset should refer to this new potential unity and therefore should be carried out within the framework defined by it. [11, p. 15]

Many conservation management and assessment standards, such as the constructs of authenticity and integrity, will need to be rethought in the light of CC. "*As circumstances change and the world goes through rapid and far-reaching transitions in the environment, land area,* *land use, ecology, energy, economic, and political and social systems, alternative ways and means of sustaining the significance of heritage places will continue to evolve*." [9, p. 16]

2.4. Heritage at risk

"Cultural heritage is always at risk. It is at risk from the depredations of war. It is at risk in the face of nature's occasional eruptions and irruptions. It is at risk from political and economic pressures. It is at risk from the daily forces of slow decay, attrition and neglect. It is even at risk from the hand of the over-zealous conservator!" [16, p. 17]

According to general need for protection of CH, different frameworks were established or developed to manage its protection. Although negative impacts of climate-related and other hazards on urban areas are widely discussed, their impacts on historic areas have not been studied extensively enough. In addition, according to the United Nations Educational, Scientific, and Cultural Organisation (UNESCO), **disaster risk reduction** (DRR) does not register as a priority area for management of World Heritage property, despite the increasing vulnerability of historic areas to hazards.

In order to enhance the resilience of historic areas (including preparation, safeguarding, conservation and management, response and recovery), is ARCH covering the whole DRM cycle, defined below and in Figure 1. DRM methodology in context of ARCH, is elaborated in detail within the content of *SotA 2 report: Disaster risk management, emergency protocols, and post-disaster response.*

Disaster risk management are *processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development*. [9, p. 96]

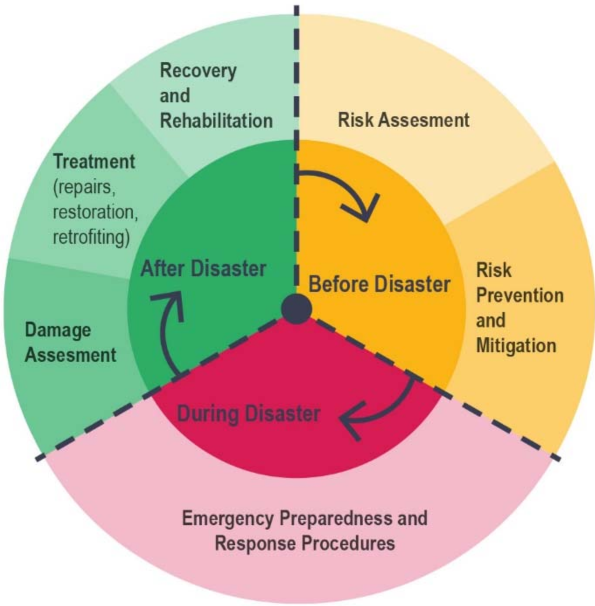

Figure 1: Diagrammatic representation of integration of disaster risk management planning into overall site management and regional planning.

Adapted from: Disaster Risk Management of Cultural Heritage in Urban Areas: A Training Guide: 1.4 Principles for Disaster Risk Management for Cultural Heritage

Available on: http://www.r-dmuch.jp/en/project/itc/training_guide/sections/section_3/module1_4.html

2.4.1. Climate change and heritage

When The International Council On Monuments and Sites (ICOMOS) was founded in 1966, in order to work for the conservation and protection of CH, CC was not considered as an urgent threat to CH. Much higher on the agenda were more traditionally understood threats to CH, like conflicts, rapid urban development and natural disasters. Nowadays, CC has become one of the most significant and fastest growing threats to people and their CH worldwide.[2]

European Commission's document on *the European Framework for Action on Cultural Heritage* [17] is defining 5 pillars on which the framework is based. **Pillar 3: Cultural heritage for a resilient Europe: safeguarding endangered heritage**. The framework entails three clusters of actions, while one aiming on **protection of CH against natural disasters and climate change**. In order to this task, a set of actions are being developed to research, develop and disseminate evidence-based and cost-effective strategies and tools. These will be used to manage risks and improve the resilience of Europe's CH in the event of natural disasters and against the intensifying effects of climate change.

2.4.2. Climate change related and other hazards

Unequivocal scientific evidence shows that unprecedented concentrations of greenhouse gases (GHGs), driven by human activities such as burning of fossil fuels and deforestation, are contributing to climate changes including warming of the oceans and atmosphere, sea level rise and diminished snow and ice. The hazards relevant to the four pilot cities in the ARCH project are outlined in Table 2 below.

Table 2: Summary of hazards related to ARCH pilot cities. Processed according to: ARCH: Questionnaire for partner cities to develop city narratives and tasks

Pilot City	Exposure to climate change related or other hazards
Bratislava	- pluvial flooding - droughts - winds erosions, slope movements, landslides - heatwaves - erosion

[2] ICOMOS, 19GA 2017/30. Resolution 19GA 2017/30 encourages all ICOMOS Members to strengthen their efforts to aid in implementing the Paris Agreement, emphasizing cultural heritage and landscape-based solutions, noting the need for rapid and deep reductions in emissions to reverse the increase in the global average temperature to well below 2°C; that adaptation efforts should take into consideration vulnerable communities and ecosystems, and enhance understanding and action with respect to loss and damage from climate change; and the need for solidarity with those nations most impacted by, or least able to bear the cost of, climate change to enable them to safeguard their heritage.

Camerino	- Seismic hazard - Hydrogeological risks *(non-specified)*
Hamburg	- Natural Hazards *(non-specified)* - stormwaters - climate hazards *(non-specified)*
Valencia	- Flooding - Heat Waves - Sea Level Rise - Saline intrusion - Coastal erosion - Forest fires - Drought

The impacts of these CCs are already damaging infrastructure, ecosystems, and social systems – including CH – that provide essential benefits and quality of life to communities. [9, p. 4] Specific drivers3 and impacts are outlined in the table 3 below. Table is for the sake of simplicity shortened to individual climate drivers although many of these climate drivers act in combination, whit complexity of interactions, difficult to capture here.

Table 3: Summary of key climate drivers and impacts, which can be expected to affect heritage materials, sites and landscapes

Summary of the types of climate drivers which can be expected to affect heritage	- Increased Temperature - Sea Level Rise - Climate Change (e.g. temperature, precipitation, humidity and wind) and air pollution combined (outdoor) - Climate Change (e.g. temperature and humidity) and air pollution combined (indoor) - Precipitation and humidity
Summary of the types of climate impacts which can be expected to affect heritage	- Sea level rise, - Coastal flooding - Coastal erosion - Loss of sea ice - Glacial melt - Permafrost thaw, ice patch melt and warming soils - Changed freeze/thaw cycles - Increased ocean temperatures - Increased storm intensity and/or frequency - More extreme rainfall - Increased humidity - Increased wind or changes in wind direction - Drought - Aridification

[3] “*Drivers are aspects which change a given system. Changes in both the climate system and socioeconomic processes including adaptation and mitigation are drivers of hazards, exposure, and vulnerability. Drivers can, thus, be climatic or non-climatic. Climatic drivers include: warming trend, drying trend, extreme temperature, extreme precipitation, precipitation, snow cover, damaging cyclone, sea level, ocean acidification, carbon dioxide fertilisation. Non-climatic drivers include land use change, migration, population and demographic change, economic development* “.https://www.ipcc.ch/site/assets/uploads/2018/02/ar5_wgII_spm_en.pdf

	- Heatwaves - Changes in seasonality - Changes in species distribution driven by climatic changes

Except for climate change related hazards, there are other types of threats, either with natural or human origin: fire, earthquakes, floods, armed conflicts, tsunami, avalanches, mud and land-slides and flows, winds or tropical storms, hazards of human origin (vandalism, theft, arson, the use of exploitation devices, accidents), inadequate maintenance, industrial pollution and disasters. Each of the hazards, impacting the heritage assets, requires development of risk – preparedness strategies and various technical and planning actions (DRM). In addition, one of the ARCH pilot cities, Camerino, is suffering from the consequence of 2016 earthquake, nature – related disaster.

In line with above, the *Partnership on Culture and Cultural Heritage of the Urban Agenda for the EU* [18] focuses on the resilience of cultural and natural heritage. In its *Orientation Paper* the challenges and key objectives for urban areas regarding resilience and heritage are four-fold:

1. to safeguard the heritage from natural disaster of climate change and to lower its vulnerability;
2. to improve the quality of CH and open/green spaces to reduce risks and promote heritage as an instrument for building resilience;
3. to manage urban transformation processes without provoking/inducing further environmental risks. Aiming this the maintenance of the built CH and the building stock is a key issue;
4. to contribute to urban resilience by supporting new quality areas and projects that do not add pressures or constitute potential threats to the environment.

3. Managing cultural heritage at risk

In addition to those impacts mentioned within the table above, is necessary to mention large scale human displacement and migration, loss of existing communities, flooding, desertification, wind damage and major changes to cityscapes, landscapes and all types of heritage buildings, sites and Places. CCs will unprecedentedly affect what is now considered to be good conservation practice, therefore some modifications will be required, either to enhance position of CH as an asset in adaptation to CCs and to address its the eligible impacts. [9, p. 16] In following part we discuss the aims of CH management, in terms of protecting diverse heritage values. We then list established methodologies for effective management of CH at risk and importance of participatory governance.

3.1. Principles for managing cultural heritage at risk

Publication *“RISK PREPAREDNESS: A Management Manual for World Cultural Heritage,”* [16] published by ICCROM in 1998,[4] as well-developed manual for experts dealing with CH in terms of DRM, appears to be relevant for ARCH. The following principles to guide effective management of CH at risk are developed within the manual. In the section below are analysed according to DRM cycle.

<u>How it addresses DRM:</u> It does considerably, while principles have implications in risk planning, recovery and response.

<u>Before disaster:</u>

- The key to effective protection of CH at risk is advance planning and preparation.
- Advance planning for CH properties should be conceived in terms of whole property (buildings, structures, and their associated contents and landscapes).
- Advance planning for the protection of CH against disasters should integrate relevant heritage considerations within a property's overall disaster prevention strategy.
- Preparedness requirements should be met in heritage buildings by means which will have least impact on heritage values.
- Heritage properties, their significant attributes and the disaster – response history of the property should be clearly documented as a basis for appropriate disaster planning, response and recovery.
- Maintenance programmes for historic properties should integrate a cultural - heritage - at - risk perspective.[5]

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[4] This publication is also mentioned in section 4.1.1.

[5] Maintenance programmes are often conceived in terms of the daily causes of deterioration of a property (temperature, humidity); this should be expanded to include analysis of all possible human and natural resources of decay and loss, to reduce or mitigate risk.

- Property occupants and users should be directly involved in development of emergency - response plans.

During disaster:

- Securing heritage features should be a high priority during emergencies.

After disaster:

- Following a disaster, every effort should be made to ensure the retention and repair of structures of features that have suffered damage or loss.

Before/during/after disaster:

- Conservation principles should be integrated where appropriate in all phases of disaster planning, response and recovery.[6]

3.2. International frameworks to manage cultural heritage at risk

Since the first international cooperation efforts in terms of international response to disasters and conflicts in the late 19th century,[7] substantial development was achieved. Mitigation and relief were prioritized within the first strategies, while post-disaster and post-conflict reconstruction and recovery began to be considered within the strategies in the 1990s.[8] Current discourse towards international cooperation has been enhanced around common approach and importance of "build back better" (BBB) approaches in post-disaster settings, peacebuilding, culture and reconciliation in post-conflict recovery, emphasizing community involvement. [19, p. 15] Below are several current related global networks listed and described.

Current global frameworks and tools for reconstruction and recovery:

- **Joint Declaration on Post-Crisis Assessments and Recovery Planning** [20] signed by the European Commission, the United Nations, and the World Bank **in 2008**. Aim of the Document is not only to foster better synergies and provide more coordinated support to national counterpart, but also develop common approach for post-crisis assessments and recovery planning.
- **Sendai Framework for DRR 2015-2030** [21]**,** endorsed by the UN General Assembly in 2015, is a 15-year, voluntary, non-binding agreement with seven targets and four priorities for action. Document recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government, the private sector and rest of stakeholders. It aims for the following outcome: "*The substantial reduction of disaster risk and losses in lives,*

[6] Adapted from: [16]
[7] For more detailed background, see: cure framework, pp. 15 – 16.
[8] We are dealing with this topic in more detail in section 4.1.1.

livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries." [21, p. 12]

- **2030 Agenda for the Sustainable Development** "*is the first **international agenda to acknowledge the power of culture** for creating decent work and economic growth, **reducing inequalities, protecting the environment, promoting gender equality and building peaceful and inclusive societies.** The New Urban Agenda adopted in 2016 also places special emphasis on the role of culture in **building sustainable cities.**"* [22, p. 1] 2030 Agenda for Sustainable Development, within its 17 Sustainable Development Goals (SDGs), adopted by United Nations. acknowledges the integral role of culture across many of the SDGs.[9] **Culture for the 2030 Agenda** demonstrates the vast scope of culture's contribution to sustainable development. "*From cultural heritage to cultural and creative industries, from sustainable tourism to cultural institutions, culture enables and drives the social, environmental, and economic dimensions of sustainable development."* [19, p. 17]

Culture in all its forms is fundamental, cross-cutting element. Although it has been included as an important component in the above-mentioned international frameworks, it still remains to be considered within BBB approach[10] and other reconstruction and recovery frameworks.

3.3. Participatory Governance of Cultural Heritage

CH is needed to be effectively and democratically governed, therefore, next to DRM, integrated policies are essential. In the model of culture-based governance, the role of communities is crucial. It requires commitment, collaboration, and coordination between stakeholders at all levels. Preservation of the CH values and promotion the cultural and creative industries is ensured by the participation of local governments, while designing, implementing and monitoring policies.

"Acknowledging the city as a 'cultural construct' where built structures and open spaces are closely linked to the social fabric." [19, p. 9] In order to plan effectively, implement and finance reconstruction and recovery strategies, is essential to incorporate participatory approaches into the governance systems.

- Key principles concerning participatory approach are these:
- Cultures of concerned communities and as well, individuals are taken into accounts
- Involvement of communities within activities such as debris removal (provide potential cash-for-work program to support livelihoods, serve as a catalyst for economic recovery)

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[9] Quality education (SDG 4), economic growth and sustainable consumption and production patterns (SDGs 8 and 12), environmental sustainability (SDGs 14 and 15), inclusive and peaceful societies (SDG 16), gender equality (SDG 5), food security (SDG 2), and health (SDG 3). Culture is explicitly addressed in Goal 11 – 'to make cities and human settlements inclusive, safe, resilient, and sustainable' – which identifies cultural and natural heritage as essential levers for promoting sustainable development.

[10] The issue is nuanced within the SotA 2 report.

- Appropriate knowledge-sharing and capacity-building
- The participatory approach is supposed to be supported by local governments, responsible for delivering basic services. [19, pp. 4-35]

"The role of associated communities and traditional custodians in best practice conservation management planning is fundamental, to ensure social inclusion and social cohesion and a full understanding of the values of the place. Meaningful public participation is also needed to ensure the legitimacy of climate change adaptation planning and implementation. Similarly, administrators and town planners have the obligation to do good and comprehensive Conservation action plans, supporting the community and the surrounding historic urban landscape." [9, p. 18]

EU has number of initiatives that impact and support the national policies in the field of CH. Particularly relevant for the topic of CH governance is the **Council conclusion on Participatory Governance of Cultural Heritage** [23] and the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, ***Towards an integrated approach to cultural heritage for Europe***, [13] both published in 2014. First of the documents mentioned above highlights that the involvement of all interested parties in decision-making, planning, implementing, monitoring and evaluating CH policies and programmes can increase public awareness of the values that it represents, reinforce transparency and accountability in the use of public resources, and build trust between citizens and public authorities. [23]

The CUlture in city REconstruction and recovery Framework [19] is operational guidance for city reconstruction and recovery using a project cycle approach. It addresses policy-makers and practitioners and provides operational tools that integrate culture throughout all phases of the DRM cycle. In the CURE framework culture functions are considered to be the main drivers to integrate people-centred and place-based policies, which in turn are employed for socio economic recovery and physical reconstruction. The focus of this section is supported within components: 1.2, 3.2, 4.3, where participatory approach is needed. This framework is further elaborated in SotA 3, considering BBB processes across the whole framework. Phases of the CURE framework are described in table 4.

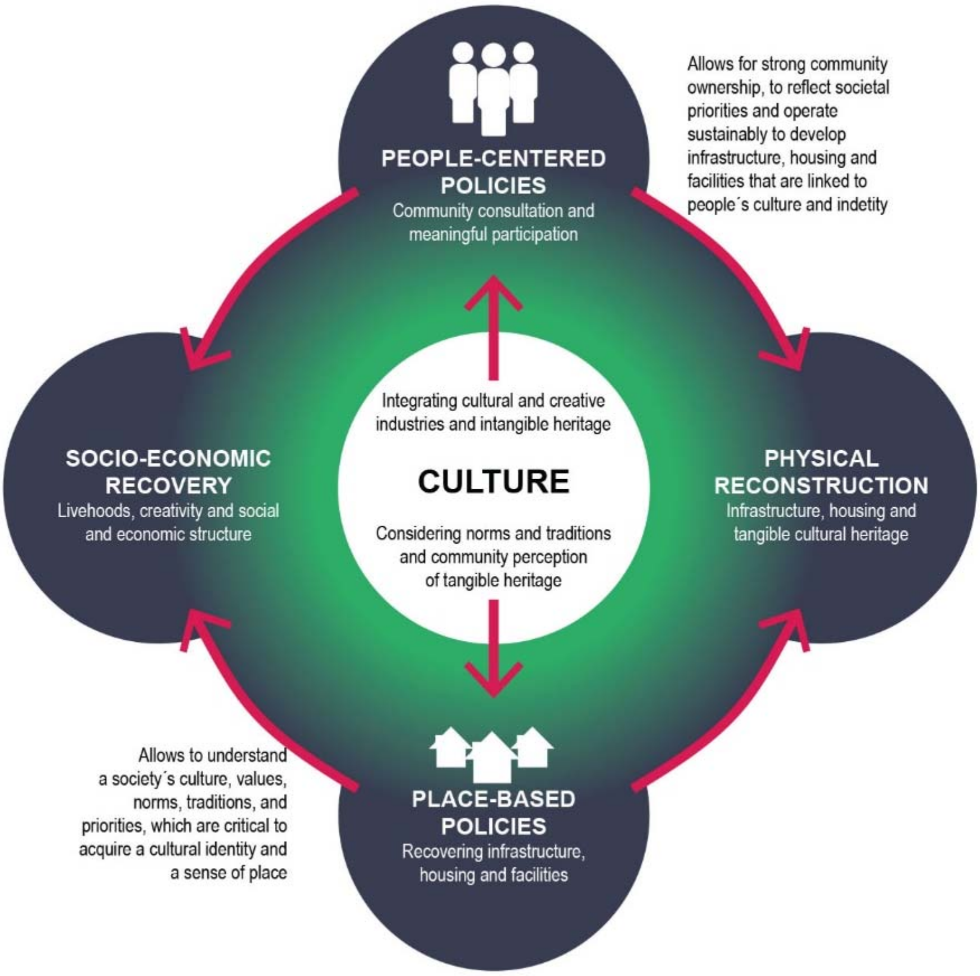

Figure 2: CUlture in City REconstruction and Recovery Framework. Adapted from: Culture in city Reconstruction and recovery: The Position Paper, Paris: UNESCO, 2018, pp. 24.

PHASE 1	Damage and Needs Assessment	Component 1.1: Tangible Cultural Heritage
		Component 1.2: Intangible Cultural Heritage
		Component 1.3: Creative and Cultural Industries
		Component 1.4: Cultural Tourism
		Component 1.5: Historic Housing Stock and Land resources
	Scoping	Component 1.6: Data Collection and Analysis
		Component 1.7: Asset Mapping
		Component 1.8: Stakeholder Mapping
		Component 1.9: Vision Development
PHASE 2	Setting Policy and Strategy	Component 2.1: Designing and Planning Process
		Component 2.2: Regulatory Mechanisms
		Component 2.3: Civic Engagement
PHASE 3	Financing	Component 3.1: Identifying Funding Resources
		Component 3.2: Management of Land Resources
		Component 3.3: Land Value Capture
		Component 3.4: Land Readjustments
		Component 3.5: City-led Financing tools
PHASE 4	Implementation	Component 4.1: Institutional Arrangements
		Component 4.2: Risk Management
		Component 4.3: Communication and Engagament Strategy

Table 4: Phases of Culture in City Reconstruction and Recovery Framework
Adapted from: Culture in city Reconstruction and recovery: The Position Paper, Paris: UNESCO, 2018, pp. 36.

4. Relevant frameworks, regulations and policies for resilient cultural heritage

When addressing the Historic Areas resilience in all the DRM Cycle we firstly need to refer to and understand the CH dominant conservation philosophy, as defined by key international frameworks, and how this is made operational at national and regional levels of governments; for what, first of all, we need to understand its evolution during the last centuries and decades.

The aim of this section is to analyse from the DRM cycle point of view the most representative documents, international standard-setting documents, regarding CH conservation; as well as national or regional policies and legislations, in order to understand how they tackle (if they do) the resilience of Historic Areas against hazards or climate change, and, to see if this perception has evolved -and how- during the last decades. A selection of the main recognized CH conservation Charts, Declarations, Recommendations and Conventions are analysed hereafter.

The international council on monuments and sites, ICOMOS, is the most representative non-government organization tackling the preservation of heritage. It develops and adopts CH **Conservation and Restoration Charters** since 1931 (Athens Charter - conference) [24], aiming to develop internationally agreed preservation and restoration principles that should be adapted to the national or local particularities by the local governments.

Some of the most representative regulations and policies for Historic Areas safeguarding are those published by UNESCO. The operational principles of such legal instruments by UNESCO are the following [25]: **Declaration,** a purely moral or political commitment, binding States on the basis of good faith. **Recommendation,** addressed to one or more States, a Recommendation is intended to encourage them to adopt a particular approach or to act in a given manner in a specific cultural sphere. In principle, a Recommendation does not create a legally binding obligation on Member States. **Convention,** synonymous with treaty, this term refers to any agreement concluded by two or more States. Such an agreement is based on the joint will of the parties upon whom the convention imposes binding legal commitments.

All the above mentioned barely tackle the Historic Areas' resilience against hazards. As part of the evolving of the CH conservation philosophy during the last centuries, DRM in Heritage Areas has also started to be assessed in the last few decades, and this has led to the main -not standard-setting- Manuals and Training Guides (underlined in this document and further analysed in ARCH's SotA 2). The aim of these documents is to include the Hazards or Risks preparedness and response in the criteria or CH sites safeguarding, as part of the "classical" heritage conservation criteria.

European Union and the Council of Europe mostly refer to the Declarations, Recommendations, Conventions and Charters by the above organizations, but also organizes its own Conventions or Treaties that develop principles, declarations or resolutions for the safeguarding of its CH.

4.1.1. Normative instruments at the International level: Declarations, Recommendations, Conventions and Charters

At an international level, key documents include:

- **The Athens Charter for the Restoration of Historic Monuments - 1931** [26]
  Adopted at the first International Congress of Architects and Technicians of Historic Monuments.

  How it addresses DRM: It does not. Related to Before disaster measures: It refers to *"strict custodial protection"*, means protection of heritage before damages occur (not hazards but damages in general). Conclusions refer to the *"Technical and moral cooperation"* of communities, states, institutions and associations. It also mentions *"The role of education in the respect of monuments".* Related to During disaster measures: It does not mention it, but in the conclusions *"It recommends that the public authorities in each country be empowered to take conservatory measures in cases of emergency".* Related to After disaster measures: It gives criteria on restoration and reconstruction (main objective of the Conference). It particularly mentions *"Modern techniques and materials"* and it refers to *"protection of areas surrounding the historic sites"*.

- **The Venice Charter. International charter for the Conservation and Restoration of Monuments and Sites – 1964** [27]
  Adopted at the second International Congress of Architects and Technicians of Historic Monuments.

  How it addresses DRM: It does not. The Venice Charter served to deepen in and detail the Heritage Conservation theory and it did, but, as the Athens Charter, in terms of disaster risk management it didn't tackle the resilience or adaptation of heritage to hazards or risks.

- **Recommendation concerning the Protection, at National Level, of the Cultural and Natural Heritage - 1972** [28]**.**
  Adopted by the UNESCO General Conference held in Paris in 1972.

  How it addresses DRM: It first mentions the need of undertaking the risks or hazards that heritage faces to.

  Before disaster: On its 23rd recommendation, that the *"Member States should investigate effective methods of affording added protection to those components of the cultural and natural heritage that are threatened by unusually serious dangers".* On it 25th recommendation it also says that *"Measures should also be taken to prevent pollution and guard against natural disasters and calamities, and to provide for the repair of damage to the cultural and natural heritage".*

  It also mentions dealing with the tourist development as a risk, noting that *"(tourism development programmes) should be carefully drawn up so as not to impair the intrinsic character and importance of that heritage"* and also *"determine the impact of visitor use"* in natural heritage sites.

- **Convention Concerning the Protection of the World Cultural and Natural Heritage - 1972** [5]
  Adopted by UNESCO in the same General Conference held in Paris in 1972. It firstly defines the climate/natural hazards that heritage faces: ***calamities and cataclysms; serious fires, earthquakes, landslides; volcanic eruptions; changes in water level, floods and tidal waves.***

  How it addresses DRM: Significantly, the Convention outlines the risks that heritage faces in its first starting consideration: "*Noting that the cultural heritage and the natural heritage are increasingly threatened with destruction not only by the traditional causes of decay, but also by changing social and economic conditions which aggravate the situation with even more formidable phenomena of damage or destruction".* In another of the basis considerations, it says *"the magnitude and gravity of the new dangers threatening them (WH), it is incumbent on the international community as a whole to participate in the protection of the cultural and natural heritage of outstanding universal value".*

  Before disaster: On its 5th article it proposes *"to develop scientific and technical studies and research and to work out such operating methods as will make the State capable of counteracting the dangers that threaten its cultural or natural heritage". This convention also established the (ongoing) "List of World Heritage in Danger"* (article 11), where it describes the sites that will be included: *"The list may include only such property forming part of the cultural and natural heritage as is threatened by serious and specific dangers, such as the threat of disappearance caused by accelerated deterioration, large-scale public or private projects or rapid urban or tourist development projects; destruction caused by changes in the use or ownership of the land; major alterations due to unknown causes; abandonment for any reason whatsoever; the outbreak or the threat of an armed conflict; calamities and cataclysms; serious fires, earthquakes, landslides; volcanic eruptions; changes in water level, floods and tidal waves".*

  When defining the Educational Programmes to be launched, it defines that *"They shall undertake to keep the public broadly informed of the dangers threatening this heritage".*

  During/After disaster: When analysing the Conditions and Arrangements for International Assistance (between State Parties), it defines that *"Requests based upon disasters or natural calamities should, by reasons of the urgent work which they may involve, be given immediate, priority consideration by the Committee, which should have a reserve fund at its disposal against such contingencies."*

- **The Declaration of Amsterdam / Amsterdam Charter – 1975** [29]
  The Congress on the European Architectural Heritage held in 1975 *(European Architectural Heritage Year)* in Amsterdam. The Committee of Ministers of the Council of Europe adopted the developed criteria in the Amsterdam Charter.

  How it addresses DRM: Unlike the 192 UNESCO Convention, it does not tackle nor mention disaster risk management in heritage sites.

- **Recommendation concerning the Safeguarding and Contemporary Role of Historic Areas - 1976** [3]
  Adopted by the UNESCO General Conference in Nairobi.

  How it addresses DRM: It focuses on *Heritage Areas* and some of the external dangers that are being exposed to, but it does not mention hazards or climate change related risks. Interestingly, it "broadens" the terms of CH Safeguarding, *"Safeguarding shall be taken to mean the identification, protection, conservation, restoration, renovation, maintenance and revitalization of historic or traditional areas and their environment."* which gives us the more holistic view of heritage conservation, and which can be seen as an initial reflection of the "before, during and after" heritage damage processes are held.

  During/After disaster: It recommends Member States that *"Public authorities should also set aside special funds for the repair of damage caused by natural disasters."*

- **The Charter of Krakow – 2000** [30]
  ICOMOS Conference on Conservation developed the principles for Conservation and Restoration of Built Heritage, the Krakow Charter, in year 2000. It first defines the conservation methods and the types of built heritage.

  How it addresses DRM: It focuses on Built Heritage conservation criteria and procedures. But, in the same time, the main difference with the other Charters is that it specifically mentions that *"As an essential part of this process* (management of dynamic changes in built heritage), ***it is necessary to identify risks, anticipate appropriate prevention systems, and create emergency plans of action"***, which can be perceived as the first mention in international Normative Instruments to identifying, prevention and the creation of emergency plans; all those elements that are actually part of the Disaster Risk Management cycle.

It seems quite evident that the drafting of this Charter was fed by the ICCROM manual called *"RISK PREPAREDNESS: A Management Manual for World Cultural Heritage"* [16] (also participated by UNESCO, ICOMOS and WHC) which was published in 1998, only two years before this Krakow Charter was approved. Although not being a Charter or Convention -not being a standard-setting document- adopted by the UN Member States or governments, it was only a well-developed manual for experts, this document that deepens in the issue should be considered for disaster risk management of Historic Areas.

Also, some years before, in 1993 and 1997 the Committee of Ministers of the Council of Europe approved two very relevant recommendations (the first documents that directly referred to disaster risk management in Heritage Sites), the *"Recommendation No. R (93) 9 on the protection of the architectural heritage against natural disasters"* and the *"Recommendation No. R (97) 2 on sustained care of the cultural heritage against physical deterioration due to pollution and other similar factors"* which will be analysed afterwards in this report.

* **Recommendation on the Historic Urban Landscape, 2011** [6]
  Adopted by UNESCO on its 35th session in Paris, November 2011.It interestingly focuses on Climate Change threats, which represents a clear change of perception on the disaster risk identification -also, slightly, the management- topic.

  How it addresses DRM: As said, it goes further with the hazards and risks identification and management for Historic Areas. Starting in the Preamble, it notes that some perceptions regarding Historic Areas, such as Climate Change, were not present when drafting the 1976 Recommendation: *"under processes of demographic shifts, global market liberalization and decentralization, as well as mass tourism, market exploitation of heritage, and climate change, conditions have changed and cities are subject to development pressures and challenges not present at the time of adoption of the most recent UNESCO recommendation on Historic Areas in 1976".* In the Introduction in also mentions *"an increasing risk of climate-related disasters".*

  Before disaster: When identifying the *Challenges* for the Historic Urban Landscapes, it underlines and describes three: *Urbanization and Globalization, Development and Environment.* It is well worth to mention how it describes the Environment related Climate Change related challenges and other hazards: *19. Human settlements have constantly adapted to climatic and environmental changes, including those resulting from disasters. However, the intensity and speed of present changes are challenging our complex urban environments. (…) 20. Changes to historic urban areas can also result from sudden disasters and armed conflicts. These may be short lived but can have lasting effects. The historic urban landscape approach may assist in managing and mitigating such impacts.*

  When considering *Tools* to be adopted for Historic Urban Landscapes, it highlights the need of planning tools to manage the changes and, also, assess the impacts of those changes: *"planning tools should (…) provide for the monitoring and management of change to improve the quality of life and of urban space. (…) Heritage, social and environmental impact assessments should be used to support and facilitate decision-making processes within a framework of sustainable development".*

  During/After disaster: It does not mention these phases, but one of the aims of the Recommendation is to facilitate decision-making processes, therefore, to be prepared to provide quick and sound responses to hazards or disasters.

In parallel to these Charters and Recommendations, particularly in the last two decades, DRM in Historic Areas has been tackled by several instruments, those which, not being standard-setting Charters, have undergone the DRM in CH sites. It is not the aim of this report to deepen in these (they have been taken into consideration in other ARCH State of the Art reports), but the following should be mentioned:

* The abovementioned ICCROM manual *"RISK PREPAREDNESS: A Management Manual for World Cultural Heritage"* (1998).
* The "*Special Thematic Session on Risk Management for Cultural Heritage"* [31] (UN World Conference on Disaster Reduction, Kobe, Japan, 2005).

- The “*Managing Disaster Risks for World Heritage”* [32] (UNESCO, ICCROM, ICOMOS and IUCN, 2010). 32

- The “*Session on Resilient Cultural Heritage”* (Sendai, Japan, 2015). [33]

- Also, some relevant publications such as the *“World Heritage: Fostering resilience”* (World Heritage n°74 - January 2015). [34]

- Finally, recently published by ICOMOS are the European Quality Principles for EU interventions (2019) with potential impact upon Cultural Heritage and tackling Risk assessment and mitigation. [35]

4.1.2. Current European Union legislation and standardization

All the previous documents are standard-setting documents, including the recommendation for the International, National and Regional governments and bodies to assure that those criteria are included in their legislation. EU itself, has, as the Charters did, also addressed the safeguarding of CH with key documents, including the following.

European Union

The **Lisbon Treaty** or **Treaty of the European Union** (TEU, 2007) [36] does *“ensure the safeguarding and development of the European Cultural Heritage”* but it delegates to the purpose made legislations. It recognises the cultural diversity of all the Member States, but notes that, the EU, as part of its core values, shall “*respect its rich cultural and linguistic diversity, and shall ensure that Europe's cultural heritage is safeguarded and enhanced”* (Article 3). The Treaty on the Functioning of the European Union (TFEU, 2007) [37] further specifies that *“The Union shall take cultural aspects into account in its action under other provisions of the Treaties, in particular in order to respect and to promote the diversity of its cultures”* (Article 167.4).

- **Recommendation of 20 December 1974 from the Commission to the Member States on the protection of the architectural and natural heritage** [38]

  Dated 1974, it refers to the “*Convention concerning the protection of the World Cultural and Natural Heritage adopted in November 1972 by UNESCO, and the European Architectural Heritage Year* (1975)*”*, both analyzed above.

- **Council conclusions of 17 June 1994 on the drawing up of a Community action plan in the field of Cultural Heritage** [39]

  It very slightly mentions *“tourism and environment”* as actions that are envisaged (those to be aware of when regarding CH conservation).

At a strategic level, the Council of the European Union adopted on 27 November 2018 the Conclusions on the **Work Plan for Culture 2019-2022** [40]**,** in which “Sustainability in CH” has been identified as one of the five priorities for European cooperation in cultural policy making [41]. Following the legacy of the European Year of Cultural Heritage in 2018, the European Commission launched a set of 60 concrete actions in the ***European Framework for Action on Cultural Heritage.*** [17]

Council of Europe

The **European Cultural Convention** (1954) had among its aims *"to promote national contributions to Europe's common cultural heritage respecting the same fundamental values and to encourage in particular the study of the languages, history and civilization of the Parties to the Convention".*

- **The Convention for the Protection of the Architectural Heritage of Europe - 1985** [42]
  It refers to the 1975 Amsterdam Charter and to the 1976 Recommendations. It only mentions *"the effects of pollution"* among the risks that architectural heritage faces.
- **The European Convention on the Protection of the Archaeological Heritage - 1992** [43]
  It mentions the need of ensuring the *"environmental impact assessment"* for the safeguarding of the archaeological Heritage Sites.

- **The European Landscape convention - 2000** [44]
  It only mentions very slightly the need of *"landscape management"* to ensure the maintenance of those facing environmental processes: *"to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and <u>environmental processes</u>".*

Between the many **Resolutions, declarations and recommendations** adopted by the Ministers responsible for CH and the Committee of Ministers, the following should be mentioned, as they directly deal with the Risk Management for CH. **These are the first (oldest) recommendations that come from the European institutions in regard of the CH management against hazards.**

- **Recommendation No. R (93) 9; on the Protection of the Architectural Heritage against natural disasters – 1993** [45]
  Although being quite outdated, it is a very interesting document. It refers (among others) to the *"Parliamentary assembly of the Council of Europe on protecting the Cultural Heritage against disasters, 1986"* and it deepens in the topic.

  It first describes the disaster risk related terminology: ***"Natural disaster"**, **"Hazard"**, **"Vulnerability"** and **"Risk"** are defined.* <u>How it addresses DRM:</u> It does address the Disaster Risk Management phases (note calling them DRM), although not comprising all (it mainly focuses on the Before Disaster tasks) and not analyzing them in depth.

  <u>Before disaster.</u> It includes a whole paragraph to *"Risk Assessment".* Another for *"Disaster prevention and mitigation strategies"* and one for the *"Legal and administrative framework for disaster protection";* therefore, it nearly covers all the *Before disaster* part of the DRM cycle (Risk Assessment, Risk prevention and mitigation and Emergency preparedness). It deepens in the issue and furthermore **it gives guidelines and also checklists for disaster prevention and mitigation strategies.** Lastly, it provides a full paragraph to the "Education and Training need" of the professionals.

During disaster. It mentions in between the *"Legal and administrative framework for disaster protection"* the need of Authorities responsible to: *"produce and maintain records, monitor disaster activity and produce protection strategies, implement salvage, recording and emergency work, provide educational and technical assistance and guidance, and plan and implement restoration projects after the disaster".*

After disaster. In the same paragraph, it mentions the need of Authorities responsible to: *"plan and implement restoration projects after the disaster"*. It also mentions contingency funds to be prepared by national and local funds: *"Adequate and quickly accessible (*economic*) resources should be established for (…) and for contingency funding in the event of a disaster".* Lastly, it mentions the restoration and recovery when speaking about the insurance of heritage assets "*it shall represent the full cost to be incurred at the time of the loss or damage, in order to repair, restore or reinstate the buildings or objects to their condition before the disaster*" but it does not deepen in particularities or recommendations for that recovery process.

- **Recommendation No. R (97) 2; on Sustained Care of the Cultural Heritage against physical deterioration due to pollution and other similar factors - 1997** [46]
  Based (between others) in the previous Recommendation, it provides two new interesting definitions; ***"Risk Analysis:** the systematic study allowing the identification and assessment of all risks which threaten the physical condition and the economic and cultural value of the heritage concerned"*, and ***"Risk Management:** characterized by the optimization of the relevant financial, technical and human resources based on thorough knowledge and skill and good coordination, with an emphasis on good communication between everyone involved".* The content itself, does not go further than the previous recommendation.

4.1.3. National and regional policies in ARCH pilot cases' countries

As previously mentioned, most of the recommendations and charts adopted by UNESCO, ICOMOS, ICOM, ICCROM or the EU itself, usually recommend each of the Member States to take into account what is being exposed to develop their own guidance and regulations, therefore, national legislations are the ones that define the legal conservation and restoration procedures for CH ant its management in Europe (meaning, EU frameworks are not legally binding, while national legislations are). Maybe, it's worthwhile pointing at European projects at the national level, such as PROCULTHER (Protecting CH from the Consequences of Disasters), co-funded by DG ECHO (Directorate-General for European Civil Protection and Humanitarian Aid Operations of the European Commission). The project aims at developing a common European methodology along with standard operating procedures for protecting CH during emergencies; promoting the development of preparedness arrangements in this sector in a number of UCPM participating States; creating a multi-national, multi-stakeholder and multi-sectoral asset able to provide guidance to interested States for developing preparedness measures for the protection of CH during emergencies and to intervene globally, in case of international emergency, to support national response efforts of affected countries in this sector.

The international legislation is relatively flexible with the States when it comes to developing domestic CH policies in the way that is most compatible with their own traditions and policy practices.[11] In many Western countries, the public sector has traditionally been the central actor in heritage management, particularly in Europe. [47, p. 39] However, the socio-political context and distribution of power in each country may vary, resulting in different responsible authorities from one system to another. Usually, in Europe certain countries have more a centralised system (Italy), others are highly decentralised (Germany).

Following, the legal instruments that refer to CH conservation and management in the four countries in which ARCH project has pilot cities, and a short analysis of how they handle the hazards and disaster risk management.

Slovakia (pilot *city* of Bratislava)

In addition to main legal framework concerning monuments protection, described above, several strategic and conceptual documents were developed by the Government of Slovak Republic:

- **Declaration of the National Council of Slovak Republic on protection of cultural heritage** from 28. 2. 2001, resolution no. 91/2001 Coll.
- **Conception of protection of monuments**, resolution of Government of Slovak Republic no. 813/2011, update: no. 411/2013 and no.189/2015
- **Strategy of protection of monuments for years 2017 – 2022,** resolution of Government of Slovak Republic no. 588 from 13.12. 2017.

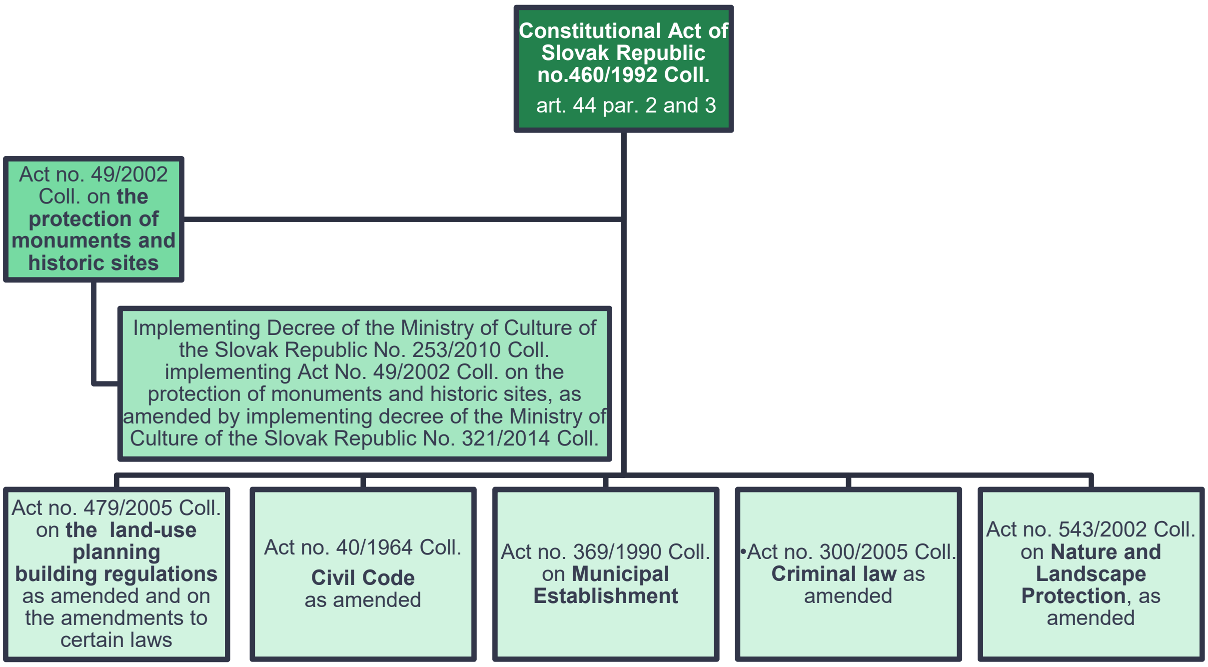

Figure 3: Protection of cultural heritage in Slovakia – main legal framework

[11] For example, the Faro Convention Explanatory report, section C, stated that "*There will often be alternative means of achieving the objectives, and it is open to Parties to choose the route most suited to their own national traditions of law, policy and practice, always taking into account the need to ensure that their own approaches are consistent with those of neighbouring States and other Parties*". Available at: https://rm.coe.int/16800d3814

How it addresses DRM: Slovak law, concerning CH does not address DRM. Even though, documents **“The concept of protection of monuments”** and **“Strategy of protection of monuments for years 2017 – 2022“,** both define the impact of climate changes on cultural monuments, they do not set any further steps nor methodology or principles to handle the negative impacts of climate change.[12]

The city of Bratislava mainly follows its Land – use plan, that does not address DRM directly. A new analytical document (Atlas) which focuses on the impacts of climate change related risks has been recently developed and will be put into practice soon, but it does not focus specifically on impacts on CH. As an administrator/owner of heritage environment, the City is required to abide to legislative framework mentioned above. Bratislava is the only city in Slovakia, with its own expert authority in this field - Municipal Monuments Preservation Institute, which however lacks the competences of the state administration. The Institute, in the role of the municipality, acts as a mediator between stakeholders of state administration, concerning the topics of CH preservation, issues partial statements for building permits and investment activities and is an advisory organisation to the city in this field.

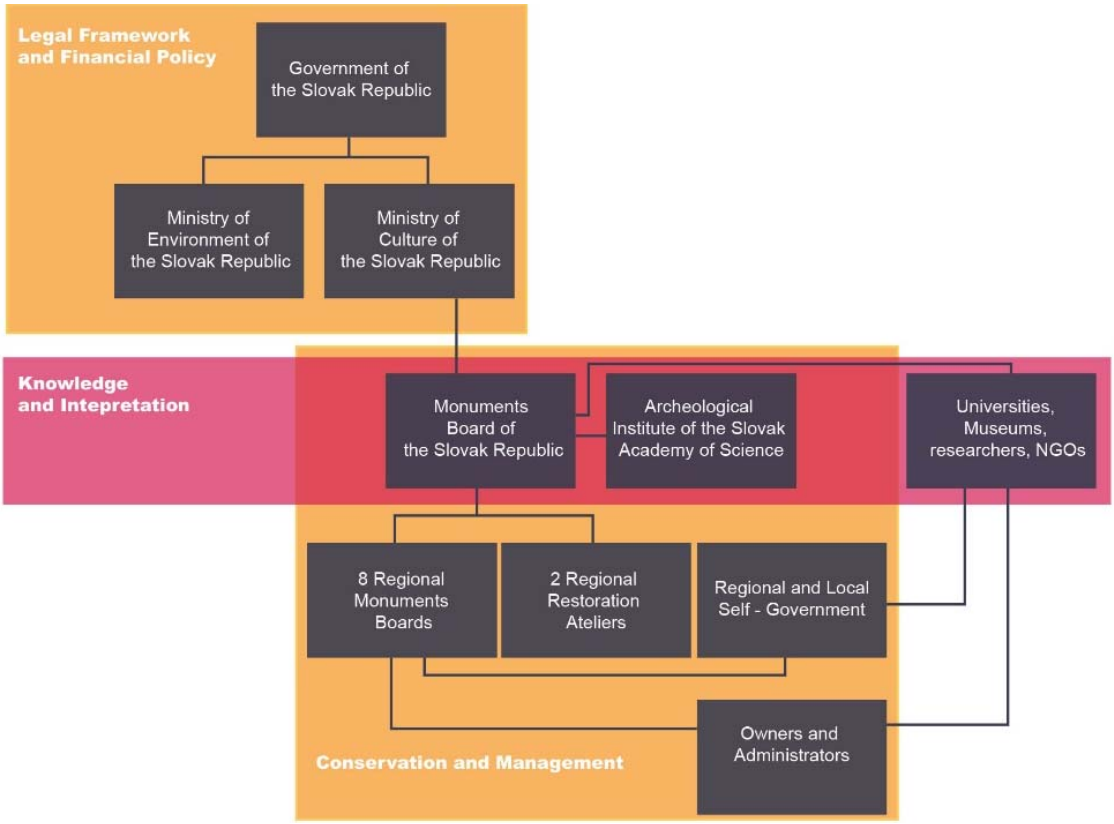

Figure 4: Institutional framework regarding cultural heritage in Slovakia. Adapted from: https://www.coe.int/en/web/herein-system/slovak-republic#Legal

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[12] The only document, defining processes in case of crisis is “Methodological instruction of Ministry of Culture of Slovak Republic on the protection of national cultural monuments in case of extreme situations” no. MK - 3010/2008-10/11546 from 21.8. 2008. However this document is rather recommendatory and concerns only movable pieces of cultural heritage.

Germany (pilot city of Hamburg)

In conformity with the jurisdictional and legislative requirements, both the Federal and the sixteen States governments of Germany are responsible for management of CH. In accordance with the division of competences between the Federation and the Länder (Federal States), the Länder are responsible for the preservation of monuments. For this reason, the structure and forms of the CH's organization and the authorities in charge of the preservation of monuments differ from one state to another. The Länder are responsible for both adopting laws and, in their capacity as the highest heritage preservation authorities (alongside the districts, municipalities and in some cases the administrative regions) – for implementing them. A Länder Ministry (or Senate's department) is the highest authority in charge of the heritage's preservation within the Länder is a designated Ministry (or Senate's department). In each case, the Land's laws on heritage preservation provide from Regional Office for the Preservation of Monuments. Its role is to advise the subordinate authorities (municipalities, districts, towns not belonging to rural districts) as well as the owners of monuments and represent conservation interests in public planning and building projects.

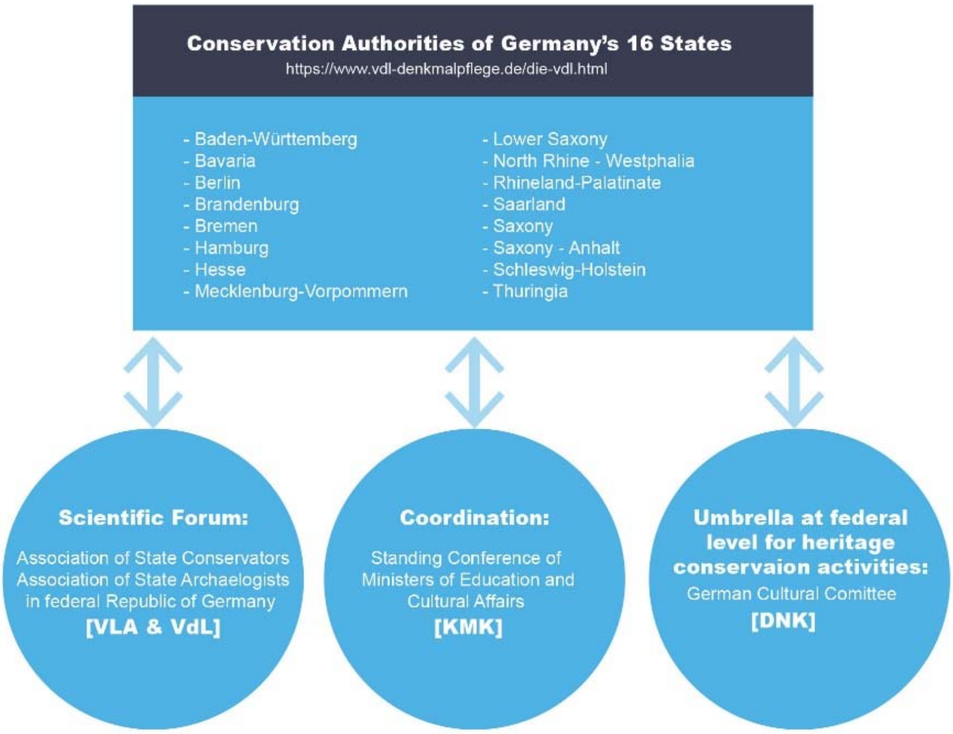

Figure 5: Institutional framework regarding cultural heritage in Germany

The lowest authorities in charge of the heritage preservation (districts, municipalities) generally implement protection and preservation's measures. In some instances, smaller Länder - such as Saarland or city-states such as Berlin, **Hamburg** and Bremen - link the different administrative authorities and levels mentioned above. In Hamburg only one administrative level exits that deals with all instances of heritage preservation. The strategic decisions and legal provisions are taken by the same administrative unit that issues locally permissions as well as implementing protection and preservation measures, risk management and tax certificates. The same unit runs as well restoration workshops and surveys the safeguarding of the World Heritage site. Archaeological heritage is dealt with by the archaeological museum of Hamburg.

How it addresses the DRM: The city of Hamburg as a Land has units in the Ministry of Interior and Sport, that are dealing with the DRM issues [48] and prevention plans. [49] Those are able to give a good overview on what is flooded, which features “main risk” in Hamburg as a “coastal city.” [50] In terms of built heritage, Ministry of town development and housing and the Bezirk Mitte (local administration) are dealing with flooding risk and DRM in the area (particularly for the Speicherstadt and Kontorhaus District, that are emphasised in the ARCH project).

Spain (pilot city of Valencia)

CH conservation in Spain is regulated by national **Law 16/1985 on the Spanish Historical Heritage** [51]. The national law is responsible for defining the CH sites that must be inventoried and/or registered as a “BIC” (*Bien de Interés Cultural* – Property of Cultural Interest), the main listing body for heritage sites in the country. The Autonomous Communities have the responsibility to establish the additional levels of protections under their own laws. Lastly, there is a public institution called Cultural Heritage Institute of Spain (IPCE), a General Subdirectorate attached to the General Directorate of Fine Arts and Cultural Heritage of the Ministry of Education, Culture and Sport. Its mission is the research, conservation and restoration of the properties that make up the CH.

How it addresses the DRM: The Spanish Historical Heritage law does not address the disaster risk management. It focuses on the inventory and register of goods but does not deepen in the procedures for heritage conservation or restoration, it neither does on disasters that heritage faces out.

In the **Autonomous Community of Valencia**, the ruling law is the **Law 4/1998**, which does not refer to disaster risks or its management.

Italy (pilot city of Camerino)

Responsibility for CH in Italy is situated on Ministry for Heritage and Cultural Activities (MIBACT). Four levels of government (State, Regions, Provinces and Municipalities) share responsibilities in the cultural field, according to Italian Constitution. Heritage protection is listed among the cultural responsibilities to be retained by the State, with few exceptions listed in art.5 of **Cultural Heritage and LandscapeCode (Legislative Decree n. 42, issued 22nd January 2004)**. Regions, Municipalities, Metropolitan Areas and Provinces, shall cooperate with the Ministry in performing its protection tasks. [52, pp. 3-5] The Ministry, through its peripheral offices, called *Soprintendenze*, assures the surveillance and the inspecting operations on the CH. Recently, the Ministry re-organised its peripheral offices. Thanks to this reform, the Local Offices of the Ministry, were unified in unique offices that have in charge competences on all the kinds of goods that form the CH but are more disseminated on the territory. In any case, the Ministry can delegate the operations on the CH and the management of Monuments and Museums to other Public Institutes or to private associations, providing that they assure to follow the guidelines and prescriptions issued by the local competent

Soprintedenza. [53, pp. 9-10]. In 2008, by the Law n° 63 26/03/2008, the system of responsibility for landscape protection has been balanced by giving responsibility back to the State, in cooperation with regional authorities [52, p. 5]. In 2010 the Marche Region developed an own law for CH: regional law n° 4 09/02/2010. The law has the objective of disciplining assets and activities about CH according the articles: 117 and 118 of the Italian Constitution and in compliance with the legislative decree n° 42 22/01/2004. With this law the Marche Region has the task of carrying out actions to protect of CH, according to the Code of Cultural Heritage and Landscape, to support and promote the conservation of the CH by restoration, prevention and recovery actions.

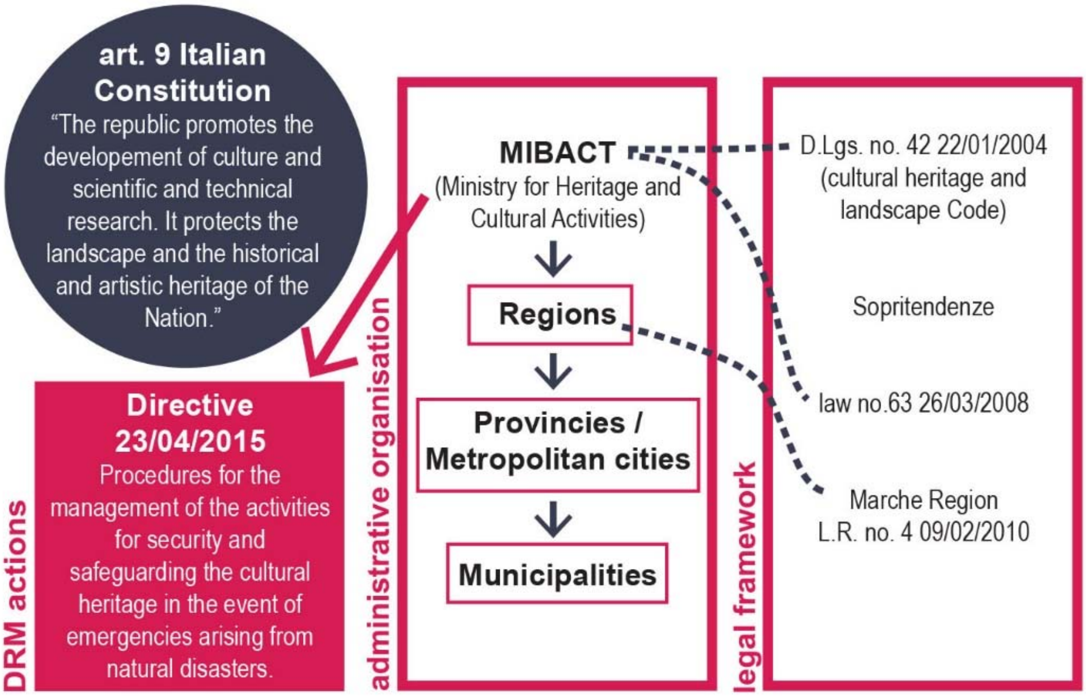

Figure 6: Institutional and legal framework regarding cultural heritage in Italy

How it addresses the DRM: According to **Cultural Heritage and Landscape Code**, MIBACT developed a specific directive in order to manage securing and rescue activities of CH in case of disasters. [54]

The city of Camerino doesn't have specific plans, programmes or guidelines about Disaster Risk Management. The management of post phases of disaster events is mainly entrusted to Protezione Civile (a public institution with the aim to protect life of people, and the integrity of buildings, infrastructures' and environment) with which all the municipalities, provinces and regions collaborate. Starting from the dramatic earthquake in 2016, the municipality of Camerino, driven by the need to manage and control the reconstruction of buildings into its territory, has started to use digital technologies, like GIS Systems, that can be considered a partial and preliminary step to develop and share a disaster risk management.

5. ARCH project issues and connections

The content of report was scoped mainly within relatively common conservational topics, while analysing towards to implementation of DRM methodologies in conservational practice, current valid legislation and management of CH. Although the issues of CC and its impact on CH became widely discussed topic in the current scholarly debate, cross – sectional overview showed, that the gap between theory and practice (legislation, governance, management tools) need yet to be filled. That was quite clearly proven by our analysis, discussed below (except for several exceptions).

Intention was to introduce the subject of typology of historic areas, the very subject of ARCH project, as reflected in the acknowledged international documents. Then to highlight nuances within the definitions and frameworks. One of the aims of the report was also to introduce and discuss several conservationist principles regarding the topic, related to the subject of ARCH. Issues of authenticity, integrity or heritage values, in terms of both tangible and intangible heritage, are not biases nor obstacles but rather fundamental principles and need to be considered within the ARCH. Following discussion on the topic of managing CH in the CC era, while respecting those principles, might be of interesting outcome (not only) within the consortium. On the other hand it should be mentioned, that conservational practice itself, might have to overcome several biases or theoretical constructs in order to link DRM cycle and CH management more effectively (e.g. towards to consideration of BBB approaches).

Throughout the report, we dedicated relatively lot of attention to examine current regulations and policies. DRM methodologies in legislative frameworks are being reflected rather recently (in several charters, recommendations and documents developed by Council of the Europe and European Commission). By the analysis we noticed almost absence of implementation of DRM policies regarding ARCH pilot cities. The ARCH project should make an attempt to search for the ways of implementation of DRM principles into existing legal frameworks of pilot cities. Especially, when length of these processes is taken into consideration. One of the ways, might be represented within the participatory governance frameworks or by bringing CH management into DRM cycle. The DRM cycle methodologies should be not only decision makers oriented, but also towards communities and individuals, that can become a part of recovery processes of (their) CH (e.g. CURE framework). However, the objectives mentioned above, should not be achieved outside of abiding of fundamental principles connected to protection of historic areas as bearers of immense cultural values.

Tendencies, that originated from international dialogue, highlighting the importance of culture in the sustainable development (Culture for the 2030 Agenda) are needed to be adopted by practice, communities, heritage practitioners, decision makers etc. Culture should be considered as an essential component in almost every framework, regarding both DRM and CH management. One of the biggest challenges of the ARCH will be to adopt these principles, combine, enhance and apply them in order to safeguard CH of historic areas.

6. Conclusion

Historic areas currently represent the most tangible evidence of the wealth and diversity of cultural, religious and social activities. Their safeguarding and integration into the life of contemporary society is a basic factor in town-planning and land development. CCs has become one of the most significant and fastest growing threats to people and their CH worldwide. In order to save these assets from the dangers of deterioration or even total destruction, there is global need to develop professional competencies, (also transmission of traditional skills and knowledge) policies, regulations and laws that allow clearer engagement between climate action and the heritage sector and to underpin these with tools that ensure accountability. The multiple and interconnecting layers of CC impacts must become a baseline competency of heritage management, as are sustainable development principles. Although negative impacts of climate-related and other hazards on these areas, are widely acknowledged and discussed, implementation of DRM cycle and CH management into praxis does not genuinely reflect the state of current debate.

The idea of CH must be acted upon in its broadest sense, when defining relations between CH, CC adaptation and resilience, culture and place are (often) closely tied. Best conservation practice recognises the deep relationship between tangible and intangible CH, and that for intangible heritage places, the traditional custodians and associated communities must be involved. CH is both impacted by CC and a source of resilience for communities. The importance is to understand those dynamics in order to safeguard our planet and its heritage amidst a changing climate.

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8. Annex

8.1. Glossary of specialist terms

Term	Explanation	Source
Heritage asset	single buildings, structures, artefacts as well as whole historic areas	[3]
Conservation-restoration	Actions and activities focused on safeguarding of (tangible) cultural heritage, respecting its significance, including providing it for present and future generations. Conservation and restoration also consist of terms: preventive restoration, remedial restoration, restoration.	[1]
Historic area/city	“Historic and architectural (including vernacular) areas” shall be taken to mean any groups of buildings, structures and open spaces including archaeological and palaeontological sites, constituting human settlements in an urban or rural environment, the cohesion and value of which, from the archaeological, architectural, prehistoric, historic, aesthetic or sociocultural point of view are recognized. Among these “areas”, which are very varied in nature, it is possible to distinguish the following “in particular: prehistoric sites, historic towns, old urban quarters, villages and hamlets as well as homogeneous monumental groups, it is being understood that the latter should as a rule be carefully preserved unchanged.	[3]
Historic urban area	large and small, include cities, towns and historic centres or quarters, together with their natural and human-made environments. Beyond their role as historical documents, these areas embody the values of traditional urban cultures.	[4]
Urban heritage	three main categories: - Monumental heritage of exceptional cultural value; - Non-exceptional heritage elements but present in a coherent way with a relative abundance; - New urban elements to be considered (for instance): The urban built form; The open space (streets, public open spaces), Urban infrastructures (material networks and mechanism).	[7]
Heritage by designation	all cultural objects that are listed, institutionalised and labelled by experts.	[7]

Heritage by appropriation	the social, or ethnologic heritage that includes landscapes, townscapes, living places and non-exceptional building ensembles.	[7]
Urban conservation	Urban conservation is not limited to the preservation of single buildings. It views architecture as but one element of the overall urban setting, making it a complex and multifaceted discipline. By definition, then, urban conservation lies at the very heart of urban planning.	[6]
Landscape approach	The landscape approach is a framework for making landscape-level conservation decisions. The landscape approach helps to reach decisions about the advisability of particular interventions (such as a new road or plantation), and to facilitate the planning, negotiation and implementation of activities across a whole landscape.	[6]
Historic urban landscape	This wider context includes notably the site's topography, geomorphology, hydrology and natural features, its built environment, both historic and contemporary, its infrastructures above and below ground, its open spaces and gardens, its land use patterns and spatial organization, perceptions and visual relationships, as well as all other elements of the urban structure. It also includes social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity.	[6]
Historic urban landscape approach	Is aimed at preserving the quality of the human environment, enhancing the productive and sustainable use of urban spaces, while recognizing their dynamic character, and promoting social and functional diversity. It integrates the goals of urban heritage conservation and those of social and economic development. It is rooted in a balanced and sustainable relationship between the urban and natural environment, between the needs of present and future generations and the legacy from the past.	[6]
Heritage site	Works of human or the combined works of nature and human, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.	[5]
Significance	Articulation of heritage values	[1]
Cultural Significance	Means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in	[10]

	the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups.	
Heritage values	Can be defined as the relative social attribution of qualities to things, therefore is depending on society and can change over time. Certain values can be related more specifically to the intrinsic aspects of the monument or site (design, material, and workmanship), while other values can be associated with its location and its relationship to the setting.	[11]
Authenticity	Heritage asset that is materially original or genuine as it was constructed and as it has aged and weathered in time.	[15]
Integrity	This term generally refers to the material completeness and sound condition of an object or site.	[11]
Historical integrity	Term relates to the current form of a heritage asset as a result of growth and changes over time.	[11]

8.2. Key resources

ICOMOS Climate Change and Cultural Heritage Working Group. 2019. The Future of Our Pasts: Engaging Cultural Heritage in Climate Action. Paris: ICOMOS, July 1, 2019. [Online].

Available on: https://indd.adobe.com/view/a9a551e3-3b23-4127-99fd-a7a80d91a29e

- Concerns cultural heritage in the era of climate change

STOVEL, Herb. *Risk Preparedness: A Management Manual for Cultural Heritage*. Rome: ICCROM, 1998. [Online].

Available on: http://icorp.icomos.org/wp-content/uploads/2017/10/ICCROM_17_RiskPreparedness_en.pdf

- Concerns management of cultural heritage in the context of risk preparedness linked to non-climate related hazards

UNESCO, The World Bank. *Culture in city Reconstruction and Recovery: The Position Paper*, Paris: UNESCO, 2018. [Online]. https://www.preventionweb.net/files/61959_131856wprevisediipublic.pdf

- Describes CURE framework and how to integrate communities and culture within the recovery of cities.

The world bank. *Guide to Developing Disaster Recovery Frameworks.* 2015. Available on: https://www.gfdrr.org/sites/default/files/publication/DRF-Guide.pdf

- Provides insight into to Disaster Recovery Frameworks

UNESCO, ICCROM, ICOMOS, IUCN, *Managing Disaster Risks for World Heritage*, 2010. [Online]. Available on: https://whc.unesco.org/en/managing-disaster-risks/

- Deals with the DRM in Cultural Heritage sites

ARCH

ARCH State-of-the-Art Report 2

Disaster risk management, emergency protocols, and post-disaster response

Deliverable No.	D7.1
Author(s)	Maddalen Mendizabal (Tecnalia), Saioa Zorita (Tecnalia), Massimo Musacchio (INGV), Antonio Costanzo (INGV)
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Table of Contents

List of Abbreviations

Abbreviation	Meaning
CH	Cultural Heritage
CPM	Civil Protection Mechanism
DMP	Data Management Plan
DoA	Description of Action
DRM	Disaster risk management
DRR	Disaster risk reduction
EC	European Commission
EC	European Commission
EEA	European Environment Agency
EISAC	European Infrastructure Simulation and Analysis Centre
ERCC	Emergency Response Coordination Center
EU	European Union
FAIR	Findable, Accessible, Interoperable, Re-usable
FP7	Seventh framework programme
H2020	Horizon 2020
HW	Hardware
ICOMOS	International Council on Monuments and Sites
IES	Institute for Environment and Sustainability
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
LiDAR	Light Detection and Ranging
MIBACT	Italian Ministry of the Cultural Heritage and Activities and the Tourism
NAS	Network-Attached Storage
NFC	National Fire Corps
RUSN	Real-time Urban Seismic Network
SEED	Standard for the Exchange of Earthquake Data
SotA	State of the Art Report
SW	Software
UAV	Unmanned Aerial Vehicle

UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
WP	Work Package

Executive Summary

Disaster risk reduction and climate change adaptation for historic areas need advanced methods and tools due to the increasing vulnerability of historic areas to hazards.

The present report focuses on strategies for disaster risk management and disaster risk reduction, with special emphases on climate change and natural hazards' effects on Heritage. In addition, examples of case studies that can represent good practices are also included and an overview of current debates and knowledge gaps which will aid the technical development work of the ARCH project.

The aim of this report is to support the development of ARCH WP4 (Hazard and Object Information management system), WP5 (Impact and Risk Assessment) and WP6 (Resilience options and Pathway) mainly.

Disaster risk management is the key topic covered in this report but with the focus on Heritage and considering the climate change, as this will impact on World Heritage conservation directly and indirectly. Therefore, there exists an overlap between disaster risk management and climate change, which we will address by integrating a climate change perspective into disaster risk reduction strategies and by including DRM related actions into climate change adaptation plans as a way to increase the climatic resilience of urban historic areas.

The present report describes briefly the three stages of the disaster risk management actions: before (pre-disaster), during (emergency response), and after (recovery) based on the time of disaster occurrence.

1. Introduction

While negative impacts of climate-related and other hazards on urban areas are widely discussed, their impacts on historic areas have not been studied extensively enough. Disaster risk reduction (DRR) and climate change adaptation (CCA) for historic areas, with their unique structure, composition, and set of regulations, call for advanced methods, and tools, either re-used from other domains or custom-developed, as well as the promotion of relevant public policies and participatory governance processes, including residents from local communities and the general public [1]. In addition, according to the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) DRR does not register as a priority area for management of World Heritage property, despite the increasing vulnerability of historic areas to hazards. Furthermore, historic areas are deeply embedded in larger urban and rural environments, providing important cultural, social, environmental, and economic functions, while relying on infrastructure services from these environments to keep functioning [2]. Therefore, there is a need to increase knowledge of climate change impacts and disaster risk management (DRM) on historic areas.

This State-of-the-Art (SotA) report focuses on strategies on DRM and DRR, with special emphases on climate change and natural hazards effects on Heritage. Apart from presenting the framework, the methods and strategies followed for pre-disaster and post-disaster are also presented, together with examples of case studies that can represent good practices (included in Annexes and referenced in the report). In addition, an overview of current debates and knowledge gaps are also presented in the report which will help the development of the ARCH project.

1.1. Background information and aim of this report

The present report aims to provide the ARCH consortium with details on relevant developments related of DRM and climate adaptation in heritage. It has the objective of supporting the technical development of ARCH WP4 (Hazard and Object Information management system), WP5 (Impact and Risk Assessment) and WP6 (Resilience options and Pathway) mainly. In addition, the aim of the report is to serve as a basis and ensure a clear and consistent application of concepts and terms related to DRM and climate adaptation in heritage.

1.2. Relation to other SotA reports and deliverables

This report is close to the other SotA 1 “Historic areas, conservation practices, and relevant regulations / policies” which refers to more DRR measures than those considered in this report and in addition it includes the regulation and policies; to SotA 3 “Building back better”, which goes in deep on post-disaster measures and highlighting the need of resilience; and to SotA 4 “Decision support frameworks and technologies” which inspires the future works on decision support systems.

1.3. Structure of this report

This document includes a section 2 with definitions of the key concepts and specialist terms. Section 3 covers the key topics and issues related to DRM and climate adaptation in Heritage which is based on the literature review. Building on the findings of the state-of-the-art review, the section 4 identifies the most important issues for consideration within the ARCH project. Section 5 includes the main conclusions of the report.

In addition, the annex of this report contains examples of case studies that can represent good practices.

2. Definitions

This section provides definitions of the key concepts and specialist terms covered in the report, focusing only on the most significant ones. The most appropriate definitions related to this SotA for use within the ARCH project are proposed in the following table.

Term		Definition	Source
1	**Adaptation**	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects	[3]
2	**Build back better**	The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment.	[4]
3	**Emergency preparedness**	The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.	[4]
4	**Emergency response**	Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.	[4]
5	**Mitigation**	The lessening or minimizing of the adverse impacts of a hazardous event.	[4]
6	**Recovery**	The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and “build back better”, to avoid or reduce future disaster risk.	[4]
7	**Rehabilitation**	The restoration of basic services and facilities for the functioning of a community or a society affected by a disaster.	[4]

Table 1: Definitions of the key concepts.

3. Key topics and issues

Based on a literature review, the state of the art on strategies and methods used in DRM and climate adaptation in Heritage are presented in this section. The key themes emerging from the literature on this topic, an overview of important debates and an identification of gaps in the knowledge base is presented in the following lines.

Literature review methodology

Principally, the literature review focused on issues linked to the following themes:

- Policies and Strategies on DRM and DRR
- Climate change and its effect on World Heritage
- Intersection between DRM and climate change
- Pre-disaster strategies
- Post-disaster strategies

A keyword search was performed in the search engines Google Scholar and Science Direct tools using the English key topic terms. Science Direct was selected as it is a powerful, current, comprehensive and widely used search engine available for analysis of interdisciplinary, peer-reviewed literature. Google Scholar was selected as it includes most peer-reviewed online journals of Europe and America's largest scholarly publishers, plus scholarly books and other non-peer reviewed journals and documents.

The final review consisted of academic and scientific papers, reports and books and represented a total of 38 documents that assess DRM and climate adaptation in Heritage.

3.1. Disaster risk management

According to United Nations "Disaster Risk Management (DRM) is the application of disaster risk reduction policies and strategies, to prevent new disaster risks, reduce existing disaster risks, and manage residual risks, contributing to the strengthening of resilience and reduction of losses". Disaster risk management actions can be grouped into three stages (before, during and after) based on the time of disaster occurrence as shown in Figure 1.

The main activities before a disaster include risk assessment, conservation or prevention, and mitigation methods and warning systems for specific hazards. Emergency response actions are designed to manage, control, or mitigate the immediate effects of an incident. These are normally reflected in an Emergency Action Plan. Actions initiated after the disaster cover damage assessment, treatment of damaged components through interventions to repair, restore and retrofit and recovery or rehabilitation activities. This stage can also serve as an effectiveness assessment of the previous stages to identified potential future improvements within the DRM steps. However, DRM cycle also needs the inputs from knowledge building of the social, environmental and economical context and stakeholder engagement to build an adequate DRM framework.

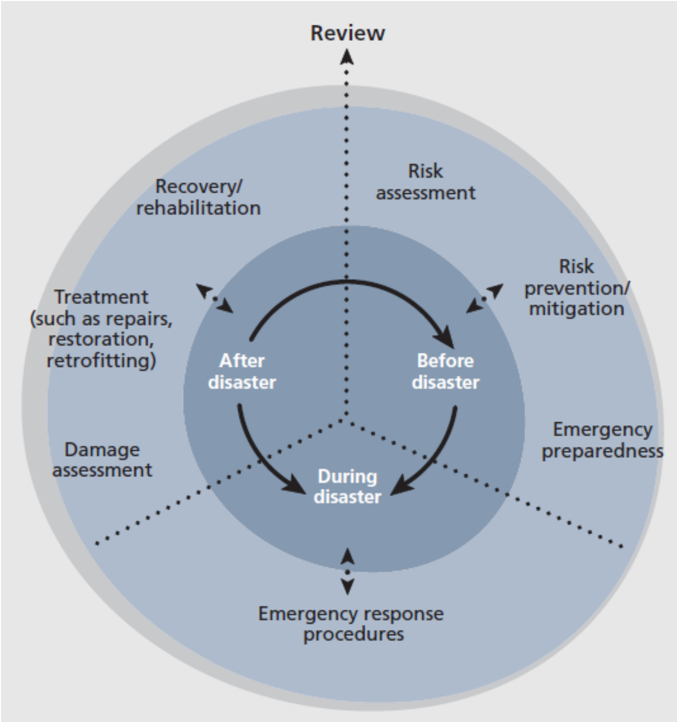

Figure 1: Disaster Risk Management cycle scheme

In the literature examples of good practices in DRM can be found. Albania elaborated a risk assessment of natural hazards and guidelines for the risk reduction of Cultural Heritage. Thailand promoted several risk prevention/mitigation projects at regional level to prevent flood risks. Italy conducted a training of stakeholders through simulation exercises to elaborate, test and improve the operational, procedural and methodological aspects of territorial and sector planning to reduce volcanoes activities consequences in cultural heritage. In the Danube, a network of existing and new protected areas are being developed to help the restoration and protection of the floodplain. More information regarding these examples is included in Annexes in the report.

3.1.1. Policies and Strategies on DRM and DRR

In 1994, a UN World Conference on Disaster Risk Reduction (DRR) was convened to discuss how to tackle the growing frequency and severity of natural disasters. The focus was on developing effective measures around preparation, response and mitigation of disasters.

In 2000, the United Nations International Strategy for Disaster Reduction (UNISDR) was launched and five years later the **Hyogo Framework for Action** [5], the main UN-wide policy on the subject of Disaster Reduction existing at the time of its conception (2005-2015), was presented. The Strategy for Risk Reduction at World Heritage Properties was presented and approved by the World Heritage Committee in 2007. Its priority actions, listed below, were structured around the five main objectives defined by the Hyogo Framework for Action. Hyogo´s five priority actions are summarized hereafter.

- Ensure that disaster risk reduction (DRR) is a national and a local priority with a strong institutional basis for implementation.
- Identify, assess and monitor disaster risks and enhance early warning.

- Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- Reduce the underlying risk factors.
- Strengthen disaster preparedness for effective response at all levels.

Later on, in 2015, the **Sendai Framework** [6] for action 2015-2030 was adopted which is based on 4 priorities:

- **Understanding disaster risk:** “Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment.”
- **Strengthening disaster risk governance to manage disaster risk: “**Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk.”
- **Investing in disaster risk reduction for resilience: “**Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation.”
- **Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and construction: “**Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases.”

At EU level, a framework for EU cooperation on disaster prevention across all types of natural and man-made hazards was agreed on in 2009. Risk assessment together with risk analysis are the pillars of this prevention framework which are fundamental for a successful disaster management strategy. Two years later the EU undertook a work to identify the risks the EU may face in the future based on national risk assessments [7]. This overview focuses primarily on risks that may have cross-border impacts and/or those larger scale impacts that may be experienced by more than one Member State.

3.1.2. Climate change and its effect on World Heritage

In the last century the increase of greenhouse gases in the atmosphere is leading to a change in our climate and, thus, in our environment. The primary consequence of this climate change is the increase of the global average atmospheric surface and sea temperature, which implies an impact on the current climatic equilibrium of the planet. This will result in modifications of e.g. precipitation patterns, droughts, sea-level rise, ocean acidification, storminess etc. Such changes will impact on World Heritage conservation directly [8] and indirectly [9]. While cultural heritage sites may be more threatened by occasional disaster events, natural heritage sites will be jeopardised by the gradual climate change and the extreme natural events.

World Natural Heritage sites such as tropical coral reefs are threatened by an increased ocean temperature and acidification, which may lead to their massive extinction. On the other hand, the increase of atmospheric temperature poses a threat to glaciers worldwide (in both mountainous and polar regions), which are melting. Another example of foreseen impact is the affection of terrestrial biodiversity from diverse factors as migration of pets and invasive species, changes in the timing of biological cycles or the frequency and intensity of wildfires.

World Heritage cultural sites are also exposed to this threat. Rising sea levels threaten many coastal sites and thus, costal cultural heritage sites. Furthermore, the conditions for conservation of archaeological monuments evidence increase degradation in the context of soil properties variations, desertification, flooding etc. But aside from these physical threats, climate change will likely impact on social and cultural aspects. Communities may change their ability to earn a living due to socio-economic transformations of the areas as well as the way they live and socialize in buildings, sites and landscapes, which can ultimately result in the heritage abandonment due to heritage loss or migration.

Conservation of heritage sites, which can be seen as adaptation measures to prevent the impacts of climate change, is likewise a fundamental action from DRR view (risk prevention/mitigation). However, a perspective to climate change should be included in the management plans of heritage sites to ensure their sustainable conservation. In this context it is important the vulnerability assessments to determine the climate change impacts on cultural and natural heritage. This will allow a better understanding on the risks link to each site and consequently better decision-making and planning. Another relevant value in conservation of heritage is the knowledge and effective lessons learnt (e.g. improving anti-flooding systems like in Venice) exchange, that will improve climatic resilience.

3.1.3. Intersection between DRM and climate change

Natural disasters have been part of human life since ancient history, however the relative recent evidence of climate change and their probable impacts have naturally interwoven disaster risk reduction and adaptation to climate change communities and work (Figure 2). This has led to the integration of climate change perspective into DRR strategies. At the same time DRM related actions are often considered in climate change adaptation plans as a way to increase climate resilience.

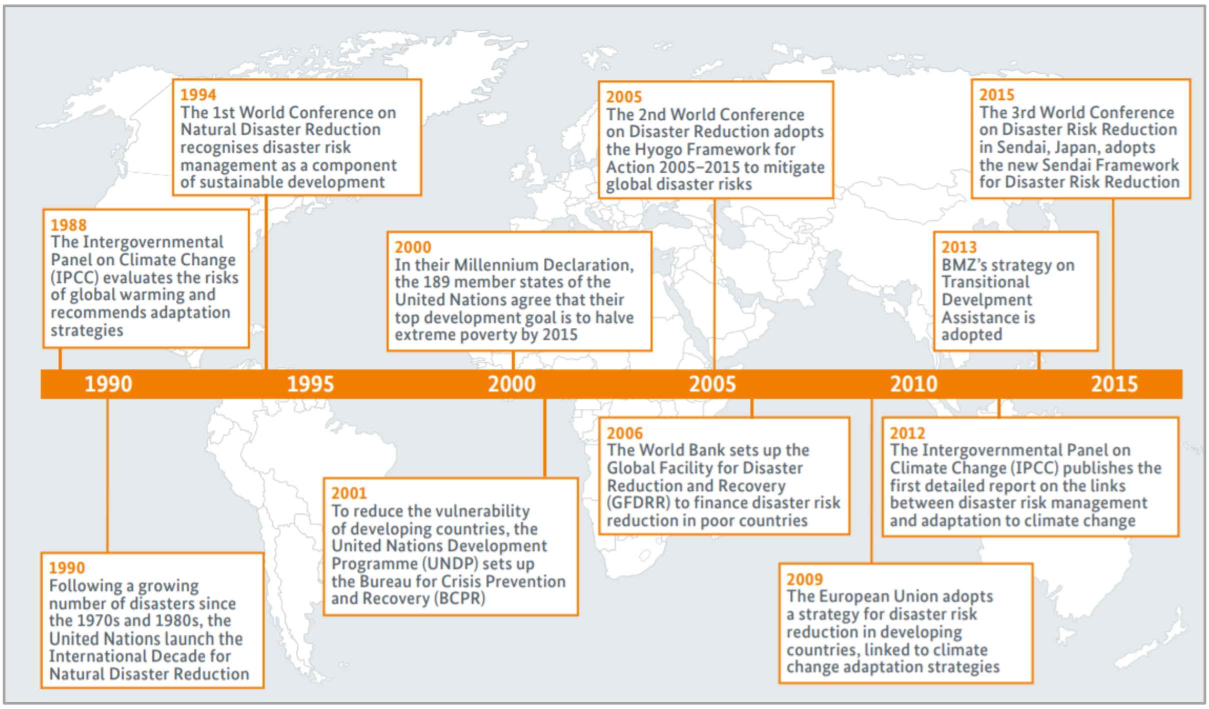

Figure 2. Milestones of investigations and policies in the domains of CCA and DRM. Source:[10]

The technical disciplines of climate change adaptation and disaster risk management overlap and complement each other as seen in Figure 3. The climate change adaptation cycle is strongly aligned with pre-disaster DRM steps. Furthermore, while climate change is linked to slow-onset and sudden weather extreme impacts where adaptation measures are put in place to diminish impacts associated to natural hazards, DRM addresses the risks associated with sudden weather and geophysical extreme events and their emergency response and posterior damage recovery.

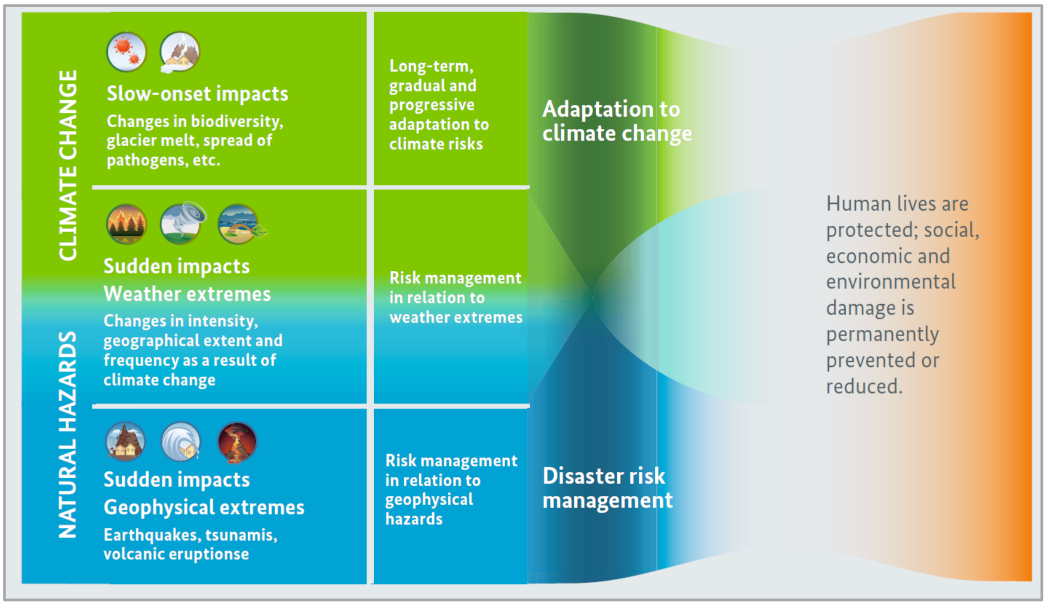

Figure 3. Intersection between DRM and adaptation to climate change. Source: [10]

3.2. Pre-disaster phase: mitigation and preparedness for heritage

The pre-disaster phase normally encompasses three steps as seen in Figure 4. However, despite having a common and comparable methodology the preparedness phase (also the DRM) should be site-specific. The pre-disaster phase focuses on actions to reduce hazard related risks in heritage, such as the use of early warning systems and all phases planning which includes emergency-response plans [11].

The aim of the pre-disaster phase is to:

(1) Reduce risk at source. The efforts are centred to reduce exposure and vulnerability to specific hazard or if possible, to eliminate the hazard. This may be achieved by improving the ambient conditions within which the cultural heritage sites.
(2) Reinforce the ability of property to resist or contain the consequences of a disaster. This include measures to strengthen and reinforce the structure or properties of heritage.
(3) Provide adequate warning. Technological systems like sensors to record, predict or announce a disaster in a timely manner are the basis of effective disaster warning.
(4) Develop an emergency plan. A participatory approach for the definition of the emergency plan is desired. Apart from an evaluation and a heritage salvage plan, efforts here involve awareness courses, on-site disaster simulations and instrumental and material provision.

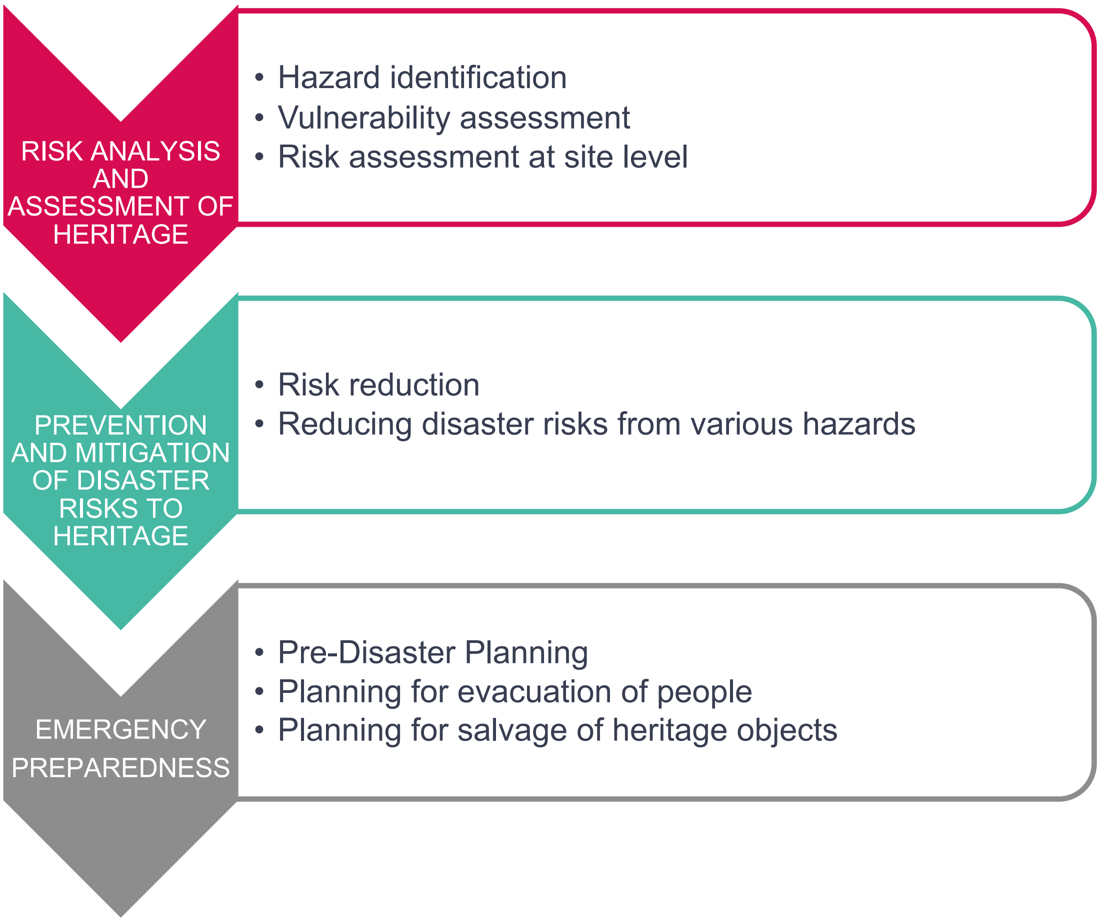

Figure 4. Pre-disaster phases´ steps

3.2.1. Risk analysis and assessment

This step requires the acquisition of information and its analysis to determine the level of risk, which is often done by a risk matrix, by considering the severity of the consequences and the probability of occurrence. The risk analysis may be undertaken at different spatial scales such as the urban level, the heritage site level or an individual heritage building/unit.

Risk assessment typically encompass two steps [12], [13]:

- Identification, analysis and evaluation of disaster risks through hazard identification and data collection linked to vulnerability, exposure and the hazard´s potential negative impacts
- Developing alternative disaster scenarios considering primary and/or secondary hazards for the heritage site. Then a ranking of risks is sought through a risk matrix. This allows the prioritisation of options in the risk prevention step.

The Intergovernmental Panel on Climate Change’s (IPCC) AR5 risk approach focuses on the interaction between hazard, exposure and vulnerability. The risk calculation is done by following a formula where the components are the probability of the hazard, exposure and vulnerability (the combination of exposure and vulnerability represents the consequences or impacts if the events occurs)[14]:

$$\text{Risk } (R) = f\,(\text{Probability of a Hazard } (p) \times \text{Exposure } (E) \times \text{Vulnerability } (V))$$

In the literature we can find different methods for risk assessments. Some of them are quantitative approaches (probabilistic, deterministic risk assessment, indicator-based approach) and others qualitative (risk matrix) [15], [16]. Although there are many methods to cover the risk assessment, expert judgement is necessary to validate the scientific results but also to establish acceptable thresholds and communicate uncertainty or confidence levels [17].

Last, prioritising risk mitigation/prevention options may be performed considering different criteria or prioritisation tools:

- Cost / benefit analysis considering both implementation and maintenance stages. This is important as human and financial resources are often scarce.
- Multicriteria analysis taking into account those monetary and non-monetary factors that may be relevant for the site-specific context.
- Effect of a proposed strategy on risks from each and every hazard or on risks to each heritage component.

3.2.2. Prevention and Mitigation

This step of DRM consists of addressing the identified risks and minimise them through a series of strategic actions. This generally includes one or more of the following elements:

- Prevention of hazards: Eliminating the source of risk, e.g. preventing graffities by ensuring security and monitoring of the site. This in many instances is not feasible for climate hazards.

- Mitigation of impact of hazards: In cases of unavoidable hazards, for instance, meteorological hazards that include heavy rainfall leading to floods or landslides, tornadoes etc., proactive measures to reduce exposure may be undertaken to reduce the impact of the risk.
- Reducing vulnerability of cultural heritage: Cultural heritage can be supplemented with robust planning and interventions to reduce its vulnerability to certain kinds of hazards.
- Capacity building: At each stage of the disaster risk management process by developing the ability and knowledge of stakeholders and organization to effectively take actions and decision on DRM [17].

Planning is key to build a robust mitigation strategy, for urban and regional planning measures in and around the cultural heritage site, to consider technical measures for protecting sites from the impact of specific hazard, to integrate DRM with other existing planning frameworks etc.

Furthermore, conservation and maintenance programmes for historic properties should include the cultural heritage-at-risk perspective. Similarly, conservation principles should be integrated when appropriate in all phases of disaster planning, response and recovery.

Other approaches [18] of conservation preparedness organize mitigation or control of risks in five type of actions depending on the most suitable:

1. Avoid the cause of the risk. This is the desirable action as it is the most effective one (if possible)
2. Block the agent of deterioration. This encompasses protective barriers or measures between the heritage and the hazard.
3. Detect the agent or hazard that leads to deterioration and their effects on the heritage assets.
4. Respond to the damages from the deterioration agents (or hazard). This action is linked to the detection of the agent of deterioration. This action focuses in the planning and preparation to allow a quick and effective response. This action would correspond to the preparedness step of the pre-disaster phase.
5. Recover from the damages and loses caused to the heritage assets by a specific hazard. This action would lie within post-disaster stage when the other mitigation actions have failed.

3.2.3. Emergency preparedness

This step deals with the planning process needed in emergency situations and it consists of planning, organizing, training, equipping, exercising, evaluating and taking corrective actions. It results in protocols and the procedures which need to be in place in the event of a disaster. These protocols should include the evacuation routes and procedures which may include maps of the property indicating exits and emergency equipment, establishment of alarm systems and emergency equipment, assembling and training an emergency team and proposing the salvage of heritage objects. Protocols should also cover post-disaster planning such as heritage damage inspection and protection actions and strategies. It should be highlighted that preparedness requirements associated to heritage buildings should have least impact on heritage value as possible. Coordination between heritage staff and external agencies and population awareness rising activities are key for a good performance.

Pre-Disaster Planning

After the risk assessment and selecting the most appropriate mitigation measures, an implementation plan should take place to achieve conservation objectives and to define emergency and post disaster rehabilitation protocols. This covers all levels of planning. Furthermore, in emergency preparedness, communication, collaboration and engagement among authorities, departments, professionals and community is essential for team building, awareness raising and, thus, a successful disaster risks planning. An emergency team is required to coordinate action with local police, health authorities and hospitals, firefighting force etc. Training of emergency teams is fundamental to test coordination and learn to prioritise activities during and immediately after a disaster. This will allow to adjust actions and prepare the teams for a prompt effective response.

Planning for evacuation of people

The evacuation plan requires all sort of information and actions to evacuate people safely in the case of an emergency. The plan should include: the evacuation protocol, the definition of evacuation routes, safe refuge places, clear roles and responsibilities by all authorities involved in the evacuation, the implementation of measures and provision of supplies and emergency equipment.

Planning for salvage of heritage objects

Likewise, there is a need for a plan to save cultural heritage collections if necessary and possible. Apart from a basic protocol with recovery operations where the same principles applied as for human beings (team definition, material supply etc.) heritage requires few extra actions. For small heritage elements inventories are essential to identify what can be recovered and where to find those elements promptly. The training and developing of skills to handle heritage and damage materials are also key to avoid further harm.

3.3. During and post disaster phase: emergency procedures and recovery process

When an emergency or a disaster affect a city or a region, efforts are spent:

- **during the emergency**, which is usually considered to last for the first 72 hours after the disaster event (but it may be even longer), **to implement various response procedures for saving people as well as heritage**, also following the training practised beforehand (Figure 5);
- **in the post-disaster phase, to restore basic services and lifelines**, including the road network and other essential facilities, to establish dwellings for the evacuated people **and afterwards to implement the recovery process**, including damage assessment, treatment of damaged components of the heritage property through interventions such as repairs, restoration and retrofitting and long-term recovery, rehabilitation and reconstruction (Figure 5).

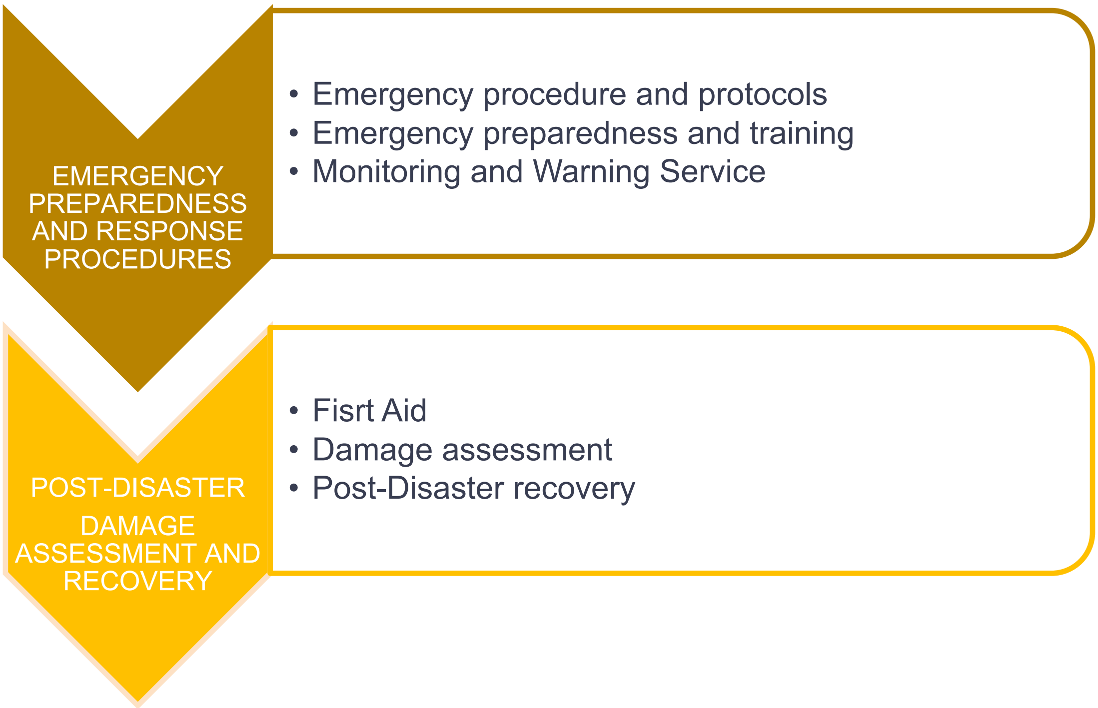

Figure 5: During and post-disaster phases´ steps

3.3.1. Emergency Procedures and Protocols

The emergency response planning with procedures and protocols can be defined as the tool to prepare systematically for possible contingencies, including major incidents and disasters.

The emergency plans articulate and integrate the procedures, which specify what must be done in certain circumstances, and protocols, which assign responsibilities to be followed from involved actors in complex operative activities, in order to understand their own roles and those of the other participants. By modifying an effective comparison with an orchestra, proposed by Alexander [19], that seeks harmony: the individual instrumentalists are the protocols, the scores are the procedures and the director is the plan. Therefore, a response plan should clearly delineate roles and responsibilities of disaster response organizations, explaining coordination both horizontally with each other and vertically with local, national authorities. Often national response plans include also how to request international resources, while local plans include evacuation and shelter plans. Typically, response plans consist of operational and logistical components, including procedures for damage and needs assessment in the aftermath of a disaster.

In summary, emergency response involves a mixture of plans, procedures, protocols and improvisation. In fact, despite preparedness, a share of improvisation cannot be avoided, it due to a degree of uniqueness presents in each new disaster [19]. Nevertheless, procedures and protocols can constrain improvisation to a necessary minimum. Emergencies are always learning fields, as such they a wealth of knowledge baggage for updating protocols able to reduce mistakes, inefficiencies and improvisations.

Although there are no consistently reliable way of defining the size of an event (e.g., major events, disasters, and catastrophes), its definition can involve the activation of different emergency protocols. Generally, the civil protection system is based on the principle of subsidiarity, according to which social and political issues should be dealt with at the most immediate (or local) level that is consistent with their resolution. Therefore, decisions should be taken at the lowest appropriate level, with co-ordination at the highest necessary level. Local agencies are the building blocks of the response to and recovery from an emergency of any scale.

The national civil protection systems are underpinned by European solidarity. In fact, although the organization and the procedures are different in the European countries[1], the civil protection authorities stand ready and prepared to help each other when national resources for disaster response are overwhelmed or need to be reinforced. Whenever the scale of an emergency overwhelms the response capabilities of a single country, the EU Civil Protection Mechanism (CPM) enables coordinated assistance from its participating states (according to the Decision of the European Parliament and of the Council No 1313/2013/EU and the respective Implementing Decision[2]).

An additional complexity in the emergency response is due to the need to integrate several dimensions: 1) hierarchical that is referred to the tiers of government; 2) geographical that indicates spatial jurisdictions, considering also the mutual assistance; 3) organizational that refer to the different agencies participating in emergencies activities; 4) functional that is correlated to the different field of the society involved (cf. Figure 6). The emergency procedures and protocols contribute to govern the system of response to civil contingencies, in which an optimum balance is searched for both integrating these forces and allowing them a degree of autonomy and freedom of action [19].

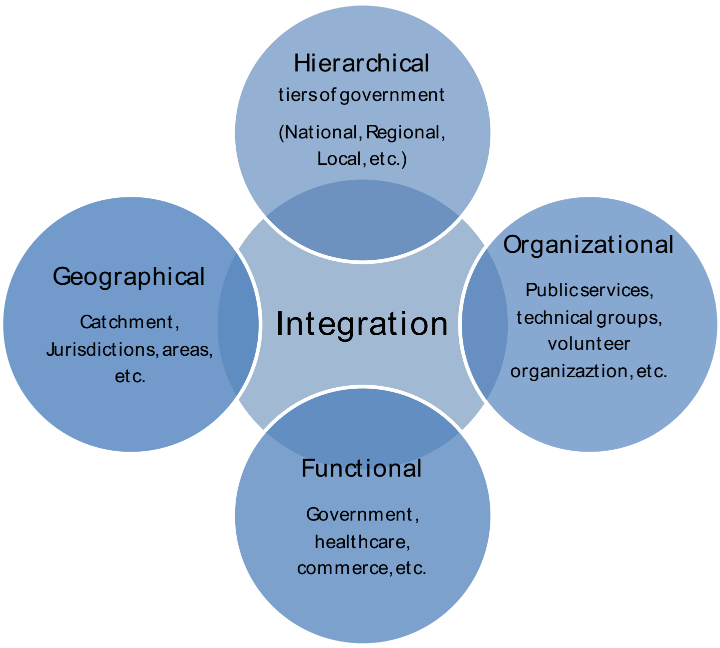

Figure 6: Dimensions to be integrated for the emergency response (modified after [19]).

[1] https://ec.europa.eu/echo/what/disaster-management_en
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02013D1313-20190321&from=EN

For example, procedures could aim to identify potential evacuation routes and refuge spaces, design emergency signage and maps, install equipment for monitoring an effective and timely response, also increasing the number of sensors and instruments already deployed on the area affected by the disaster event. Moreover, specific procedure and protocols should organize various kinds of emergency supplies and equipment, beside ensure the evacuation of people.

With reference to the cultural heritage, given the particularity and, often, fragility of the heritage objects, the procedures for saving them need:

- to collect pre-disaster documentation and preparing inventories for inspection;
- to identify the sources of risk, also those induced (e.g., the occurrence of fires following an earthquake);
- to understand the levels of control required to mitigate risks;
- to develop skills to handle damaged materials;
- to plan response and recovery operations for cultural heritage collections

In this context, in the last years, the Italian MIBACT have released and updated specific procedures to manage activities and to secure and safeguard cultural heritage in case of emergency due to a natural disaster (DIRECTIVE April 23rd, 2015). In particular, datasheets are provided for the damage assessment of the main heritage objects and the administrative and technical competences and responsibilities to be recall during an emergency are identified under the management of the Italian Department of Civil Protection operative unit.

3.3.2. Emergency preparedness and training

Emergency response protocols and procedures aim of guiding response teams to cope the crisis. A big assumption behind these protocols is that people could follow the right behaviours and react correctly under stress [20]. However, this assumption is not always valid as real histories often have demonstrated [21]. Some author, even, sustain that "the key to effective crisis management lies not so much with the writing of detailed manuals (that have a low likelihood of being used, and an even lower likelihood of being useful)"[22]. Also, humans would make mistakes during an emergency phase, which could produce more severe consequences via chain reactions. Common mistakes generally include inadequate situation assessment, erroneous judgements, blind allegiance to the procedures, adverse reaction under stress, unclear roles resulting in tasks falling through the cracks, and miscommunication [20], [21], [23]. A solution of this problem is represented by regular training, that allows a practical simulation to equip each member of the response teams with the capabilities, flexibility, and confidence to handle unexpected and sudden events [22]. Three main conventional methodologies are available for emergencies: classroom-based training, Tactical Decision Games (TDGs), and emergency drills in the real system [20], [24], [25].

In all European countries, the key personnel who ensure the fulfilling tasks of civil protection and crisis management are regularly trained and prepared accordingly to national plans and legislative. The organization of the activities and the involved bodies differ at national level (cf. https://ec.europa.eu/echo/what/disaster-management_en). Nevertheless, to cope cross-border emergencies and to facilitate the synergy between national civil protections, a training programme has been set-up by the EU for civil protection and emergency management personnel to enhance prevention, preparedness and disaster response by ensuring compatibility and complementarity between the intervention teams and other intervention support as well as by improving the competence of the experts involved. The details can be obtained on the webpage https://ec.europa.eu/echo/index_en.

Recently, a training activity named "Exe Flegrei 2019"[3] has been deployed in Italy simulating the unrest of Phlegrean Fields volcano complex. The exercise project was conceived with a clear objective to update volcanic risk planning for the Phlegrean Fields area. The project which started some years ago, eventually led to the definition of the scientific scenario of reference and the consequent identification of interested areas, and involving Prefecture of Naples, the Campania Region and the centers of competence of the Italian DCP. Within the exercise activities, a special focus has been dedicated safeguard and management of the cultural heritage with a dedicated task. The scenario envisaged a simulation of activities for the securing of movable cultural assets with evaluation of site conditions and movement from the container to the storage. The exercise was an opportunity to elaborate, test and improve the operational, procedural and methodological aspects of territorial and sector planning. Moreover, the activities on the cultural heritage gave opportunity to MiBACT (Ministry for the cultural heritage and activities and for the tourism) to test:

- the emergency procedures for activating national and regional crisis units and integrating them with the civil protection system coordination centers;
- the employment of specialized figures for the formation of teams (Italian National Fire Corps and Carabinieri for the Protection of the Cultural Heritage and Anti-counterfeiting) to be used in the protection of cultural heritage
- the interoperability between specialized volunteers and MIBACT officials in competition with cultural heritage managers (movable and immovable assets).

3.3.3. Monitoring and Warning Service and Emergency Operation Centre

Hazards vary considerably in their predictability and the amount of lead time, if any, for preparations to take place. Nevertheless, warning and associated response are two vital elements of most emergency plans. The short-time warning must be distinguished from the forecast of hazards. For instance, earthquakes are predictable in terms of characteristic parameters with a probability of occurrence associated to the return time, but the impending shocks are not predictable in a short-time window. Nevertheless, a seismic monitoring system can provide information about potential effects and damages, immediately after that an earthquake occurred. Instead, the data sharing and functional linkages between the hydro-meteorological services and emergency response units can provide useful information about water bombs or tornados, based also on digital modeling, with lead times of some hours before the catastrophic event makes landfall. Hazard early warning systems issue warnings to help

[3] http://www.protezionecivile.gov.it/media-communication/dossier/detail/-/asset_publisher/default/content/exe-flegrei-2019

communities safely evacuate from hazardous areas. Warnings need to involve three essential components: scientific and technical, administrative and social [19] (cf. Figure 7).

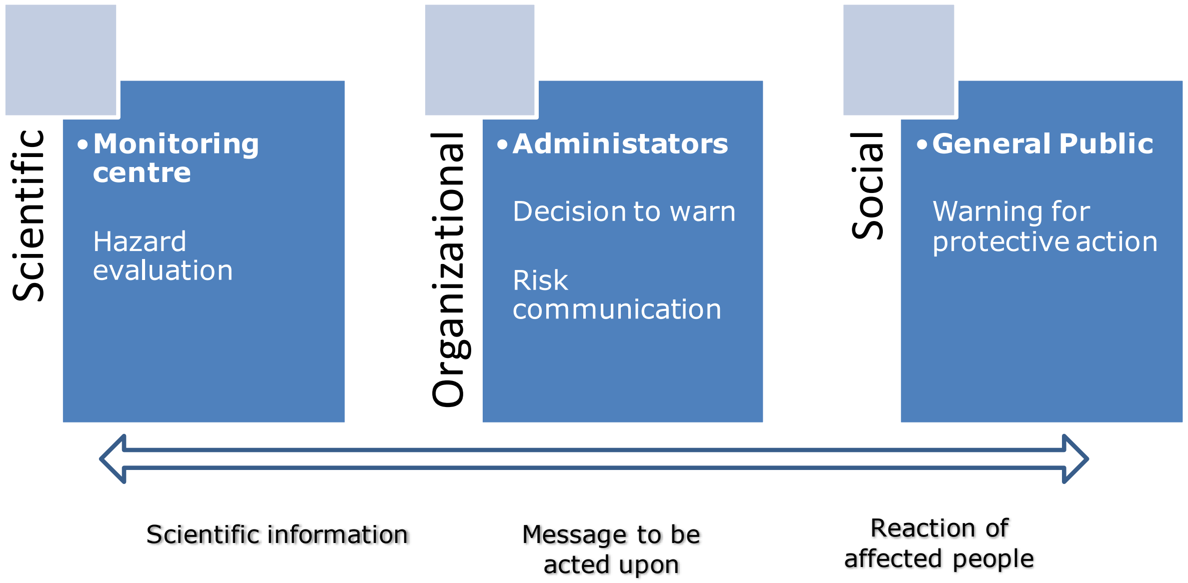

Figure 7: Warning process from technical-scientific monitoring to reaction of affected people (modified after [19])

Given the importance of monitoring and early warning system in crisis prevention, advances researches are oriented to introduce data-driven Artificial Intelligence (AI) methods, such as Deep Learning, which demonstrate promising skills to learn implicitly from data alone, but require significant computing capacities and a large amount of annotated, high-quality training data (e.g., [26]).

A key element of a robust emergency response system is the establishment of an operations centre, that coordinates the emergency services. Generally, the centre is responsible for activating staff to respond to emergencies; requesting resources, such as equipment and teams; coordinating response and recovery activities; tracking resources; and collecting information from the field like damage and needs assessments [27].

For instance, through the CPM, the EC plays a key role in coordinating the response to disasters in Europe and beyond and contributes to at least 75% of the transport and/or operational costs of deployments. In fact, after a request for assistance, the Emergency Response Coordination Center (ERCC) mobilises assistance or expertise. The ERCC monitors events around the globe 24/7 and can ensure rapid deployment of emergency support through a direct link with national civil protection authorities. The ERCC is the heart of the EU Civil Protection Mechanism and coordinates the delivery of assistance to disaster-stricken countries, such as relief items, expertise, civil protection teams and specialised equipment. The ERCC manages a reserve of pre-committed assistance from EU Member States and Participating States that can be immediately deployed. These countries may commit resources on standby in a pool, ready to be deployed as part of a faster and more coherent European response when the need arises.

The centre also provides emergency communications and monitoring tools through the Common Emergency Communication and Information System, a web-based alert and notification application enabling real time exchange of information. Cooperation across the EC has facilitated the development of disaster forecasting and disaster management tools. The Institute for Environment and Sustainability of the EC has supported the development of

- the European Flood Alert System alerts the ERCC on the most severe flood events
- the European Forest Fire Information System provides daily meteorological fire danger maps and forecasts up to six days before, including maps of burnt areas and damage assessment
- The Global Disaster Alerts and Coordination System, developed by the Commission's Joint Research Centre and used jointly by the EU and UN, is a fully automatic 24/7 alert system which gathers data about natural events (earthquakes, tsunamis, tropical storms, floods and volcanoes).
- The Meteoalarm is an online alert platform established by the European meteorological services, which issues European weather warnings.
- An agreement with the European Mediterranean Seismological Centre has allowed earthquake detection in the Mediterranean area to be considerably quicker and accurate, by adding sensors in Tunisia.
- The EC also cooperates with the Intergovernmental Oceanographic Commission (IOC-UNESCO) on the establishment of a tsunami warning system for the North Atlantic and Mediterranean region.

3.3.4. First aid and Damage assessment

The immediate and interdependent actions taken to stabilise and reduce risks to endangered cultural heritage during and after an emergency are collectively defined as cultural heritage first aid.

Once the priority operations for saving lives and ensuring security are completed, cultural heritage first aid can be activated. In practice, the right time for initiating first aid varies and depends on the different factors [28]:

- the nature and scale of emergency;
- the access to affected areas;
- the scale of damage caused to cultural heritage and/or its significance for stakeholders;
- the significant cultural heritage (e.g., a World Heritage site may require specific skills for inspection).
- Local capacity and preparedness.

The assessment of damage is a key point towards post-disaster recovery of the cultural heritage; in fact, the analysing the degree of damage of the heritage object as a consequence of the disaster, as well as analysing new risks which may have been provoked by the disaster, can useful to make secure the asset in the immediacy and, afterwards, to rehabilitate it. The complete process involved in documenting, assessing and communicating post disaster damage to heritage needs to be explained to the operators and stakeholders. In addition, guidelines for carrying out preliminary and detailed assessment of damage to the assets are required in reporting phase; in fact, often it is not possible to undertake surveys and documentation immediately after the disaster because of difficulty in access, safety problems and lack of resources. Nevertheless, compliance with timelines in the implementing damage assessment is essential to implement effective emergency protection measures and to start the recovery process. As example, the emergency protection measures undertaken immediately after the severe seismic events in Italy (from the 1976 Friuli earthquake to the 2016-2017 seismic sequence in Central Italy) managed to save buildings that might otherwise have been demolished and replaced, and permitted them to withstand the aftershocks [29].

Therefore, to guarantee homogeneity and the completeness of information, specific protocols should support the technical operators from the beginning of the observations up until detailed documentation and analysis of physical condition of affected sites or object. Compiling and recording of data and analysis correctly is important, not only for carrying out long term repairs and restoration, but also serves as a useful resource for the site managers to review and update the disaster risk management plan.

3.3.5. Recovery and Rehabilitation

Cultural heritage first aid is only successful if followed by conservation efforts to restore function and access. In practice, a delicate balance must be guaranteed between safety considerations and maintaining values, authenticity and integrity of cultural heritage. Repairs and conservation of heritage plays a key role in the disaster recovery, aiming anyway to minimize intervention and preventing demolition of heritage structures as far as possible.

Thus, once you have implemented first aid for the damaged cultural heritage, documented the entire process and set up a monitoring routine, the next step is to prepare a consensus-driven action plan for recovery and rehabilitation, which involves: detailed condition assessments; conservation treatments for tangible heritage; risk mitigation; restoration of livelihoods and services; improved use of cultural heritage following the principles of sustainable development, and ‘build back better' [28].

There are evidences which suggest that cultural heritage often suffers not just from disaster but also from inadequate and uncoordinated post-disaster recovery actions [30]. For example, the activities to quickly remove debris from damaged structures can worsen the damage of the assets inside them, or inadequate reconstruction efforts after an earthquake without right consideration of seismic protection techniques make structures again exposed to future events [31]. Therefore, the stakeholders need to be better prepared if they are to effectively respond to disaster impacts on heritage assets and support sensitive recovery, especially when local communities and livelihoods are closely connected to heritage sites. In fact, the recovery process can be strongly facilitated by collaboration with relevant authorities and stakeholders at different levels, in order to preserve culture and heritage, enhance safety and sustainability, and exploit cultural heritage as catalyst for social and economic recovery. For example, the National Committee of ICOMOS played a significant role during post-tsunami recovery of the cultural sites in Sri Lanka and successfully advocated the importance of including cultural heritage values in post-disaster recovery plans [32].

The key aspects influencing the recovery process are:

- long-term measures to ensure that the rehabilitation process is quickly started and the future disaster risks are reduced as much as possible;
- raising resources, both financial and human, through the larger institutional network at local, regional, national and even international levels as necessary.
- understanding the significance of the tangible and intangible values associated with cultural heritage and using it as an asset for recovery.
- preserving the heritage value of the sites, following a minimal intervention policy as far as possible and including local stakeholders in this process.
- reviewing site management as well as local and regional planning and management systems.
- technology for repair, retrofitting and restoration of cultural heritage;
- linking recovery with mitigation through development of human resources and planning measures;
- raising community awareness and participation in the recovery process.

3.4. Overview of current debates and knowledge gaps

Most risk analyses are focused on single hazards and do not consider multi-hazards in which several research communities need interact. The FP7 MATRIX project tried to fill the gap through event-tree and fault-tree strategies. Liu et al. [33] also proposed a systematic hazard

interaction classification that improves the MATRIX approach. But still, there are methodological gaps that need to be covered to develop a consistence multi-risk analysis that goes beyond indicator-based approach (e.g. Bayesian networks, agent-based models, system dynamic models, event and fault trees, hybrid models) [34], [35]. In addition, DRM should work to be a cross-cutting issue, promoting the involvement of different specialist fields [10].

After the IPCC introduced the risk components in the AR5 document, the proposed risk formula has been widely accepted in the research community. However, there is not yet a standardised methodology for the risk assessment (one can do a quantitative or qualitative assessment using the same components but with a different way of combining the concepts, different weighting or normalization methods for example) that will ensure comparability between studies. It this sense ARCH will follow closely the evolution of the ISO/TC 262 (for example the ISO/NP 31050). In addition, the end users of risk-assessment studies are demanding user-friendly tools which generates useful information for decision making [36].

Related to the risk analysis, the Impact Chains concept and methodology has emerged recently (first published in 2013 and used in some H2020 projects like RESIN in 2015 or SOCLIMPACT in 2018) in climate risk assessment [37], but it has not been used in DRM. The Impact Chains diagrams can be a useful tool for including in the cause-effect relation the climate change issues. Therefore, the inclusion of this concept in DRM should be analysed.

It is also known that the quantitative risk assessment has a high data demand and therefore there is an important challenge on increasing the data availability (largely at local level), not forgetting the data quality and the need for validation of the obtained risk assessment analysis [36].

The DRM community already worked strengthening the multi-level approach. BMZ highlighted the need to follow this work and reinforce the relation between levels (local, national, international) but also the cooperation between agents (administration, society, private sectors, research institute, …) [10]. In addition, Gonzalez et al. mentioned the need to go in deep in the correct scales selection for the DRM [34].

Another gap in the risk assessment and climate change is the lack of knowledge in the future vulnerability. A lot of work is been doing in future climate projection, but less effort is been doing in vulnerability related indicators projections (e.g. changes on socio-economic indicators, land use or urbanisation) [36].

An important gap is the lack of clarity with regards to the terms and definitions connected with multi-risk and multi-hazard approaches, therefore is most important to provide a common vocabulary. In addition, also for input parameters, there is a need to harmonize existing methodologies on data collection and databases across the European countries. In this case, there are already on-going programs dealing with this, such as the INSPIRE (http://inspire.jrc.ec.europa.eu/) initiative of the European Union.

During previous funded project, stakeholders highlight—besides the necessity to implement a multi-risk and multi-hazard approaches with financial, political, conceptual, methodological and operational aspects—three particular barriers as being most problematic [38]:

1. The absence of common methodologies and data for different types of hazards and risks is considered the most problematic barrier. In particular data on cost estimations are also not fully comprehensive due to the role played by insurance companies, therefore their assessments are not fully comprehensive or independent.
2. Political priorities differ from multi-risk assessment improvement.
3. A significant limit is the absence of cooperation between the institutions, organizations and departments, reducing transparency in the decision processes. Results of assessments are not always let available to other stakeholders outside the institution which was responsible for the assessment.

Last but not least, over the last decade, DRM felt the need to use the resilience and sustainability concepts and this need forced the use of the concept “building resilience of nations and communities to disasters” present in Hyogo framework for action 2005–2015. Nevertheless, there is a lack of empirical research that introduces the resilience conceptualization systematically in the DRM [39].

4. ARCH project issues and connections

Building on the findings of the state-of-the-art review, this section identifies the most important issues for consideration within the ARCH project. This includes:

The DRM will have the focus on World Heritage and will consider the climate change in the context of ARCH project. The before, during and after stages of the DRM covered in the project will ensure the alignment of the concepts and approaches with the ones considered in World Heritage and Climate Change studies. Therefore, ARCH project will follow the concepts and approaches from the DRM (Sendai Framework for Disaster Risk Reduction 2015-2030) and aligned with the IPCC's Assessment Report 5 (AR5) and UNESCO World Heritage. In this regard, the risk analysis should follow the AR5 risk approach, where the components are the probability of the hazard, exposure and vulnerability.

In the literature we find different methods for risk assessment. ARCH should select the one fits better the ARCH purpose: some are quantitative approaches (probabilistic, deterministic risk assessment) and others qualitative (risk matrix, indicator-based approach among others). Considering that the risk analysis will be done for the heritage (for which it is hard to have the hazard probability data at fine scale, or obtain the damage costs data among others), a priori it seems more feasible to use a qualitative approach like the indicator-based approach including expert judgement (interaction with agents). This will depend on the data availability (quality and quantity).

It is also identified interesting the use of the Impact Chains in the risk analysis and therefore ARCH will explore in this line.

The ARCH platform could support the emergency operations during and post disaster (e.g., providing tools to collect pre-event data useful for the recovery process or analysing the impacts to inform the training and management activities).

In addition, the platform will develop tools for monitoring effects of the disaster at the local scale that could affect the damage distribution (e.g. for seismic risk, the continuous recording of the ground accelerations will permit to elaborate shake maps at urban scale).

5. Conclusion

Climate-related and other hazards are impacting and will impact in the future on World Heritage. Studies are needed on this to find advanced methods and tools to building resilience. This means that the DRM should include concepts and methods from other domains (climate change, resilience, sustainability, world heritage) or need to custom-developed if necessary. ARCH project will ensure the alignment of the proposed concepts and methods with the other domains.

In this regard, ARCH will use the risk components described in the IPCC AR5 document and in addition will explore the way to co-create the risk assessment methodology (having a focus on methods that includes interaction with agents) and explore the applicability of the Impact Chains approach for Heritage risk assessment. The present report highlighted the need to have a standardised methodology for the risk assessment which will ensure comparability between studies. Therefore, ARCH will closely follow the evolution of the ISO/TC 207.

It is also known that the quantitative risk assessment needs to balance the high data demand with the data quality and the need for validation of the obtained risk assessment analysis. Another key challenge detected in this report is the need of the future vulnerability analysis. In this regard, more effort needs to be done in future vulnerability projection (e.g. changes on socio-economic indicators, land use or urbanisation). ARCH will try to find future vulnerability studies to see what can be applicable in the present project.

This report highlights the need of multi-level and multi-hazard approach and the need of methodologies for future vulnerability analysis. The ARCH project will probably not be able to give an answer to these questions but will have them present for making some steps in this direction.

Regarding to the multi-risk and multi-hazard approaches, ARCH will follow on-going programs dealing with this, such as the INSPIRE (http://inspire.jrc.ec.europa.eu/) initiative of the European Union, to see how they approach the following barriers: the absence of common methodologies and data for different types of hazards and risks; political priorities differ from multi-risk assessment improvement; the absence of cooperation between the institutions, organizations and departments, reducing transparency in the decision processes.

Last but not least, ARCH will consider the resilience and sustainability concepts into the DRM.

6. List of Figures

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8. Annex

Key resources

The key resources – books, papers (open access only), webpages – on the topic are included in this section.

1. **Risk preparedness: A management Manual for World Cultural Heritage**
- Citation: H. Stovel, Risk preparedness: a management manual for world cultural heritage. Rome: ICCROM, 1998. ISBN 92-9077-152-6
- Accessible on: https://www.iccrom.org/sites/default/files/ICCROM_17_RiskPreparedness_en.pdf
- Short summary: it gives an overview of risk-preparedness for cultural heritage (principles, planning approaches and hazard-based strategies).

2. **Managing Disaster Risks for World Heritage**
- Citation: R. Jigyasu et al., Managing Disaster Risks for World Heritage. Paris: United Nations Educational, Scientific and Cultural Organization, 2010. ISBN 978-92-3-104165-5
- Accessible on: http://whc.unesco.org/en/managing-disaster-risks
- Short summary: the objectives of the document are: 1) to help heritage authorities reducing the risks from natural and humanmade disasters; 2) to present the DRM framework and methodologies; to support the a DRM plan preparation; 3) to help finding the arguments for the heritage conservation; 4) to help in the integration of the DRM plan in different levels (national, regional).

3. **Promoting disaster resilient cultural heritage**
- Citation: World Bank and GDFRR
- Accesible on: http://documents.worldbank.org/curated/en/696061511882383371/Promoting-disaster-resilient-cultural-heritage
- 2017
- Short summary: this key resource highlights a number of recommendations that can help policy makers and practitioners further develop DRM practices for more resilient cultural heritage. The document: 1) includes key definitions and lays out the context for protecting cultural heritage; 2) presents common challenges and a framework for managing disaster risk; 3) summarizes good practice and lessons learned; 4) presents select case studies; 5) summarizes key recommendations. The document is an easy to read document useful for analyzing different international experiences in creating and promoting the cultural heritage more resilient to disasters

4. **First aid to cultural heritage in times of crisis**
- Citation: ICCROM and Prince Claus Fund
- https://www.iccrom.org/it/publication/first-aid-cultural-heritage-times-crisis

- ISBN 978-92-9077-281-1
- 2018

Short summary: it is a Handbook for coordinated emergency preparedness and response to secure tangible and intangible heritage. The document gives guidelines: 1) to develop coordinated emergency plans; 2) to enhance disaster resilience in-risk prone regions of the world; 3) to define practical toolkit and checklists. It is specifically oriented on the first aid of heritage assets in times of crisis and describes pathways for preserving culture that start with development and end with resilience.

DRM IN WORLD HERITAGE SITES IN ALBANIA

BERAT, BRUTINI, GJIROKASTRA

The UN launched a project called "Natural Risk Preparedness and Mitigation - Building capacity in the field of risk mitigation for Cultural Heritage properties in Albania" between 2011-2013. The project started with an intensive training on Disaster Risk Preparedness and Management for heritage professionals and civil emergency responders which led to a methodological framework for DRM planning. Special focus was devoted to risk preparedness for earthquakes and fires, but consider others.

Then a Risk Analysis of natural hazards and the guidelines for the risk reduction of Cultural Heritage in Albania were elaborate. The risk analysis was conducted considering several exposed attributes like architecture, coexistence (various religious and cultural traditions), artisan tradition, urban heritage and natural heritage.

A post "site by site" visit of UNESCO-ICCROM team secured a post-training coaching support to devise new management plans for the studied sites.

Finally, a science-based seismological and geo-vulnerability mapping was performed to provide useful information for: (1) Establishing guidelines and criteria of interventions in urban areas and cultural sites and (2) defining priorities for interventions. As a result, several measures on prevention and mitigation, emergency preparedness, response, recovery and rehabilitation (short and long term) were proposed.

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Source: R. Jigyasu et al., 2014. Disaster Risk Management of Cultural Heritage Sites in Albania, CNR IGAG, Rome

DRM IN WORLD HERITAGE SITE IN THAILAND

Integrating heritage in urban and regional planning: risk preparedness for the Historic city of Ayutthaya

Over ten ancient towns and several archaeological sites and monuments were flooded due to incessant heavy rainfall during several weeks in 1995. Many historic sites were damaged, and some buildings collapsed. The main cause of increasing flood intensity in historic areas of Ayutthaya was the lack of effective land-use control, causing many natural floodways and retention areas to be destroyed and developed as functional urban areas. In fact, traditional flood prevention systems using water gates and dykes had been effective in Ayutthaya for centuries until they suffered deterioration and destruction in recent years.

As a preventive measure for such devastating floods in the future, several projects were formulated at regional level. These included construction of dams and reservoirs, grass plantation along the banks of major rivers, floodwater retention projects, dredging of waterways and removal of water weeds. Revitalization of ancient city moats, walls and gateways was proposed to prevent future floods. Site plans were also prepared for monuments in lower areas outside the city to be protected by dams and drainage systems.

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Source: K. Ronarit, 1997, Risk Preparedness for Cultural Properties: a Case Study on the Old Cities of Bangkok and Ayutthaya, Kobe/Tokyo International Symposium on Risk Preparedness for Cultural Properties.

DRM IN WORLD HERITAGE SITE IN ITALY

Training through simulation exercises: salvaging cultural heritage in Phlegrean Fields (Italy)

Phlegrean Fields is a volcanic depression called "caldera" in the center of Pozzuoli. Compared to the central volcanoes, characterized by frequent eruptions occurring from a single crater and the deposits of volcanic materials the caldera shows eruptions that are unlikely to present regular patterns. In general, explosive eruptions of variable scale prevail, arising from scattered mouths, some or many of which may be very intense and violent. The last eruption of the Phlegraean Fields occurred in 1538. Since then, the volcano has been dormant although it shows signals of activity such as seismicity, gas emissions and soil deformation. From 2012 to the present, the variations of some monitoring parameters measured in the caldera area required an increase in the alert level from green to yellow and the activation of the operational attention phase.

In order to protect cultural heritage, the scenario envisages a simulation of activities for the securing of movable assets with evaluation of site conditions and movement from the container to the storage (Baia Castle, Bacoli). The procedures for the employment of specialized figures for the formation of teams to be used in the protection of cultural heritage must also be tested. The exercise was an opportunity to elaborate, test and improve the operational, procedural and methodological aspects of territorial and sector planning. The players have been identified in terms of role and responsibilities as reported in the following table.

Activity	Responsible
Crisis and National Coordinator Unit (UCCN) delegates Regional Crisis Unit (UCCR)	Coordinator of damage level survey unit
Organize teams to assess the damage to immovable asset	Coordinator of the technical unit and safety interventions
Organize teams for the recovery and security of movable asset	Coordinator of damage level survey unit
Assessment of damage to immovable assets by filling dedicated forms to be delivered to Command and Control Centre (DICOMAC)	Coordinator of the technical unit and safety interventions
Assessment of damage to movable assets by filling dedicated forms. The documentation collected is delivered to DICOMAC	Coordinator of the technical unit and safety interventions
Movement of the movable assets present inside the immovable assets (e.g., museum) towards the safe packing and filling area	Coordinator of temporary warehouses and first intervention laboratory
Transport of movable assets toward safe storage	Carabinieri Cultural Heritage Protection Unit

DRM IN WORLD HERITAGE SITE IN DANUBE

Flood mitigation through ecosystem restoration: the Danube in south-eastern Europe

In Europe, floods are the most common type of natural disaster, threatening lives and livelihoods and incurring great cost. As an example, in summer 2002, one hundred people lost their lives through flooding of the Danube. The calculated cost of the flooding was €10 billion in Germany, €3 billion in Austria and €2 billion in the Czech Republic.

Studies of satellite pictures and geographical data systems determined that the direct cause of flooding was rapid snow melt and heavy rains. However, the restriction of the floods to former floodplains demonstrated that the underlying causes of the disaster were poor planning and investment, allowing industry, agriculture and property to be located on the high-risk Danube floodplain. More than 80 per cent of the previous natural floodplain in the Danube Basin has been lost in the last 150 years due to such measures. The Danube Delta World Heritage site is one of the few remaining areas along the lower and middle Danube which still contains large natural floodplain ecosystem complexes capable of mitigating the flood risk. Flood analysis and models suggest that if natural processes were restored in the most affected areas, the water level would be 40 cm lower during flooding events.

Recent studies based on climate models predict that intensity and frequency of flooding will increase in the future. While climate change is difficult to address directly, mitigation through ecological restoration of floodplains, including reconnecting side channels and widening of the riverbed upstream of settlements, would reduce flood risks by restoring ecological functions. These measures would provide additional ecosystem services including provision of wood, reed, fish, drinking water, nutrient reduction and storage.

A network of existing and new protected areas including Srebarna Nature Reserve World Heritage site (Bulgaria), Ramsar Sites, Biosphere Reserves and National and Nature Parks is being developed to help the restoration and protection of the Danube floodplain.

Sources: European Environment Agency, 2005, EEA Briefing – Climate Change and River Flooding in Europe

ARCH

ARCH State-of-the-Art Report 3

Building Back Better

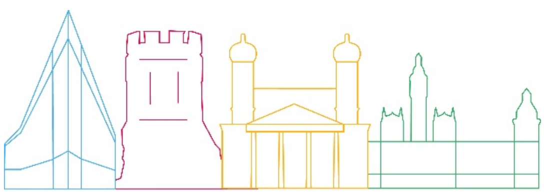

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Table of Contents

List of Abbreviations

Abbreviation	Meaning
BBB	Building Back Better
CC	Climate Change
CCA	Climate Change Adaptation
CURE	CUlture in city REconstruction and recovery
DRF	Disaster Recovery Framework
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
GFDRR	Global Facility for Disaster Reduction and Recovery
IRP	International Recovery platform
ISMEP	Istanbul Seismic Risk Mitigation and Emergency Preparedness
PDNA	Post-Disaster Needs Assessment
PDRP	Pre-Disaster Recovery Planning
RNA	Recovery Needs Assessment
SotA	State-of-the-Art
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction

Executive Summary

This report provides a comprehensive review of methods and frameworks for Building Back Better and how to include it in the Disaster Management Cycle. Specific focus is given to Building Back Better in the context of climate change adaptation and cultural heritage.

A general framework for Building Back Better is introduced and it is shortly discussed how a Disaster Recovery Framework, as well as a Pre-Disaster Recovery Plan can be developed. Based on these general discussions the CUlture in city REconstruction and recovery framework, developed by UNESCO and the World Bank, described. This framework aims to put culture at the forefront of recovery and reconstruction and thus closes existing gaps in the Building Back Better approach in the context of cultural heritage.

In addition, the report identifies critical issues and biases of Building Back Better in general and when addressing cultural heritage.

Based on these discussions recommendations for the ARCH project are made, including the stronger inclusion of local and traditional knowledge when identifying / developing resilience options, the potential inclusion of intangible cultural heritage in the information management systems, the examination of impacts to intangible cultural heritage, and linking the ARCH Disaster Risk Management framework and resilience assessment framework with the CUlture in city REconstruction and recovery framework.

1. Introduction

1.1. Background information and aims of this report

This report aims to clarify the concept of Building Back Better (BBB), with a specific focus on BBB in the context of cultural heritage and climate change adaptation (CCA). It is predominantly definitional in focus and should enable the reader to understand the terms and concepts of BBB, how it can be integrated in Disaster Risk Management (DRM), and what the main challenges for BBB are, especially in the context of cultural heritage.

1.2. Relation to other SotA reports and deliverables

To be successful, Building Back Better has to be integrated in all phases of the Disaster Risk Management cycle, needs to consider existing practices and regulations, and needs to be aware of potential biases that might endanger the adoption of BBB measures. As such this report needs to be seen in the context of the other reports included in deliverable D7.1:

- **SotA Report 1** handles conservation practices and relevant regulations / policies, which need to be considered when designing BBB processes and measures for cultural heritage
- **SotA Report 2** handles Disaster Risk Management, emergency protocols, and post-disaster response, which are all processes relevant to BBB
- **SotA Report 4** describes decisions support frameworks and technologies for CCA and DRM, which need to include processes for Building Back Better
- **SotA Report 5** handles gender aspects in conservation, regulation, and disaster risk management of historic areas. As such, it handles relevant biases often found in BBB
- **SotA Report 6** handles standards and regulatory frameworks, which also should be considered when designing BBB processes and measures

Besides the direct links to the other reports in D7.1, this report will also inform the development of the Disaster Risk Management and Resilience Assessment framework in task 7.3 and the development of the Resilience Options Inventory in task 6.1.

1.3. Structure of this report

After this introduction the report continues with an overview of the most relevant definitions for Building Back Better. This is followed by a systematic discussion about how BBB is included in DRM, how BBB can help to improve resilience against climate change and natural hazards, how cultural heritage can be built back better, and which potential biases have to be addressed during the reconstruction phase in order to build back better. The report concludes with a discussion on the most important issues with regard to Building Back Better for consideration within the ARCH project and a summary of the main findings.

2. Definitions

Building Back Better

The concept of Building Back Better originates from the reconstruction efforts after the Indian Ocean tsunami of 2004 (cf. [1]). The first comprehensive definition of Building Back Better was provided by the United Nations General Assembly in 2016 (cf. [2]):

> *“”The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment”*

ParlAmericas and the United Nations Office for Disaster Risk Reduction (UNDRR) extended this definition in 2019 (cf. [3], emphasis added):

> *“This concept refers to the use of the post-disaster recovery and rehabilitation phases to build the resilience of nations and communities, through the integration of disaster risk reduction measures in the restoration of physical infrastructure and social systems and in the revitalization of livelihoods, economies and the environment.* ***This process should focus on improving the location and characteristics of construction, taking into consideration new risk zones and the population’s recent experiences in responding to the impacts of natural hazards****.”*

The inclusion of the development of new risk zones is an important addition, making sure that future changes in hazard intensity and likelihood are considered during rebuilding efforts. Similarly, taking recent experiences of the affected population into account is paramount for any rebuilding effort, if they are to be successful. However, in the context of (built) cultural heritage focusing on improving the location and characteristics of construction needs to be considered carefully, as physical alterations to heritage sites might have effects on social structures and habitats (cf. [4]).

Therefore, we suggest to adopt a slightly altered version of the definition for the ARCH project:

> *“This concept refers to the use of the post-disaster recovery and rehabilitation phases to build the resilience of nations and communities, through the integration of disaster risk reduction measures in the restoration of physical infrastructure and social systems and in the revitalization of livelihoods, economies and the environment.* ***This process should take into consideration new risk zones and the population’s recent experiences in responding to the impacts of natural hazards.****”*

Pre Disaster Recovery Planning (PDRP)

An important concept directly linked to Building Back Better is Pre Disaster Recovery Planning, which is defined by the International Recovery Platform (IRP) and UNDRR (cf. [5]):

> *“Any planned attempt to strengthen disaster recovery plans, initiatives, and outcomes – before a disaster occurs. […] PDRP consists of a series of decisions and actions to be taken both before and after a disaster, in order to:*

- *Identify and establish shared recovery goals, objectives, and strategies – to guide post disaster decision-making, ensure that relief and recovery activities align with long-term development goals, address actual needs, and enhance resilience to future disasters.*
- *Develop and have ready the capacity to plan, initiate, and manage – an efficient, adaptive, and well-coordinated recovery effort that progresses towards the recovery goals."*

Disaster Recovery Framework (DRF)

Another important concept linked to BBB are Disaster Recovery Frameworks, defined by the Global Facility for Disaster Reduction and Recovery (GFDRR) (cf. [6]):

> *"This framework would guide governments and other implementing stakeholders in the middle and longer term recovery efforts. The framework would help in articulating a vision for recovery; defining a strategy; prioritizing actions; fine-tuning planning; and providing guidance on financing, implementing, and monitoring the recovery. Through developing a country-level disaster recovery framework, a government will be better positioned to drive a process that unites all development partners' efforts. Additionally, by developing a framework to manage recovery, a government may be able to better address longer term disaster vulnerability through coherent programs that bridge the current gap between recovery and development."*

How Building Back Better, Pre Disaster Recovery Planning, and Disaster Recovery Frameworks are linked is discussed in detail in the next section.

3. Key topics and issues

This sections first gives a brief introduction on how to phase Building Back Better into Disaster Risk Management, before detailing how to address Building Back Better in the context of Climate Change Adaptation and Cultural Heritage.

3.1. Building Back Better in Disaster Risk Management

A first guideline for implementing BBB in post-disaster reconstruction efforts was introduced by Clinton in 2006 (cf. [7]). Based on a literature review, Mannakkara and Wilkinson in [1] establish a general purpose BBB framework, comprising four key categories and six principles, as a starting point for better inclusion of Building Back Better in Disaster Risk Management (see Figure 1).

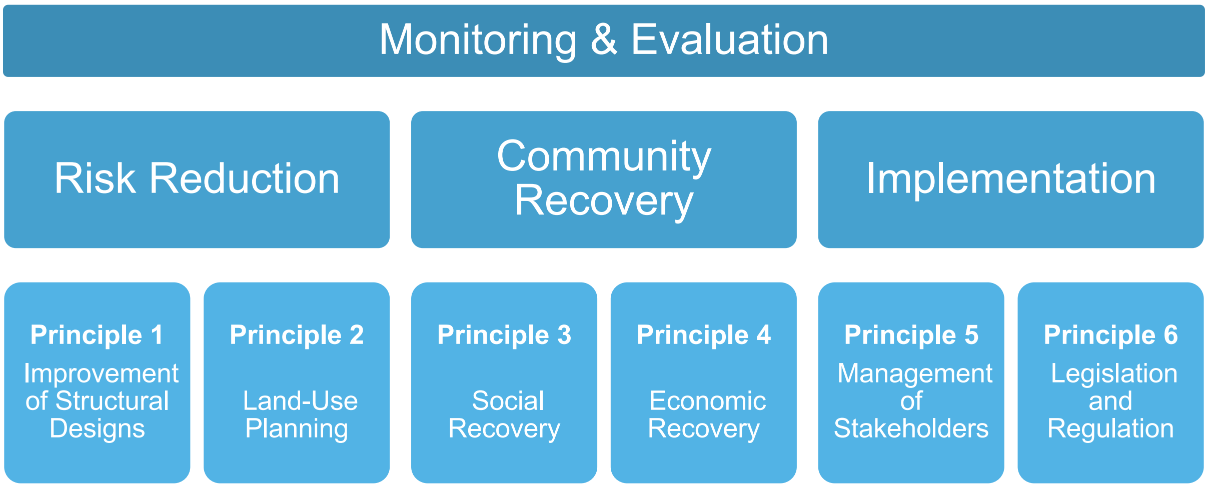

Figure 1: BBB framework as developed in [1]

The four key categories identified by Mannakkara and Wilkinson are: Risk reduction, community recovery, implementation, and monitoring & evaluation. While the latter is an overarching category that needs to be implemented across all actions, the other three categories have a more specific focus.

Risk reduction includes all measures to improve a community's physical resilience to hazards and comprises the improvement of structural designs and the enforcement of revised building codes (Principle 1), as well as the use of hazard- and risk-based land-use planning (Principle 2) (for this and the following paragraphs cf. [1]).

Community recovery focuses on the improvement of social (Principle 3) and economic (Principle 4) recovery, mainly by providing needs-based, locally and culturally appropriate recovery solutions that focus on the well-being of affected communities. This means that recovery efforts require the participation of and consultation with locals in order to be successful.

Implementation covers the means by which risk reduction and community recovery are put into place and comprises the identification of stakeholders and coordination of their roles and relationships for efficient recovery processes (Principle 5), as well as associated legislative and regulative measures (Principle 6).

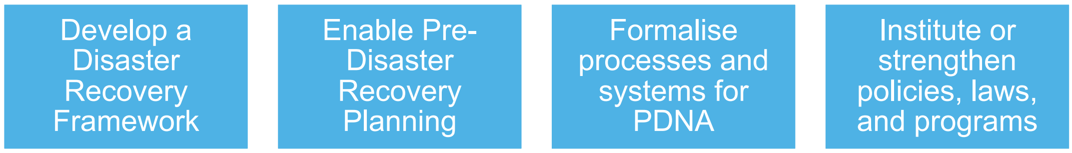

Figure 2: Tasks recommended by [8] to implement BBB in DRM

In order to systematically implement Building Back Better in Disaster Risk Management UNDRR in [8] suggest the four tasks pictured in Figure 2. These tasks are highly interdependent and have overlapping goals and processes, as described in more detailed in the subsequent sections.

3.1.1. Development of a Disaster Recovery Framework

The development of a Disaster Recovery Framework has the aim to establish an all-hazards disaster recovery framework for better management of pre- and post-disaster planning and operations. To develop the framework all stakeholders relevant for disaster recovery should be included. Having a common DRF among the large variety of stakeholders involved in recovery actions, many of which unfamiliar with the dependencies among them, simplifies management processes and ensures adherence to Building Back Better principles (see [8]).

How to develop a DRF is described by GFDRR in [6]. The authors break down the development process into six Modules, as depicted in Figure 3.

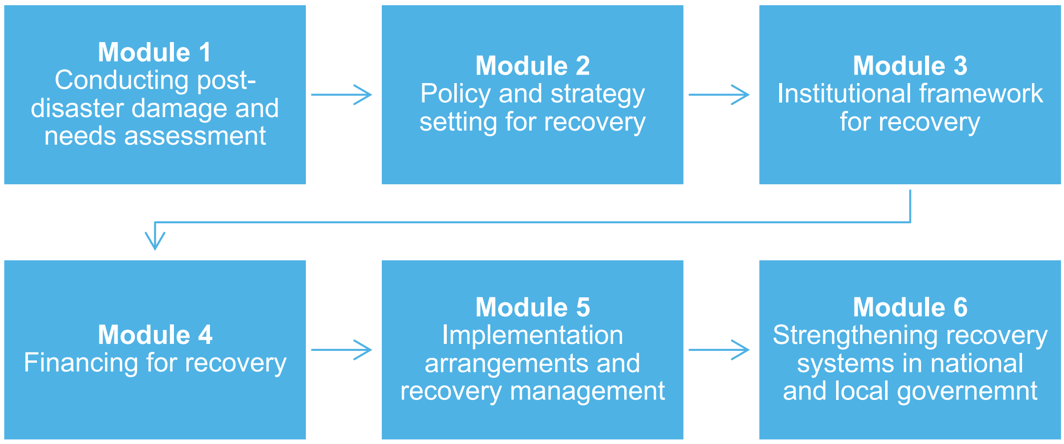

Figure 3: Process for development of a Disaster Recovery Framework according to [6]

Module 1 establishes a link between a Post-Disaster Needs Assessment (PDNA), or similar disaster assessments, and the Disaster Recovery Framework. A damage and needs assessment process is a prerequisite for the development of a DRF, as it provides damage / loss estimates and quantifies needs on which the DRF builds for detailed planning, prioritisation, financing, and implementation of recovery actions (for this and the following paragraphs cf. [6]).

Module 2 aims at supporting integrated, cross-sectoral disaster recovery by articulating a central recovery vision that enables to build consensus among stakeholders, ensure coherence with the development programs, and incorporate resilience and BBB. This vision should be backed by a recovery policy framework that articulates the imperatives for recovery – including Building Back Better – and identifies the priority sectors for recovery. To implement the vision and policy framework, a central oversight mechanism for cross-sectoral and integrated disaster recovery is necessary. This ensures a consistent application of the policy principles, harmonised recovery results, and a consistent monitoring and evaluation of recovery actions.

Module 3 ensures that governmental and non-governmental entities involved in disaster recovery are managed effectively by clarifying roles and processes. This ensures continuity from humanitarian response to recovery and participation of the affected community in the recovery process.

Module 4 addresses the four major financing challenges in post-disaster recovery: quantifying the economic costs of the disaster, developing response and recovery budgets, identifying sources of financing, and setting up mechanisms to manage and track funds.

Module 5 tackles the actual management and implementation of the recovery program, which requires the establishment of a coordination mechanism to ensure coherent support for policies and programs, the establishment of standard implementation procedures and reconstruction standards, as well as monitoring and evaluation mechanisms.

Finally, **module 6** targets three specific areas to strengthen recovery systems: the identification and usage of a standard disaster assessment method, the preparation of recovery frameworks prior to a disaster to improve resilience, and setting aside funds for disaster recovery in fiscal strategies to reduce the budget shock after a disaster.

The development of a DRF feeds naturally into the development of a Pre-Disaster Recovery Planning process, as described in the next section.

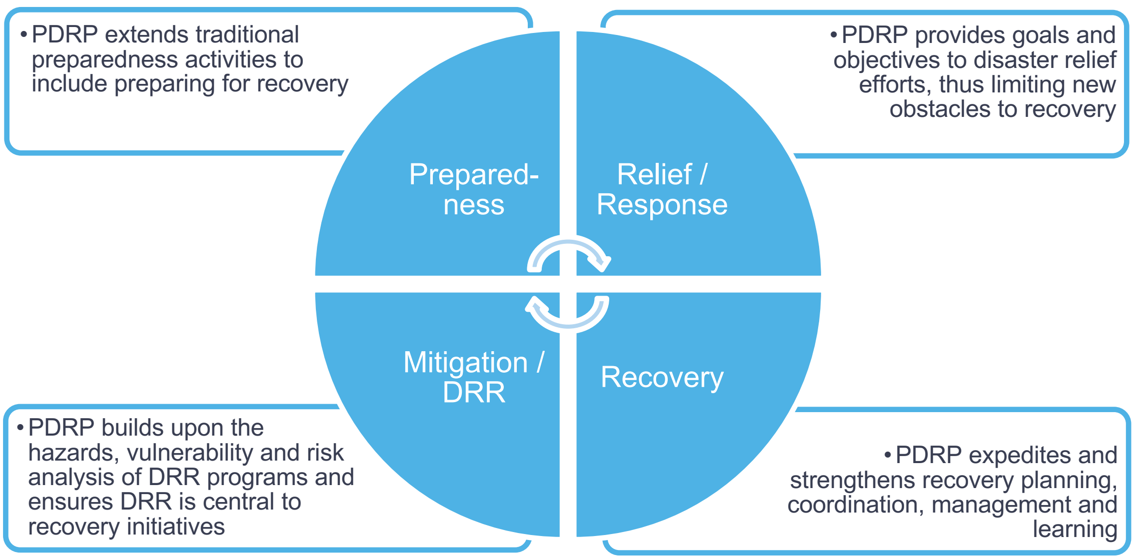

Figure 4: PDRP in the DRM cycle, according to [5]

3.1.2. Enabling Pre-Disaster Recovery Planning

Enabling Pre-Disaster Recovery Planning is important for a community's capacity to effectively and efficiently manage all recovery, reconstruction, and rehabilitation needs after the occurrence of a disaster. It focuses on promoting and building effective leadership initiatives, developing national and local laws / policies to encourage planning activities, and developing support mechanisms and programs for these tasks. By addressing difficult and time-consuming recovery planning tasks before any actual disaster, supports post-disaster recovery immensely and allows to dedicate enough resources to identify opportunities for BBB (cf. [8]).

Pre-Disaster Recovery Planning fits naturally in the DRM cycle and *"strengthens efforts within each [DRM] phase and facilitates the transitions between relief, recovery and development"* [5].

The IRP and UNDRR in [5] describe how PDRP fits in the DRM cycle (see Figure 4) and how to operationalise PDRP (see Figure 5). Pre-Disaster Recovery Planning consists of three components (cf. [5]):

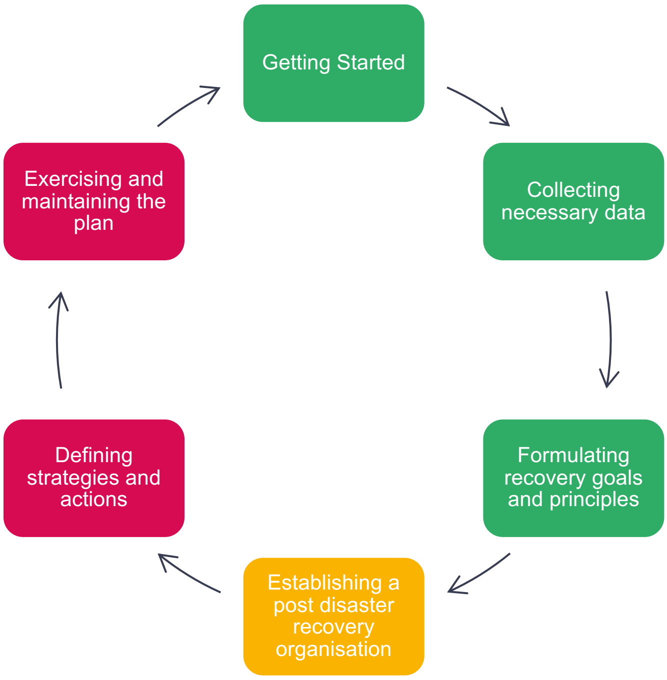

Figure 5: Components and planning process of PDRP (see [5])

1. **Developing goals, objectives, and strategies** for post disaster recovery based on informed disaster scenarios (Figure 5, green boxes).

2. **Creating a recovery organisational structure** that assigns post disaster roles and responsibilities (Figure 5, yellow box).

3. **Planning and implementing pre-disaster actions** that will expedite and strengthen post disaster planning and implementation (Figure 5, red boxes).

The pre-planning process itself is a cyclical, non-linear, participative process divided into six steps that might take place concurrently: Getting started, collecting necessary data, formulating recovery goals and principles, establishing a post disaster recovery organisation, defining strategies and actions, exercising and maintaining the plan (for this and the following paragraphs cf. [5]).

Getting started is the most critical step of the pre-planning process and depends heavily on the level at which the pre-planning is undertaken, the mechanisms for introducing policies and procedures, the political and financial support, and the required amount of awareness-raising and education to engage all relevant stakeholders. It is important to note that potentially affected stakeholder should not just be targeted by awareness-raising campaigns, but should be enabled to actively participate in the planning process in order to enable a successful community recovery process in the event of a disaster. The result of the initiation phase should be the creation of a multi-stakeholder planning team including government and non-government stakeholders that share a joint understanding of PDRP.

After the process is initialised, the **necessary data has to be collected** to allow the development of all-hazard disaster scenarios. These scenarios should not only consider direct but also secondary hazards, known and potential vulnerabilities, as well as existing development and disaster management plans. Based on these scenarios key intervention areas should be identified in which to frame recovery needs.

Based on the developed disaster scenarios **recovery goals and principles can be formulated**. The IRP and UNDRR define recovery goals as *“a vision of the recovered community or society”* [5], while recovery principles *“make clear the values which will guide how the goals are achieved”* [5]. The definition of recovery goals and principles requires the participation of the general public, because only those goals and principles can be achieved / followed that reflect those of the affected communities. The IRP and UNDRR recommend to define recovery principles at national, sub-national, and local levels, while recovery goals should be set by local authorities to enable a demand-driven recovery that aligns with the needs and priorities of the affected communities.

At the same time that recovery goals and principles are formulated, **a post disaster recovery organisation should be established** to avoid the creation of ad hoc task forces in the event of a disaster that usually lead to losing valuable time to developing and learning new systems of working.

Based on the disaster scenarios, goals, and guiding principles, recovery issues should be identified and prioritized in order to **define necessary strategies and actions** to address them. The identified actions and strategies should at least be divided into pre- and post-disaster, with a potentially even finer separation into recovery preparation, early recovery, and long-term recovery. For all post-disaster actions and strategies identified, two questions should be answered to identify pre-disaster strategies and actions:

- Can this be accomplished before the disaster?
- What can be done before the disaster to facilitate the post-disaster strategy?

The PDRP process is not a one-off event, but needs to be **reviewed and updated regularly**. Therefore, the defined strategies and actions need to be **exercised** to expose gaps, overlaps, and potential conflicts as well as familiarising everybody with their responsibilities. In addition, recovery goals / principles – and with them issues, strategies, and actions – might change over time, e.g. due to changing stakeholder groups.

3.1.3. Formalising processes and systems to enable effective PDNA

This task *“aims to institutionalize and strengthen the plans, systems, and infrastructure by which rapid and effective post-disaster recovery assessments – inclusive of opportunities to Build Back Better – may be performed at the national or local level.”* [8] Besides the already mentioned requirements of a PDNA for the development of a DRF, formalising the PDNA processes also reduces the possibilities for data gaps, biases, and errors due to variances in data targets and collection methods by the diverse agencies and organisations involved in recovery efforts (cf. [8]).

3.1.4. Instituting or strengthening policies, laws, and programs

Instituting or strengthening policies, laws, and programs that promote, guide, and support Building Back Better has the aim to establish the necessary support for communities to achieve disaster risk reduction, climate change adaptation, and sustainable development in recovery. During this task *“stakeholders [should] investigate the need for programs that support recovery planning and operations, identify and assess availability, cost, and benefits of opportunities, and address gaps”* [8], which is strongly linked to the development of a DRF.

3.2. Building Back Better for Climate Change Adaptation

Building Back Better in the context of Climate Change Adaptation means that any recovery (planning) process, including PDNA, DRF, and PDRP, has to take climate change projections and scenarios into account in order to systematically incorporate adaptation measures in recovery actions. According to [9], this can result in a more cost effective implementation of adaptation measures, particularly for long-lived infrastructures, and prevent potentially irreversible effects recovery actions might have on future adaptation measures.

The IRP, the United Nations Development Programme (UNDP), and UNDRR in [9] give several suggestions on how to address CCA in the recovery phase. They suggest to conduct a detailed needs assessment at the start of the recovery phase with specific focus on recovery with adaptation options in order to prioritise needs under climate change scenarios. This Recovery Needs Assessment (RNA) can complement an initial needs assessment for emergency intervention conducted immediately after a disaster. In addition, *“governments should ensure that all regulations (e.g. building codes, public health regulations) are also climate-proofed [and] should ensure that all proposed recovery programs […] are climate-proofed in the design stage.”* [9]

When designing adaptation measures – and especially when designing adaptation measures for cultural heritage – the incorporation of local and traditional knowledge via community participation is important, since this knowledge usually has been modified over time and can offers higher resilience and lower redundancy (cf. [9]). In addition, Charlesworth and Fien argue in [10] that *“[…] encouraging people to apply their knowledge and skills in recovery and reconstruction efforts will [strengthen the bonds of social capital,] the sense (and love) of place and community spirit needed to bear the trepidations and disappointments of waiting for the situation to be normalised.”*

The IRP, UNDP, and UNDRR in [9] also discuss several barriers for successfully including Climate Change Adaptation into recovery efforts. For example, recovery efforts that are highly targeted at climate change impacts often do not address non-climate change challenges and usually require new approaches with a high level of innovation that is often costly and fundamentally challenging to cultural and political norms. In addition, the authors note that there often is not enough information dissemination about the recovery phase – as opposed to the emergency / relief phase – and, specifically, that the wider potential climate change /

environmental impacts of recovery efforts are not discussed enough. Lastly, one of the major barriers to climate change adaptation in recovery efforts is the insufficient availability of and access to climate change information at the local level. Affected communities, local and national authorities need micro-level information in order to make informed decisions for Building Back Better.

3.3. Building Back Better for Cultural Heritage

Building Back Better in the context of cultural heritage is especially complicated, because the underlying principles of Building Back Better often clash with the conservation of historic assets as well as the local cultural and social constructs.

Delay and Rahmayati argue in [11], based on surveys in post-tsunami Aceh, that *“Building back differently is not only potentially disorientating to communities looking to re-establish connections with familiar physical settings because things look, feel, and seem foreign, but also because many of the latent coping and recovery mechanisms that communities need to draw upon in such times are interrelated with the material world in which they existed.”* And that *“in some cases, ‘building back better’ undermines the functionality, vitality, and cultural importance of local built environments and implicit social mechanisms that are important for both long-term social recovery and comprehensive community participation within relief and reconstruction efforts.”* Delay and Rahmayati argue further that *“explicit external agendas in which relief and aid is contingent upon or targets social transformation can contribute towards further disorientation, and loss of involvement in key phases of recovery”*.

Therefore, recovery and reconstruction efforts for cultural heritage need to be even more mindful to involving local communities as well as local and traditional knowledge. To achieve this, culture needs to be mainstreamed into all phases the DRM cycle and be at the forefront of Building Back Better.

One way to achieve this is the Culture in city Reconstruction and recovery (CURE) framework, developed by UNESCO and the World Bank in [12].

3.3.1. The CURE Framework

UNESCO and the World Bank developed the CURE Framework to address issues of culture not being at the forefront of the recovery and reconstruction phases and the discrepancy with BBB when addressing cultural heritage. Specifically, they identify a disconnect between the reconstruction and recovery phase as well as between place-based and people-centred strategies in these phases.

While people-centred approaches focus on people, their needs, values, and social practices, *“place-based strategies reflect the need to build on local contexts and leverage local characteristics to empower local stakeholders by allowing decision-making processes that are more reflective of local realities and contextual conditions”* [12]. People-centred approaches are usually employed in post-crisis recovery, while placed-based approaches are used in reconstruction processes (cf. [12]). In addition, the authors identify – similar to Delay and Rahmayati in [11] – that *“there tends to be a tension between reconstruction and recovery that* *[is] driven by external actors instead of local communities, which draw on local knowledge and culture"* [12].

To combine both approaches, UNESCO and the World Bank adapt the People, Place, and Policy (3P) approach developed by UNESCO in [13] to a culture driven framework for city recovery and reconstruction (see Figure 6).

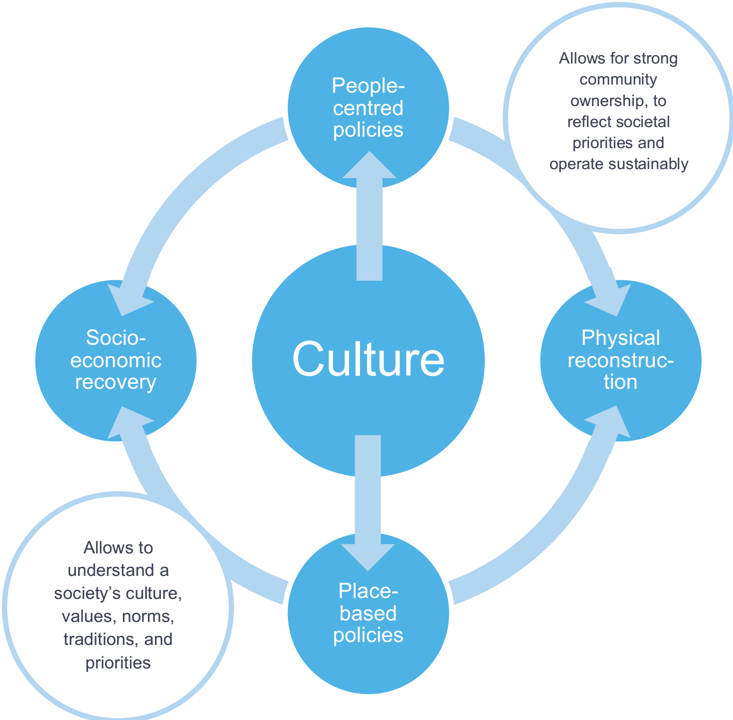

Figure 6: CURE Framework, based on [12]

In the CURE framework culture functions as the main driver to integrate people-centred and place-based policies, which in turn are employed for socio-economic recovery and physical reconstruction, BBB principle already identified by Mannakkara and Wilkinson in [1] (see Section 3.1). The framework is intended to cover the whole city, not just historic areas, and follows three basic principles (cf. [12]):

- **People-centred approach as the heart of place-based strategies:** The cultural and creative industries, as well as intangible cultural heritage should be the centre of the reconstruction process to rehabilitate or rebuild infrastructure, housing, and facilities that are linked to people's culture and identities.

- **Place-based approach as the heart of people-centred strategies:** Prioritise the restoration and strengthening of societal organisational structures and traditions, traditional crafts, cultural and creative industries, and the safety of intangible cultural heritage.

- **Culture as the foundation to integrate place-based and people-centred strategies:** Ensures that community needs, priorities, aspirations, and traditions are central to the reconstruction and recovery processes.

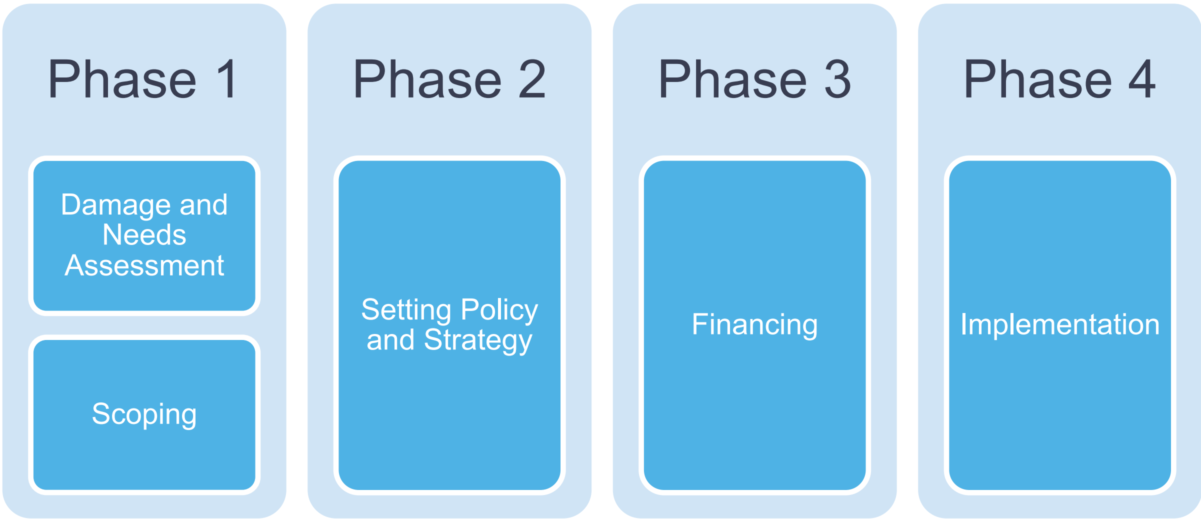

Figure 7: The phases of the CURE framework, based on [12]

To operationalise the CURE framework, UNESCO and the World Bank suggest a four-phase-approach, similar to the development of a Disaster Recovery Framework (cf. Section 3.1.1). Figure 7 visualises the four phases, which are not meant to be implemented in a sequential order, because they tend to overlap and are part of an iterative process that is highly dependent on the specific local conditions.

Phase 1: Damage and Needs Assessment

As in module 1 for the development of a Disaster Recovery Framework, this first phase links the damage and needs assessment to the recovery project cycle. Damages and impacts, i.e. physical damages and the value to restore or reconstruct historical assets, as well as economic losses, e.g. from interrupted use of cultural heritage, need to be assessed (for this and the following paragraphs cf. [12]).

Because cultural heritage is part of a larger urban fabric, these assessments should take the impact of the whole city into account.

This phase is dependent on the identification of historic and non-historic areas to enable targeted approaches for reconstruction and recovery. Such information can, for example, come from site management plans, which usually should include assessments of site values and the attributes that carry these values, as well as an inventory of all tangible heritage assets and details of their location and conditions. It is important to note that information about cultural heritage should not only come from official records. As Delay and Rahmayati observe in [11] *"what local inhabitants [think are] important components of the built environment [can fall] outside our more formalized understanding of heritage"*, because there exist "localised conceptions of culture and heritage".

This phase also requires the examination of intangible cultural heritage practices, cultural and creative industries, and cultural tourism assets. Specifically, the damage and needs assessment should look at five components: tangible cultural heritage, intangible cultural heritage, creative and cultural industries, cultural tourism, and historic housing stock and land resources.

Component 1.1: Tangible cultural heritage

For tangible cultural heritage on-site damage assessment, based on historic documentation and information about economic values associated with the loss of the assets function, have to be conducted by experts. These damage assessments are the basis to calculate replacement values, taking into consideration that historic assets have important non-use and non-market values.

Component 1.2: Intangible cultural heritage

Damage assessments for intangible cultural heritage require consultative processes based on local, community-centred historical knowledge where community members take the lead in identifying which assets have been affected to what extent.

Component 1.3: Creative and cultural industries

In addition to damages to tangible and intangible cultural heritage, damages to creative and cultural industries have to be assessed. These are establishments that provide or produce cultural goods or services, including schools of craft or informal training centres. These assessments must include which skills, knowledge, or know-how might have been lost and whether any established craftspeople were displaced. In addition, damage assessments for creative and cultural industries need to include institutional aspects, e.g. regulatory or licensing authorities for arts and culture.

To assess damages, UNESCO and the World Bank recommend to employ replacement cost methods to account for funds needed to rebuild structures or the industry. For this baseline data is necessary, including

- number, type, and size of commercial and manufacturing facilities, their specifications and machinery;
- annual production and equivalent monetary amount;
- destination of the manufactured goods; and
- local and domestic consumption and value of cultural product exports.

Component 1.4: Cultural tourism sector

Under this umbrella fall productive activities that cater mainly to visitors. Here, damage assessments must examine both the demand and supply-side to make sure that the rebuilding timeline for tourist accommodations correspond with the estimated number of tourists during recovery.

Component 1.5: Historic housing stock and land resources

Damage assessments for historical housing need to also consider the related land, because housing units in historic areas can be built on land with unclear property rights and might be occupied by people with uncertain or undocumented tenure (mainly an issue in developing countries).

Assessments for this types of historic asset require consultation of pre-disaster regulations and guidelines specific to the historic areas, land-use and architectural requirements, as well as national and local housing regulations.

Phase 1: Scoping

Once relief efforts are completed and the affected area has reached a more stable state, scoping can take place. This part of the first phase builds on the damage and loss estimates as well as the preliminary listing of reconstruction and recovery needs (cf. Sections 3.1.1 and 3.1.2).

Similar to module 2 of the DRF development, scoping requires to bring together all stakeholders in order to identify their needs and develop a common vision for reconstruction and recovery, based on a thorough data analysis to develop a broad picture.

The scoping phase consists of four components: data collection and analysis, asset mapping, stakeholder mapping, and vision development.

Component 1.6: Data collection and analysis

Data collection for scoping should be conducted both at micro (historic area) as well as macro scale (city-wide) and include baseline data on all sectors in order to understand a city's relationship within its country and region. UNESCO and the World Bank suggest to include pre-disaster information on *"cultural and natural heritage assets, economic data, social data, growth dynamics, market assessments, and obstacles to growth"* [12]. This pre-disaster data could then also be used to benchmark the achievement of the BBB principles.

Component 1.7: Asset mapping

This component deals with recording the available human, social, cultural, economic, and physical resources in the affected areas and requires community input to understand the value of assets and ensure a comprehensive approach.

Component 1.8: Stakeholder mapping

As stated previously, a key component for BBB – in particular for cultural heritage – is the identification and engagement of key communities and local organisations, including under-privileged groups that have not conventionally participated in the planning recovery process (cf. Section 3.1.2). UNESCO and the World bank suggest in [12] to map out the dynamics and relationships among stakeholder groups for better understanding.

Component 1.9: Vision development

The vision development is the main component of the scoping phase. Similar to the Pre-Disaster Recovery Planning described in Section 3.1.2, the goal of this component is to provide a shared idea of the future direction of the city that is owned by all stakeholders and is empirically grounded using all available data sources from pre- to post-disaster.

Phase 2: Setting Policy and Strategy

After needs and damages are assessed and a common vision is defined, operational actions that translate this information into an implementable plan need to be defined. This is the goal of the second phase, similar to module 2 of the DRF development (cf. Section 3.1.1) and the first component of the PDRP planning cycle (cf. Section 3.1.2).

The policy and strategy phase of the CURE framework consists of three components: Designing a planning process, regulatory mechanisms, and civic engagement.

Component 2.1: Designing a planning process

The planning process for post-disaster reconstruction should be inclusive, transparent, and objective, allowing public, private, and community stakeholders to interact in the reconstruction development and implementation. UNESCO and the World Bank recommend to establish a central coordination entity to make sure that different sectoral reconstruction plans align with each other (cf. [12]).

Component 2.2: Regulatory mechanisms

The reconstruction phase after a disaster is an opportunity to revise existing planning regulations and ensure the development of building codes and regulations that will produce a more sustainable and resilient urban area. In order to support the uptake of new regulations and the implementation of new building codes, post-disaster approval processes should be streamlined (cf. Section 3.1.4).

GFDRR suggest in [14] that *“building codes should ensure resilience and compatibility with traditional construction practices and features. Proper building codes and technical guidelines can include the harmonisation of construction projects and materials of new structures compatible with the local cultural and natural heritage.”* The Istanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) project that implemented seismic retrofitting designs at multiple heritage structures is a good example of such an approach (cf. [14]).

Component 2.3: Civic engagement

As in the previous phases of the CURE framework, the involvement of affected communities in all activities of reconstruction and recovery is essential. Therefore, all *“planning [activities] must evaluate community dynamics, capacity, and post-disaster social capital to identify the way in which communities can be engaged in the reconstruction and recovery processes.”* [12]

Phase 3: Financing

Before implementation can begin, funding needs to be secured, which is challenging in a post-disaster setting. According to UNESCO and the World Bank *“[t]he process usually starts with a large, upfront investment by the public sector to rehabilitate infrastructure and housing. The process then moves to leverage government investment and public assets to attract private sector investment.”* [12] This is in line with module 4 of the DRF development (cf. 3.1.1) and consists of five components: Identifying funding resources, management of land resources, land value capture, land re-adjustment, and city-led financing tools.

Component 3.1: Identifying funding resources

The aim of this component is to identify a reliable pool of funds to start rebuilding. It is important to note that the reconstruction process differs from the regular budget cycles and procedures, i.e. it must be quicker and more flexible due to rapidly changing conditions.

Component 3.2: Management of land resources

This component is mainly targeted at cities in the developing world, where property ownership does not necessarily follow a clear-cut regime. The aim should be to employ local institutions and traditional dispute resolution mechanisms, as well as effective community participation to manage post-disaster urban land resources.

As UNESCO and the World Bank note *"[i]n cities with a large number of informal settlements, crises may provide an opportunity for the normalisation of land tenure."* [12]

Component 3.3: Land Value Capture

Land Values Capture is a set of different financing schemes that cities can use to leverage land assets in financing infrastructure (see [12] for details).

Component 3.4: Land re-adjustment

Land re-adjustment is a principle that allows landowners to pool their land in cooperation with the local government to undertake a redevelopment project, but *"should [only] be undertaken [in historic areas] in exceptional cases, where lands are of unusual shape or result from recent subdivisions. The priority should be given to the conservation of architectural and urban heritage and the traditional urban fabric."* [12]

Component 3.5: City-led financing tools

This component handles the use of incentives or regulations to create attractive real estate markets and encourage redevelopment in post-disaster situations where the private market is not yet strong enough to invest. For example, local authorities can transfer development rights, offer grants for specific purposes, or use tax-based incentives.

Phase 4: Implementation

Once damages and needs are known, a plan is made, and financing is secured, implementation can start. The aim of this phase is to bring together all previous elements of the reconstruction project cycle by setting up an institutional framework that ensures the sustainability of the process and divides the project into logical activities. This is in line with modules 5 and 6 of the DRF development (cf. Section 3.1.1) and component 2 and 3 of the PDRP cycle (cf. 3.1.2).

The implementation phase consists of three components: Institutional arrangements, risk management, and communication and engagement strategy.

Component 4.1: Institutional arrangements

The phase begins with setting up a reconstruction and recovery management structure with a long-term vision that should lead all efforts from emergency management to the recovery phase through to normal governance and stability. This structure can either be centralised, decentralised, or a hybrid between the two.

A centralised structure could locate the reconstruction and recovery management within the central government, which is the usual approach for disasters that surpass regional and state boundaries. In decentralised reconstruction management systems policy-making at the local level is prioritised with some support and coordination provided by the national government. Finally, hybrid systems work across different levels of government, but remain under tight supervision from the central government.

UNESCO and the World Bank note that *“[u]nder certain circumstances, a development corporation can be formed to take on the reconstruction efforts, but only under the control of local governments. These development corporations must have strong technical capacities, notably in culture, heritage, and communication. They operate outside of restrictive civil service legal frameworks (especially for recruitment and procurement) and are semi-autonomous.”* [12]

These corporations should have a clear mandate that establishes how the population and local government will keep control and should take *“social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity [into account], when establishing the boundaries of the project area, to enable a sound urban design and reconstruction strategy.”* [12]

Component 4.2: Risk management

The reconstruction after a disaster faces similar risks as any large-scale construction project. However, *“[i]n rebuilding after crisis, the stakes are even higher because of trauma and a lack of human and social capital.”* [12] Therefore, implementation of recovery and reconstruction measure requires a sound risk management approach.

Component 4.3: Communication and engagement strategy

The implementation phase needs to be accompanied by a communication and engagement strategy. UNESCO and the World Bank in [12] identify five components of an effective communication and engagement strategy:

- Mapping existing initiatives on the ground including good practices to identify possible institutional and financial partners.
- Giving due consideration to the importance of public and civic spaces in the collective post-conflict healing process
- Advocating for increased collaboration between institutions, civil society organisations, cultural and artistic public policies, and youth-led initiatives.
- Taking into account post-disaster induced change in the composition of the inhabitants of historic urban areas and the emergence of new local communities.
- Mediating conflicting opinions on the value of heritage for different local communities amid political and identity tensions as reconstruction can also trigger conflict when one community / authority might claim their heritage and reject that of other communities.

Therefore, it is critical to ensure public participation that encourages collaboration between communities and reconstruction teams.

Another very important point is to choose the right medium for communication. Choosing the wrong medium might limit the communities that can be reached, because not all communication mediums are equally relevant for all community groups (cf. [5]).

3.4. Biases in Building Back Better

In the previous section we already discussed some of the potential problems that can occur when trying to apply BBB to cultural heritage. Another issue that is identified by Delay and Rahmayati in [11] considers (re)construction managed by Non-governmental organisations: If (re)construction is driven by NGOs and filtered through arrangements of construction companies and subcontractors, delays, confusion, and the construction of housing inappropriate within local cultural and social context can result. This might force displaced people to react to very different and unfamiliar spatial parameters, which are not sympathetic to pre-existing conditions. In addition, this can undermine important mechanisms for internally-driven social rehabilitation, as well as effective distribution of aid resources.

This reinforces the point made several times previously that community engagement is key for BBB. Delay and Rahmayati even argue in [11] to *“counter ‘build back better’ with ‘reconnecting with the cultural past’ as another lens for conceptualizing post-trauma relief and reconstruction projects.”* And to define *“community recovery as re-establishing as best as possible the social trajectory and momentum that existed within a community prior to a disaster, to the point where communities can manage the longer-term effects of devastation and trauma within frameworks of stability and change defined internally.”* They argue further that the *“success of recovery efforts [should be measured] as how well communities are able to continue as cohesive social and cultural entities in the aftermath of reconstruction.”* UNESCO and the World Bank address some of these issues with the CURE framework in [12]. However, since the implementation of the CURE framework is contingent upon the specific local situation, the authors want to reiterate these potential biases at this point.

Other biases that BBB can be prone to come from its strong link to the recovery phase and include:

- People benefiting from recovery projects have a vested interested in the continuation of the project and might be less inclined to criticise the project or discuss problems (cf. [9]). It is especially important to be aware of this bias when gathering information and engaging affected communities (e.g. when letting people exchange experiences about the project).
- Recovery efforts to date still reflect traditional gender stereotypes, prioritizing the needs of men and excluding women from equitable assistance, placing them at even greater risk of future harm. In addition, women’s skills and knowledge are still too often marginalized, limiting their opportunities to participate to a larger extend in Building Back Better (see [15]).[1]

[1] We refer to State-of-the-Art Report 5 for a more nuanced discussion of this issue.

- Building Back Better often focuses on physical improvements to construction characteristics (see Section 2), which can run counter to concerns of heritage practitioners about loss of authenticity and integrity when not considering traditional materials and knowledge/technologies for such improvements (see [16])

4. ARCH project issues and connections

As the previous sections have shown, there does not exist one definitive process for Building Back Better, but rather a set principles and methods to be applied over the whole DRM cycle that have to be tailored to local conditions and need to be conscious of the specific issues of CCA and cultural heritage. While CCA can be included in BBB relatively easy, BBB for cultural heritage is complicated and can run counter to heritage conservation as well as damage recovery and reconstruction effects, as discussed in Sections 3.3 and 3.4. Nonetheless, if done right BBB can significantly help to increase the resilience of tangible and intangible cultural heritage. To achieve this, culture needs to be put at the centre of the DRM cycle, as described in [12].

This leads to the first issue ARCH should examine: **Which aspects of the CURE framework can / should be included in the ARCH DRM framework, developed in WP7, and how?**

The majority of the discussed general publications about Building Back Better and associated frameworks / guidelines identify the improvement of structural designs, enforcement of revised building codes, and adaptation of land-use planning as important principles. As discussed in Section 3.3, this can be problematic in the context of cultural heritage – and thus in the context of ARCH. Changing the structural design or building codes of (tangible) cultural heritage can only be done to a very limited extent without running the risk of changing the cultural and social value. In addition, changes to cultural heritage might endanger its legal status, e.g. as World Cultural Heritage. Similarly, changes in land-use planning need to consider effects on tangible and intangible cultural heritage. Otherwise, risk-informed land-use planning might result in unforeseen effects, e.g. changes in traditional behaviour of communities or even migration of communities away from a heritage site.

This identifies the second issues ARCH should examine: **Which changes to building codes and structural design to historic assets can be done without risk of changing the cultural and social value, authenticity, and integrity (see also SotA report 1)? And can the effects on social / cultural value be measured reliably? The resilience options inventory, developed in WP6, should try to assess the effects certain resilience measures have on these aspects.**

In addition to the above mentioned principles, the involvement and participation of local communities and the use of local / traditional knowledge was emphasised. As shown by UNESCO and the World Bank in [12], cultural heritage can play a key role in this regard, as it reflects cultural, historical, and social values. The information contained within cultural heritage (be it build materials / architecture or traditional community knowledge) can play an important role when designing recovery plans and measures. At the same time, the strong cultural and social values of cultural heritage for a multitude of communities can require more extensive consultation processes.

This has implications for multiple work packages:

- The co-creation process, conducted in WP3, should try to engage a larger set of stakeholders from the pilot cities than just the project partners. This was already anticipated by including specific local co-creation activities for every city, aimed at employing the developed method and tools to solve local problems while engaging with local stakeholders.

- Since intangible cultural heritage and cultural / social constructs are an immeasurable asset for DRM and BBB in the context of cultural heritage, **ARCH should examine if and how these intangible assets can be included in the information management systems of WP4.**
- In addition, it would be worthwhile to **examine in WP5 if and how the effects of disasters on intangible cultural assets and cultural / social constructs can be assessed.**
- **The resilience options inventory, developed in WP6, should aim to include resilience options based on local practices, knowledge, and know-how**. In part, this will be addressed via task 7.2 (Review, map, and characterise experiences and good practices). However, **ARCH should additionally examine how to enable the inclusion of further local knowledge into the resilience options inventory**.

Lastly, when adapting the UNDRR Disaster Resilience Scorecard for Cities for the ARCH resilience assessment framework in WP7, **it should be examined how more focus can be put on cultural heritage appropriate BBB issues at appropriate position(s), including more specific assessment questions regarding PDRP, DRF, and relevant points from the CURE framework.**

5. Conclusions

This report discussed the concept of Building Back Better (BBB), with a specific focus on BBB in the context of cultural heritage and climate change adaptation (CCA). After introducing the most important definitions of Building Back Better, Pre-Disaster Recovery Planning, and Disaster Recovery Framework, a general BBB Framework and how to incorporate it into the DRM cycle was discussed. Afterwards, specific issues in BBB for CCA and cultural heritage were discussed. As has become clear, there does not exist one definitive process for Building Back Better, but rather a set principles and methods to be applied over the whole DRM cycle that have to be tailored to local conditions.

When applying BBB to cultural heritage, numerous issues have to be addressed, from relatively obvious regulatory issues like limited possibilities to change building codes or structural composition of historic assets to complex issues regarding the effects of disasters and recovery / reconstruction efforts on intangible heritage and social / cultural constructs. The CURE framework was presented as a first step in bringing culture to the forefront of recovery and reconstruction (and thus BBB).

For BBB in the context of cultural heritage to be successful, culture has to be mainstreamed into the DRM cycle, the involvement and participation of local communities and potentially affected population groups has to be strengthened, and local / traditional knowledge has to be included when designing recovery and reconstruction efforts.

To address the identified issues, the report made several suggestions on how to address recovery / reconstruction and BBB issues over the different work package of ARCH and suggested to include stringer references to the CURE framework.

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7. Annex

7.1. Glossary of specialist terms

Term	Explanation	Source
Building Back Better	This concept refers to the use of the post-disaster recovery and rehabilitation phases to build the resilience of nations and communities, through the integration of disaster risk reduction measures in the restoration of physical infrastructure and social systems and in the revitalization of livelihoods, economies and the environment. This process should take into consideration new risk zones and the population's recent experiences in responding to the impacts of natural hazards.	Adapted from [3]
Pre-Disaster Recovery Planning	Any planned attempt to strengthen disaster recovery plans, initiatives, and outcomes – before a disaster occurs. […] PDRP consists of a series of decisions and actions to be taken both before and after a disaster, in order to • Identify and establish shared recovery goals, objectives, and strategies – to guide post disaster decision-making, ensure that relief and recovery activities align with long-term development goals, address actual needs, and enhance resilience to future disasters. • Develop and have ready the capacity to plan, initiate, and manage – an efficient, adaptive, and well-coordinated recovery effort that progresses towards the recovery goals.	[5]
Disaster Recovery Framework	This framework would guide governments and other implementing stakeholders in the middle and longer term recovery efforts. The framework would help in articulating a vision for recovery; defining a strategy; prioritizing actions; fine-tuning planning; and providing guidance on financing, implementing, and monitoring the recovery. Through developing a country-level disaster recovery framework, a government will be better positioned to drive a process that unites all development partners' efforts. Additionally, by developing a framework to manage recovery, a government may be able to better address longer term disaster vulnerability through coherent programs that bridge the current gap between recovery and development.	[6]

7.2. Key resources

UNDRR, “Building Back Better in recovery, rehabilitation and reconstruction,” 2017. [Online]. Available: https://www.unisdr.org/files/53213_bbb.pdf.

- A general guide on how to include BBB in the DRM cycle

IRP and UNDRR, “Guidance Note on Recovery: Pre-disaster recovery planning,” 2012. [Online]. Available: https://www.unisdr.org/files/31963_predisasterrecoveryweb.pdf.

- A general guide on Pre-Disaster Recovery Planning

ParlAmericas and UNDRR, “Parliamentary protocol for disaster risk reduction and climate change adaptation: Aligned with the Sendai Framework for Disaster Risk Reduction 2015-2030,” 2019. [Online]. Available: https://parlamericas.org/uploads/documents/ENG_Protocolo_DRR_Online_Version.pdf.

- A general guide on how to address climate change adaptation in recovery and reconstruction efforts

UNESCO; The World Bank, “Culture in city reconstruction and recovery,” 2018. [Online]. Available: https://www.preventionweb.net/files/61959_131856wprevisediipublic.pdf.

- The description of the CURE framework, i.e. how to mainstream culture in recovery and reconstruction efforts

P. Delay and Y. Rahmayati, “Cultural Heritage and Community Recovery in Post-Tsunami Aceh,” in From the ground up: Perspectives on post-tsunami and post-conflict Aceh, P. Daly, R. M. Feener and A. J. S. Reid, Eds., Institute of Southeast Asian Studies, 2012, pp. 57,78.

- A critical discussion of BBB principles and recovery efforts, based on surveys in post-tsunami Aceh, including extensive discussion on how to include culture in recovery efforts

ARCH State-of-the-Art Report 4

Decision support systems: applications, frameworks, and technologies

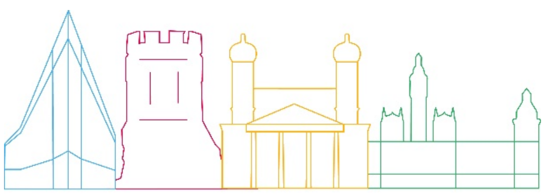

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Table of Contents

List of Abbreviations

Abbreviation	Meaning
AR5	IPCC Assessment Report 5
BSotA	Beyond the State of the Art
CC	Climate Change
CCA	Climate Change Adaptation
CHC	Cultural Heritage Conservation
CHP	Cultural Heritage Preservation
CI	Critical Infrastructure
CIP	Critical Infrastructure Protection
DRR	Disaster Risk Reduction
DS	Decision Support
DSS	Decision Support System(s)
EISAC	European Infrastructure Simulation and Analysis Center
GHG	Green House Gas
GIS	Geographical Information System
IBVA	Indicator-Based Vulnerability Assessment
INSPIRE	Infrastructure for Spatial Information in Europe
IPCC	Intergovernmental Panel on Climate Change
MCDA	Multiple Criteria Decision Analysis
MCDM	Multiple Criteria Decision Making
SEIS	Shared Environmental Information System
SotA	State of the Art
TRL	Technological Readiness Level
UNDRR	UN Office for Disaster Risk Reduction
VSB	Vulnerability Sourcebook
VSBM	Vulnerability Sourcebook Method

Executive Summary

Due to complexity and variety of uncertainties, climate change adaptation for historic areas is a ‘wicked problem’, i.e. a problem that is difficult or even impossible to solve, optimally. Decision Support Systems (DSS), often defined as ‘computer technology solutions that can be used to support complex decision making and problem solving’, can help to reduce uncertainties by evaluating quantitative data and supporting the process of prioritising actions and solutions, and thus give guidance to decision makers and authorities with the goal of improving decision quality.

This State-of-the-Art report provides an overview of DSS, especially in the context of management and response risks, physical damage and economic impacts to cultural heritage objects and areas caused by climate change effects, natural and man-made incidents and other large-scale events. The report begins with a short summary of the development and history of DSS in the last 50 years. Much of the early research was dedicated to understanding what DSS could be, what support they could provide, and what limitations they have. Several different methodologies for designing DSS have been developed, including model-driven, data-driven, knowledge-driven, and communication-driven DSS. All these systems share a common worldview: While the DSS recommends actions, the decision ultimately is left to a human decision maker, who is thus responsible for its outcome. For this reason, the decision maker, the DSS user, needs to understand the way the recommendation has been generated and what the limitations of the DSS are.

The report then goes on to present an overview of computer-based DSS for ARCH’s core application domains, namely climate change adaptation and cultural heritage preservation. All decision-making in these domains relies on data and information derived from that. Therefore, the overview also covers the range of available and necessary technology for eliciting required data, like environmental monitoring and 3D object/areas scanning, and information and knowledge management systems for processing the elicited data and information derived thereof.

The report introduced the DSS already in use or developed by ARCH partners, examines existing functionality, and discusses first ideas of missing features and potential ways to deliver them.

1. Introduction

The late 20th century marked a rapid growth in public concerns about the future of the Earth's environment due to severe climate change impacts, leading to a demand of evidence-based actions to reduce those impacts and to adapt to them. Understanding the processes of climate change and determining actions for climate change adaptation however is a wicked problem with high complexity and many uncertainties. Methods and tools are needed to support decision makers and authorities for identifying effective solutions and making appropriate decisions.

Decision Support Systems (DSS) are part of the comprehensive management and response to critical situations. Situational awareness is raised by sensing and monitoring given circumstances, which are processed into quantifiable information thus allowing easier understanding of the acquired data. Data from various sources are correlated into a comprehensive view of the situation leading to new insights on the situation. This can be set into a framework that identifies and displays e.g. the given and occurring risks and problematic conditions, and give guidance and support for deciding for an effective solution.

This report offers an overview of DSS with a special emphasis on DSS in the field of climate change adaptation and cultural heritage preservation and common methods and technology used for DSS. This includes sensing, monitoring and surveillance systems, developing approaches that offer ways of processing such sensed data into e.g. models (e.g. when it comes to objects), propagation maps (e.g. when it comes to areas), simulation and scenario forecast (e.g. for determination of future evolutions), planning systems (e.g. corresponding to city planning).

1.1. Background information and aim of the report

This report reviews the state of the art in computer-based DSS for ARCH's core application domains, namely climate change adaptation and cultural heritage preservation. The aim is to identify areas of possible innovation that bear the potential of producing useful DSS with added value for ARCH's stakeholders. All decision-making in these core domains relies on data and information derived from that. Therefore, the state of the art review also covers the range of available and necessary technology for eliciting required data, like environmental monitoring and 3D object/areas scanning, and information and knowledge management systems for processing the elicited data and information derived thereof.

1.2. Relation to other SotA reports and deliverables

The Deliverable D7.1 consists of six SotA Reports that inform several tasks in the ARCH work packages 2, 5, 6, and 7. DSS as described in this report relate to the other SotA Reports of this deliverable as follows:

- **SotA Report 1** handles conservation practices and relevant regulations/policies that are relevant information needed as input data for the DSS.
- **SotA Report 2** handles Disaster Risk Management, emergency protocols, and post-disaster response that are relevant information needed as input data for the DSS.

- **SotA Report 3** handles the framework and processes of Building Back Better that need to be integrated in the DSS.
- **SotA Report 5** handles gender aspects in conservation, regulation, and disaster risk management of historic areas that have to be considered when designing a DSS.
- **SotA Report 6** handles standards and regulatory frameworks that are important information when designing and using a DSS.

1.3. Structure of this report

The report is structured into the following main sections:

- **Section 2**: Decision Support System: Brief history of DSS and an overview of DSS for the application domains of ARCH.
- **Section 3**: Environmental Monitoring and 3D Object/Areas Scanning: Detailing concepts and most applicable technologies to be used for acquiring data for DSS in ARCH
- **Section 4:** Information and Knowledge Management: Outlining main approaches to process existing and acquired data and for producing actual knowledge for end users.
- **Section 5:** Progress Beyond the State of Art (BSotA): Discussion of outcomes and conclusions indicating expected progress BSotA.

2. Overview of Decision Support Systems

2.1. Introduction

In this report, we understand a Decision Support System (DSS) [68]-[70] as a computer-based information system that supports organisational decision-making activities [29]. DSS can be particularly useful when a problem has characteristics of a ‘wicked problem’, a term coined in the domain of social policy planning [35]. According to Wijnmalen et al. ([37] p. 8 (p. 250)),

> *“‘Wicked’ problems are categorised by a great number of uncertainties relating to issues including stakeholders involved, the boundaries of the problem, the effects of long-term developments, organisation and responsibilities. In such contexts, decision making is rather based on subjective, judgement-based assessments.”*

Generally, the objective of a DSS is to produce information for a problem by analysing the data, in an intelligent and fast way a human cannot in reasonable time. Decision-making can be supported by a wide array of tools and methods. Decision support tools include statistical figures, maps with special information layers, or simple Excel sheets. Historically, a number of different understandings, definitions, and research approaches on DSS exist, with the specific meaning of the term shifting over time and depending on the community, from being firmly rooted in operations research to a visual interface giving access to data warehouses [25].

A common view is that a computer-based solution to be classified as a DSS has to support governmental, business, or organisational decision makers with at least four functions [33]:

- Provide a *unified view* on data or information stored in one or more databases or documents;
- offer functions to customise that view, and use visualization to *improve the understanding* of the existing data and its interdependencies;
- provide access to models and/or analysis tools to *explore potential improvements*; and
- provide these functions in an interactive fashion to *support non-expert users*.

Wijnmalen et al. ([37] p. 11 (p. 253)) characterise two fundamental types of methods and techniques for decision support, namely ‘hard’ and ‘soft’ ones:

> *- ‘hard’ methods and techniques are predominantly based on quantitative analysis (characterized by mathematical models, algorithms, factual and objective information; value proven by theory). These are well-suited to puzzles;*
>
> *- 'soft' methods are based on human judgement in a qualitative analysis (governed by guidelines and non-mathematical reasoning principles or interpretative logic; value proven by experience). These are likely to be used for addressing wicked problems.*

2.2. Historical developments

A number of historical overviews on the field of DSS exist [2][8][18][24][25]; the next few paragraphs roughly follow the introduction to the field by Power [25].

While the roots of DSS can be traced back to the works of Vannevar Bush [4] and Douglas Engelbart [8], the first DSS in a modern sense were researched and implemented in the second half of the 1960s, when the advent of time-shared mini-computers led to an explosion of computing applications beyond centralised number crunching. As a first systematic study in 1966-1967, an early researcher in the field, Michael S. Scott Morton, developed and evaluated a 'Management Decision System' allowing marketing and production managers to coordinate production planning for laundry machinery [26]. In a further research step, Gorry and Scott Morton argued in 1971 that such a "Management Decision System" would primarily help to take structured decisions in a well-understood environment, while a computer system focussing on semi-structured and unstructured decisions should be named "Decision Support System" [9]. To be useful, such a system would have to be, it was found, robust, easy to control, simple, and complete in all details relevant for the decision [15].

Most early DSS were *model-driven*: they used limited access to data and input provided by the decision makers to parameterise and execute financial, optimisation, or simulation models [25]. While they had the potential to help analysing a given situation and decision options, they generally did not offer access to large databases, especially not to real-time ones [23]. Following the first 15 years of research, development, and evaluation of model-driven DSS, one verdict was "encouraging but certainly not uniformly positive" [25][28].

In the late 1970s, the first *data-driven* DSS combined model-driven systems and relational databases, beginning with offering real-time information screens for senior executives [12]. These systems, providing access and first visualisations of historic and real-time company data grew into data warehouses with additional real-time analytical processing [5]. In the 1990s, a popular category of data-driven DSS was Business Intelligence (BI) products, providing "concepts and methods to improve business decision making by using fact-based support systems" [25].

Knowledge-driven DSS added specific problem-solving capabilities to the availability of models and data, which allows them to recommend potential actions to decision makers [25]. While some systems have their roots in research conducted in the 1960s, their application flourished in the 1990s [14][23]. While classic knowledge-driven DSS often utilizes expert system technology [11], recent technological advances have brought into focus DSS applying Machine Learning methods [25].

In addition to model-driven, data-driven, and knowledge-driven DSS there were a number of technological side arms that evolved from being (part of) DSS into their own categories of software tools. *Communication-driven* DSS included tools to facilitate communication and collaboration, e.g. groupware and video conferencing [23]; *document-driven* or text-oriented DSS provided easy access to a multitude of documents, including "policies and procedures, product specifications, catalogues, and corporate historical documents" [25]; and *web-based* DSS provided DSS functionality not through software to be installed on a decision-maker's computer, but via a web-browser on a PC or thin client [22].

2.3. Current developments and trends

During 50 years of research and implementation, DSS developed from simple model-based tools available via time-shared mini computers to web-based portals to corporate data resources unlocked by major artificial intelligence breakthroughs. On that way, the decision makers using DSS have pawned or facilitated classes of tools like groupware and video conferencing.

Corresponding to the competitive environments DSS usually exist in, adoption, utilisation, and success of their implementation are still regularly analysed. Current surveys and meta-studies [17][31] show the still increasing research interest, with the majority of the studies (56 percent) using quantitative methods, and a large minority (40 percent) examining and comparing DSS from multiple sectors such as government services, transportation, insurance, communications, health care, banking, agriculture, construction, and professional services [31].

A main research field currently is the *adoption of DSS by end-users* and the identification of the factors that impact that adoption, the motivating factors determining the behaviour of end-users towards the systems, as well as the overall success of the usage and its impact on the organisation itself. That impact is often measured as decision quality and performance [32] or in the dimensions of information quality, service quality, system quality and use, user satisfaction and net benefits [6][7]. While significant gains realised by DSS adoption are noted, many researchers see a need for further research caused by the prospective users' lack of motivation, capabilities, and ability to explore the system [31][32].

A fast-growing branch of *end-user DSS* research is the development and evaluation of *Recommender Systems*, i.e. systems that personalise online product, service, or news article recommendations [17]. With first systems being developed in the 1990s the field has seen, being part of the ever-increasing importance of e-commerce, a significant research attention for decades. Following the general trend, in the last few years the applications of machine learning technologies does see a lot of research interest, with first systematic surveys and meta-analyses [13][20]. Here, supervised machine learning approaches seem to be most popular by far (156 studies examined them), with unsupervised learning approaches following as second (46 studies were found). Only very few authors examined semi-supervised or reinforcement learning approaches [20]. Regarding types of machine learning algorithms used, ensemble learning, K-means and Support Vector Machines lead in the DSS field.

Other current research fields include the design of *interactive visualization* elements based on evaluating users' cognitive style and spatial ability [16], the utilization of *crowd-sourced and social media data* [21][30][34], as well as the potential advantages by utilizing *machine learning technologies* beyond simple input classification [20].

2.4. DSS in the context of Protection of Cultural Heritage

The use of DSS has been suggested in the field of cultural heritage for recommending restoration actions [69] and restoration materials [71], estimating the restoration budget [72], identifying ideal room ventilation conditions for preventive conservation purposes [73], ranking heritage buildings intended for renovations [62] and prioritizing preservation actions [74][75]. The ranking and prioritisation of preservation actions is important for the efficient restoration of cultural heritage objects under limited budget. The main challenges of decision support in Cultural Heritage Conservation (CHC) and Cultural Heritage Preservation (CHP) and the above-mentioned methods are described more analytically in the following.

2.4.1. Main challenges of decision support in Cultural Heritage Conservation and Preservation

Cultural heritage serves as an important factor in the fields of sociocultural capital, education and economic development [56][59]. In 2008, UNESCO defined in the 'Policy Document on the Impacts of Climate Change on World Heritage Properties' the following research areas concerning the preservation of cultural heritage [55]:

- "Understanding the vulnerability of materials (indoor, outdoor, buried) to climate variables (for example, particularly too much or little moisture effects).
- Understanding how traditional materials and practices need to adapt to extreme weather events and a changing climate.
- Development of fail-safe methods and technologies for monitoring the impact of climate change at properties.
- Understanding climate change impacts causing changes in society i.e. movement of peoples, displacement of communities, their practices, livelihoods, and their relation with their heritage."

According to [62] the main challenge in heritage preservation is the identification of the main purpose for the preservation. This can be the preservation and/or increase of the heritage's item's value for either research, and/or social and symbolic status, and/or sentimental value. Decision on adaption actions are based on economic factors, the variety of stakeholder demands and values and the environmental impacts on the building [59]. DSS frameworks are designed to identify the main proposes for preservation and prioritize and rank preservation actions under consideration of the costs.

2.4.2. Methods and tools

Decision making in cultural heritage is highly limited by the data available about the heritage site. Data compilation, exploitation and management is a key factor for DSS. In [57] and [58] Kioussi et al. provide methods for improved and integrated documentation strategies that are built on already existing documentation procedures. They propose an integrated documentation protocol developed in three stages. These are the identification of the state-of-the-art in the field, the advancement of the current data level and documentation procedure and finally the development of appropriate indices for the correlation of the updated and standardised data, which then are used in the decision making process.

Facing the economic factor in decision making processes, the study conducted in [72] presents a cost estimation concept based on the case-based reasoning (CBR) approach instead of a traditionally intuitive estimation method. In CBR model, two retrieval techniques, 'Inductive Indexing' and 'Nearest Neighbour', are applied to retrieve relevant cases from the knowledge-based database. Two of the most common types of Taiwan historical buildings are tested to explore the restoration cost implications. The result reveals that the CBR solution can effectively predict the actual restoration cost (since the retrieval result, based on past project's experiences, has taken work order changes and modifications of the budget into account), solve order change problems, and reduce the budget review time, to avoid a lengthy and complicated procedure delaying the restoration implementation.

In a more recent work regarding CBR [69], it appears that, as a problem-solving approach that uses specific knowledge of previous experiences for solving new problems, in a very similar way to how humans rely on their previous experience, it is a very promising approach. A CBR-based problem diagnostics application, proposed there, is intended to support Construction Industry workers on the restoration site in problem solving in the specific area of the built stock restoration in a fashion resembling the experienced workers' approach. The solution presented and results obtained in its current testing, provide a good basis for identification of the correct problem causes, i.e. are allowing for a more efficient identification of the problem and appropriate restoration actions.

Since the performance of each material on the restoration phase significantly differs with respect to its type, chemical properties and the building substrate, a decision support architecture able to face these obstacles is proposed in [71]. In that paper, a new DSS architecture suggesting the most suitable restoration actions for cultural heritage monuments is described. The architecture first includes the introduction of an aligned integrated documentation protocol acting as cultural identity card. Then, a collective intelligent DSS is proposed which is able to interoperable describe the cultural content while simultaneously suggest the most suitable restoration options as that conservation is achieved at a maximum degree, while potential negative effects on the monument status and 'cultural quality' is minimised.

In the area of preventive conservation, special climate requirements are present. Especially fluctuations in climate values should be reduced in order to avoid damages of the sensitive materials of cultural heritage. For example, in several applications, no modern ventilation systems are present, such that the only ventilation option is the opening of windows and doors by human. Therefore, serious climate fluctuations occur, if the ventilation strategy is not adapted to the climate situation. To avoid this situation, a monitoring and DSS is developed in [73]. In the face of the specials needs of reducing climate fluctuations in the area of preventive conservation, a fuzzy approach to realise a predictive monitoring and DSS considering weather forecasts, is presented. A method for adapting weather forecasts to local microclimates is analysed. The fuzzy approach allows considering the inexactness in predicted values, which increases the system robustness significantly.

Decision makers or executors often encounter with taking decisions on which heritage is prioritised to be restored within the limited budget [62]. However, very few tools are available to determine appropriately restoration priorities for the diverse historical heritages, perhaps because of a lack of systematised decision-making aids. In [74], a model for determining restoration priorities of cultural heritage under the limited budget is proposed and compared to current procedure favoured by decision makers in the Cultural Heritage Administration. To illustrate the model's efficiency, 14 cultural heritages in Korea were studied and the results were statistically analysed. Few primary contributions of this document are summarised at identifying significant criteria through three Delphi rounds and providing an alternative process for carrying out an assessment of restoration urgency of cultural heritage. It reflects the contribution effect of evaluators' expertise and knowledge on weighting the criteria and scoring restoration needs in an objective and quantitative way, as well as assisting the executors in interpreting probabilistically the ranks of restoration priorities for making a decision more rational and persuasive, comparing to the procedure depended on intuitive decisions.

A more recent work on prioritisation [75] discusses the meaning and nature of urban cultural heritage, and the available methods for its evaluation in the perspective of sustainable city development. That paper presents the multiple criteria assessment of alternatives of the cultural heritage renovation projects in Vilnius city. The model consists of the following elements: determining attributes set affecting built and human environment renovation; information collection and analysis; decision modelling and solution selection. The main purpose of the model is to improve the condition of the built and human environment through efficient decision making in renovation, supported by multiple attribute evaluation. Delphi, analytic hierarchy process (AHP) and additive ratio assessment method with grey values (ARAS-G) methods, considering different environment factors as well as stakeholders' needs, are applied to solve the problem. To illustrate the model's efficiency, it has been applied to eight cultural heritages and the results were analysed. The decision support model presented in that paper can be used for objective evaluation in a realistic consultation and a fairly advanced administration. Based on this system, heritage buildings are evaluated. The eight criteria set presented in that paper are not perfectly satisfactory for all countries. The multiple-criteria-decision-making-based grading system is of considerable use to urban planners. It provides them with a stronger basis for determining which decision should be made. This would facilitate urban regeneration through the integration of the conservation scheme into the city development plan, while minimizing conflicts between stakeholders.

Generally, decision-making problems are complicated due to various factors affecting the event evolution and the uncertainty of decision information [76][77]. Especially, the study of [76] was part of RODOS (Real-time Online Decision Support), an ongoing European Union (EU) project on developing a support system for nuclear emergency management. Decisions on countermeasures are not only driven by the need to avert the radiation dose to the population, but are based on complex and multi-attribute problems, involving, for example, monetary costs and socio-psychological factors, such as stress and anxiety. These decisions have far-reaching consequences, yet they often have to be made under severe time-pressure constraints and conditions of uncertainty. Moral and ethical values held by decision makers and stakeholders are as important as the technical issues about the consequences of radiation. Even some of the underlying assumptions in neutral risk assessments may contain value judgments. This complex situation thus places high demands on the decision-making processes. Furthermore, according to [77], there are many comparison matrices for a complicated risk assessment problem, but a decision has to be made rapidly in emergency cases. However, in the analytical network process (ANP), the reciprocal pairwise comparison matrices (RPCM) are more complicated and difficult than AHP. Concluding, the design of effective DSS is a critical step towards improving the conservation of cultural heritage objects and shall incorporate intelligent decision-making methods to cope with the aforementioned key characteristics of object conservation, requiring dynamic, real-time, effective and cost-efficient solutions.

A DSS named ArcheoRisk [78] was developed to include the safeguarding of archaeological sites within the environmental management of the Venice lagoon and to select most effective safeguarding/rehabilitation interventions, whenever needed. The DSS relies on a Geographical Information System platform (Arcview) and is composed of two modules: (1) assessment of archaeological risk, (2) selection of interventions. It can be easily applied to different case studies and environments, thus providing a promising reference of GIS-based DSS and risk analysis application for the integrated management of environmental and cultural heritage.

The exDSS software, which is described in the first part of [79] and which has been developed for the purposes of the Climate for Culture project, is another, fully functional open source software for developing decision support tools. The applicability is not only in the field of cultural heritage, but it can be used anywhere, where the know-how of the experts can be structured into a form of logic decision trees or diagrams. The decision support tool for indoor-climate risk assessment and control, which have been outlined in the second part of the report, is freely available [80]. Due to flexibility of the exDSS software, various clones of the project can be created which are then free for modification. Thus, rather than a final and closed product, a platform for creating decision support tools is provided. The authors also see a large potential in the possibility to derive the future indoor-climate risk indices from the wide set of maps, which has been provided as one of the main results of the Climate for Culture project. Finally, the given decision support module has also been used for the dissemination of the Climate for Culture project results. Particularly, the case study reports and various guideline texts are available directly on the web interface of the Conclusions or are web-linked to them as pdf files.

Recently, simulation-enabled methods [81][82] have been introduced as part of emerging DSS, addressing cognitive and team functioning modelling [82] and environmental simulation [83]. Particularly, the purpose of [81] is to report on the design and use of a gaming simulation as a means of assessing one group decision support system (GDSS) for emergency response. The paper reviews related past work and focuses on the authors' recent experience in conducting quasi-experiments to assess Emergency Management imPROViser (EMPROV), a GDSS for improvisation in emergency response operations. The authors conclude that gaming simulations have the potential for assessing a DSS and its impact on the group it is designed to support.

More recently, [82] reports ongoing work whose objective is to increase the efficiency of emergency response solutions (ERS) through iterative cycles of human in-the-loop simulation, modelling, and adaptation. Ultimately, this cycle could either be achieved offline for complex adaptation (e.g., development of a novel interface), or online to provide timely and accurate decision support during an emergency management event. The method is able to achieve a high degree of realism and experimental control through the use of an innovative emergency management simulation platform called SYnRGY. That work is focused on the identification of critical functions associated with emergency management and on the development of a 'cognitive toolbox' to support them. This is possible with the holistic and objective measurement and modelling of cognitive and team functioning during simulated scenarios involving experts.

Key research challenges [68] in supporting successfully respective actors, refer to the ability of the DSS to accommodate evolving multi-factor knowledge, stemming either from real-time information (collection of data from sensors) or even from next generation simulation engines that can effectively incorporate both domain-specific and generalized simulation models. Despite this fact, however, the use of simulation methods for DSS development in cultural heritage related information is very limited.

Furthermore, as also in the focus of the ARCH project, climate change impacts on cultural heritage are more widely discussed. Fatorić et al. [56] show in their review paper, that research in this field increased since 2003. They state the presence of a wide range of methods, also due to local specifications, but they also state the need of using further interdisciplinary, multidisciplinary and transdisciplinary approaches for climate change adaptation. Current approaches such as in [59] and [60], consider the change of attributes, metrics and weights of the cultural resources over time and suggest a regular update of these. In [61], Forino et al. provide a value-focused, decision-analytic approach for climate adaptation planning for buildings in Newcastel, Australia. They present the cultural heritage risk index (CHRI) for assessing climate change-related risk for CHP, which incorporates risk as a function of hazard, exposure and vulnerability.

2.5. DSS in the context of Climate Change Adaptation

In this section, we summarise the main challenges in Climate Change Adaptation (CCA), motivate the need for specific Decision Support (DS) for stakeholders and actors in urban CCA, and give an overview on methods, tools, and recent standardisation activities in CCA. We conclude with pointing to recent best practices in DS for CCA.

2.5.1. Main challenges in Climate Change Adaptation

Climate Change Adaptation is a challenging task for the entire society. This task involves many different stakeholders, actors and practically all governance levels. Focal points of adaptation activity are urban and built-up areas, since more than 73% of the population of the EU-28 live in these types of areas.

As mentioned in the introduction, CCA has the characteristics of a ‘wicked problem’. In the following paragraphs, we characterise some of the factors that add to the complexity of CCA for urban areas, based on own experiences in the RESIN project [46].

The first, three-fold challenge is the related to actors in CCA. In many cities, there is still no dedicated person or department in charge of CCA. That is, the ownership of the CCA process is unclear, which may result in a delayed start of the CCA process or in less than optimal adaptation planning. The second part of this challenge refers to the fact that in the large agglomerations that urban areas are, a multitude of stakeholders needs to be included in the CCA process. These can be subject matter experts from different municipal departments, operators of infrastructure, stakeholders from the local economy, and last, but not least, the citizens. With so many actors involved, it is only natural that any planning of adaptation measures may lead to conflicts of interest. The third part of the challenge is related to governance. At certain points in the CCA process, the policy level needs to be involved. The policy level needs to approve adaptation plans and grant the required resources.

The second challenge arises from the uncertainties that CCA actors need to deal with. The first uncertainty is inherent to today's climate models that are available. This includes the correctness of the predictions (like rise in average temperature, change in rainfall patterns), the possible spatial precision of the predictions (which are decisive for effective local adaptation planning), and the correctness and the completeness of data for performing local risk assessments (if available at all).

More than thirty years ago, investigations of climate change started and simultaneously research and development on climate protection and climate change adaptation commenced on a global scale. These activities produced a wealth of information sources on climate change and guidelines and tools for climate change adaptation. Thus, the third challenge for CCA actors who want to make use of this wealth off assets is to identify relevant and well-suited assets for their needs.

Lastly, the fourth challenge is related to a recent change in fundamental methodology. Five years ago, the Intergovernmental Panel on Climate Change (IPCC) proposed a paradigmatic shift from indicator-based vulnerability assessment of climate-related hazards to a risk-oriented assessment, motivated by the desire to converge with concepts used in related domains like Disaster Risk Reduction (DRR) and Critical Infrastructure Protection (CIP). This shift in paradigm is suited to foster coordination of action in these domains for making better use of limited resources by using synergies. However, the proposed shift to risk assessment lacked a concrete method describing how to apply it practically, which constituted a barrier for inclined early adopters. Hence several different institutions started developing their own risk assessment scheme for CCA [44][45], which contributes again to the third challenge.

2.5.2. Types of Decision Support for Climate Change Adaptation

Experiences in projects like RESIN [44] and RAMSES [39] showed that it is possible and necessary to employ a mixture of both types of methods. For some areas of decision support in CCA, it is indeed possible to use quantitative analyses, as in assessing specific risks like fluvial flooding or heat stress. In addition, the availability of quantitative analyses may help convincing the policy level setting the right priorities.

For the remainder of this section, we provide a brief overview of the state of the art in decision support for CCA along five categories: frameworks, methods, general tools, information technology-based tools (IT tools), and standardisation.

Frameworks

Frameworks are a means of visualising proposed decision support processes and their embedding in or relation to other processes. Figure 1 shows an example from Wijnmalen et al. [47] that depicts the four main stages of decision support (after initiation). Each stage has, recursively, a similar four-stage structure. In addition, the entire process may need to be repeated. For the RESIN project, Carter and Connelly [48] present a cyclic framework for CCA, shown in Figure 2. The first cycle starts with a baseline risk assessment, continues with selecting and prioritising adaptation options, planning adaptation measures and ends with monitoring their implementation. A second, parallel cyclic – or rather continuous – process is shown that depicts the changes in the environment while the adaptation process takes place. These changes require a repetition of the adaptation process.

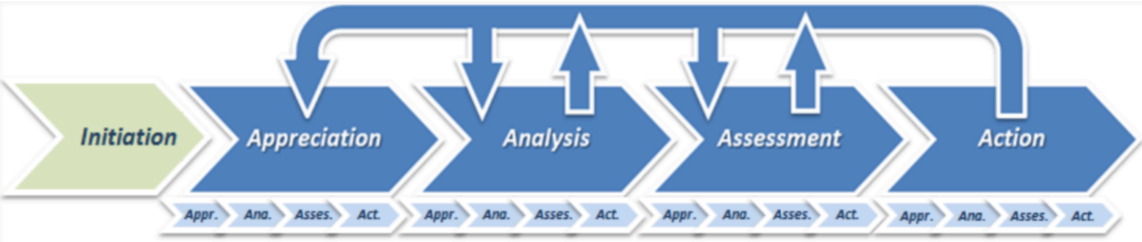

Figure 1: **Four main decision support stages [47].**

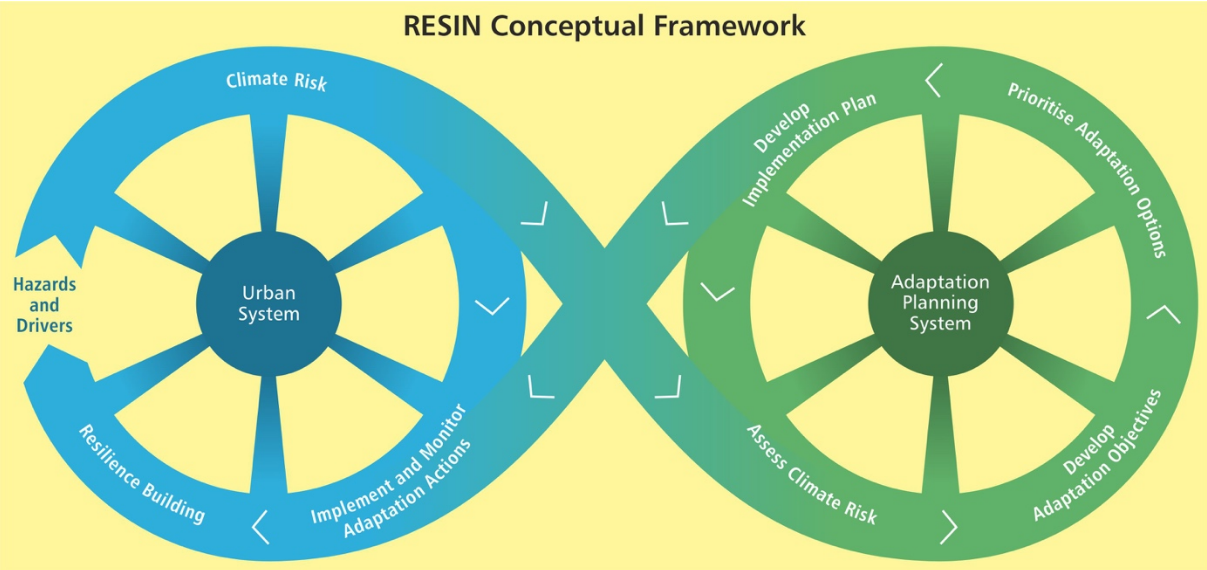

Figure 2: **RESIN concept framework for climate change adaptation processes [48]**

Methods

The ultimate goal of decision making in CCA is making optimal use of the limited available resources for achieving the highest possible degree of urban resilience against consequences of climate change. Decision support developed for and used in the complex task of CCA can be roughly divided into the following categories of action:

1) Assessment
    a. Vulnerability assessment (qualitative / quantitative)
    b. Risk assessment (qualitative / quantitative)
2) Reporting and presenting results to the political level
3) Planning, implementing, and monitoring adaptation measures

Ad 1) Assessment. Up to the publication of IPCC Assessment Report 5 (AR5) in 2014 [42], indicator-based vulnerability assessment (IBVA) was the general method of choices for performing assessments, though a standard implementation was lacking. Tapia et al. (2015, [50]) list some 70 papers in their literature review, most of them published in the 20 years since 1994. Compared to this wealth of vulnerability assessment methods, there are of course less papers that have addressed the paradigmatic shift to risk-oriented assessment proposed in the IPCC AR5. Tapia et al. (2015, [50]) were one of the first to react to the AR5 publication. They propose to calculate relative climate risk for cities as a score composed of aggregated and weighted indicators for hazard, exposure and vulnerability for each consider climate change induced hazard ([50], p. 68).

The German GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH) developed a modular method for vulnerability assessment, the Vulnerability Sourcebook Method (VSBM, [40] and [41]), published in the same year as AR5. Targeted mainly towards CCA in developing countries, this method has been widely used. In 2017, the same authors published a risk supplement, in which they adapted the VSBM for addressing risk rather than vulnerability.

Simultaneously, the RESIN project developed IVAVIA (Impact and Vulnerability Assessment for Vital Infrastructures and built-up Areas), which proposed a different way for adapting the VSBM to risk assessment [44]. The IVAVIA methodology aims to guide a risk-based vulnerability assessment, helping to map, analyse and communicate the impact of climate trends and weather events on key elements of your city's physical, social and economic fabric. IVAVIA provides guidance on how to prepare, gather, and structure data for risk-based vulnerability assessment; quantify and combine vulnerability indicators; assess risk; and present outcomes. As such it helps in understanding and visualising the cause-and-effect relationships of climate change, identifying geographical risk and vulnerability hotspots, assessing the demographic, economic and local impacts of climate change now and in the future, identifying entry-points for adaptation measures and areas where priority action is needed.

Both VSBM and IVAVIA include qualitative and quantitative methods for risk assessment. This allows stakeholders to choose a method depending on available resources and data. Since quantitative assessment requires data availability, knowledge in statistics, and more time than qualitative assessment, it may not be feasible for some stakeholders to perform a quantitative assessment. This makes quantitative assessment an area that is predestined for tool support.

Ad 2) Reporting and presenting results to the political level. After concluding an initial risk assessment, the results must typically be presented to the political level in order to get their support. Since this is a crucial stage in the adaptation process, some sources provide also guidance for presenting the results ([40], [44]).

Nowadays, many cities participate in frameworks like 'Covenant of Mayors for Climate and Energy'[1] or the '100 Resilient Cities'[2] initiative of the Rockefeller Foundation. Typically, these frameworks require periodic reporting of their members on their progress in CCA in a standardised (within one such framework) way. The mutual exchange and learning in such frameworks may also be considered a decision support method.

Ad 3) Planning, implementing, and monitoring adaptation measures. This category of action covers a good part of the right cycle in the RESIN conceptual framework, namely developing

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1 https://energy-cities.eu/project/covenant-of-mayors-for-climate-energy/

2 http://www.100resilientcities.org

and prioritising adaptation options, and developing, implementing, and monitoring an adaptation plan. This category of action involves to a good part finding and identifying best practices (relevant adaptation options, existing adaptation plans), but involves also application of methods for assessing adaptation options (like cost-effectiveness analysis, multi-criteria analysis) and monitoring the implementation of selected adaptation measures (using monitoring indicators).

General tools

General tools typically come in two flavours: comprehensive guidance documents and web-based information systems. Examples for step-by-step guides that guide the stakeholders through the adaptation process are the already mentioned Vulnerability Sourcebook ([40], [41], [45]), the RESIN IVAVIA Guideline document [44], ICLEI ACCCRN Process manual [52] and the RAMSES transition handbook and training package [39]. The regional Asian Cities Climate Change Resilience Network (ACCCRN) connects professionals and communities across Asia to build inclusive urban climate change resilience (UCCR) that focuses on poor and vulnerable people affected by climate change. It empowers people in building climate resilience, influence urban agendas, and build a regional resilient community in Asia where there is rapid urbanization and fast-growing cities that are prone to sudden shocks, as well as long-term stresses. Experiences and lessons learned from the ACCCRN will benefit the co-creativity in ARCH.

From the plethora of web-based information sources we just want to mention two. The first one is the EU Climate-Adapt Platform. It is maintained by the European Environmental Agency (EEA) and thus has an official character. EU Climate-Adapt is well-suited for aligning local adaptation with EU policies. The platform has also adopted selected mature results of EU funded research projects and offers a number of CCA tools.

The second web-based information source is the RESIN e-Guide[3], which consists of a learning centre and a workspace for own CCA projects. The learning centre describes all stages of the adaptation process and lists related information sources and tools. The workspace, accessible only for registered users, is a private workspace that allows creating and editing adaptation projects. Users can upload data, manage access rights, store intermediate results and monitor progress.

Nieuwenhuijs [51] provides a comprehensive list of adaptation support tools covering one or more of these stages, with a focus on urban adaptation support. Some of the tools are focused on a specific type of hazard such as heat stress, some for specific regions such as coastal regions and some are of more general nature. The take home message here is that the EU Climate Adapt platform has gathered many useful such tools from concluded projects and other parties and offers and maintains them on their website. Examples are the EU Climate Adapt Adaptation Support Tool[4] and the Urban Adaptation Support Tool.

3 http://wiki.resin.itti.com.pl

4 https://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool

Specific IT tools

The entire process chain from risk assessment to adaptation monitoring can benefit from specific IT-based decision support tools. For risk identification, it is quite common to use IT tools based on Geographical Information Systems (GIS). One example is the RESIN European Climate Risk Typology[5], which provides a categorisation of risk based on geographical location at the spatial resolution of NUTS3 regions in Europe. For each such region, a wide range of climate risk indicators is provided, including risk relative to the average within the same type of region.

Databases are typically employed for gathering indicator data or whenever large datasets need to be collected and maintained. An example of a customised database for CCA is the RESIN Adaptation Options Library[6], which provides access to a structured body of adaptation options gathered from some 1,200 publications and tagged with additional information like a cost-effectiveness assessment.

Specific IT tools include tools for reporting, for the presentation of results, for visualising impact chains, and sometimes pre-configured Excel sheets like the UNDRR Scorecard Excel Sheets for applying the UNDRR Disaster Resilience Scorecard for cities [53]. It goes beyond the scope of this State of the Art report to present more such tools. The interested reader may refer to the RESIN e-Guide that provides a comprehensive overview of existing tools for each of the phases of the CCA process.

Standardisation

Several standardisation activities that are relevant for urban actors in CCA have been started in the last five years. A recent study of the RESIN project provides a comprehensive overview of the status of the national and international activities in this respect as of October 2018 [49]. We have listed below a selection of eight of the international activities that we consider most relevant. They comprise a glossary of terms in environmental management, three guides (risk assessment and adaptation planning for CCA, smart city operating models for sustainable communities), and three lists of indicators related to different aspects of sustainable cities. As of September 2019, six of these standards have been published and three are still under development.

Table 1: Standards relevant to urban CCA

Standard	Title	Status
ISO 14050:2009	Environmental management: vocabulary	Published
ISO 14090:2019	Adaptation to climate change: principles, requirements and guidelines	Published

5 http://www.resin-cities.eu/resources/risk-typology/ direct link: http://european-crt.org

6 https://resin.vmz.services/apps/adaptation/v4/#!/app/landing

ISO/CD 14091	Adaptation to climate change: vulnerability, impacts and risk assessment	Draft
ISO/AWI TS 14092	Green House Gas (GHG) management & related activities: requirement & guidance of adaptation planning for organizations including local governments and communities	Draft
ISO 37106:2018	Sustainable cities and communities: guidance on establishing smart city operating models for sustainable communities	Published
ISO 37120:2018	Sustainable cities and communities: indicators for city services and quality of life	Published
ISO 37122:2019	Sustainable cities and communities: indicators for smart cities	Published
ISO/FDIS 37123	Sustainable cities and communities: indicators for resilient cities	Draft

2.5.3. Best practices in Decision Support for Climate Change Adaptation

As mentioned earlier, CCA is a multi-stakeholder endeavour. Stakeholder Workshops are the preferred means to bring stakeholders from various involved domains together for joint goal definition, risk assessment, and planning. The choice of methods for the different phases of the adaptation process depends on factors like available resources (person power, knowledge, data) and targeted time frames or deadlines. An adaptation team in a small city may not have the knowledge in statistics for performing a thorough quantitative analysis. Here, scientific support from local universities and academic institutions may alleviate the situation.

In times of limited resources, we recommend also using synergies with related domains like Disaster Risk Reduction and Critical Infrastructure Protection (CIP). Such collaboration is suited to identify common interests, the potential for coordinated action, and new options for financing adaptation measures. Actors in CCA, DRR, and CIP may resort to broader resilience assessments methods like Resilience Maturity Model of the SMR project [38] or the Disaster Resilience Scorecard for Cities of the UN Office for Disaster Risk Reduction (UNDRR) [53].

Lastly, we strongly recommend subject matter experts and actors in urban CCA to make use of the existing and forthcoming standards mentioned in Section 2.5.2. Using standards has a high potential of benefits. It would facilitate mutual exchange and comparability of adaptation measures and progress in CCA. In addition, we expect that further tool development will also built on or support published standards.

3. Environmental monitoring and 3D object/area scanning

For DSS in the fields of CCA (Climate Change Adaptation) and CHC (Cultural Heritage Conservation) a multitude of data that provide information concerning environmental aspects are needed. Often such data are not yet available and need to be elicited anew, like 3D data of cultural heritage buildings and artefacts, or need to be updated regularly.

This section gives an overview on relevant environmental issues surveyed in ARCH and a non-exhaustive roundup of systems as well as already existing platforms that enable the respective monitoring, like sensor systems for capturing data, platforms for accessing, processing, and displaying data.

3.1. Environmental issues addressed in ARCH

In ARCH, we comprehensively address a multitude of important environmental issues that may have direct impact on current and future condition of tangible and intangible cultural heritage:

- Air pollution and contamination with gases and substances: have potentially negative effect not only on human health, but also on degradation of global environment, in the context of ARCH project, specifically damaging to outdoor cultural heritage. Concentrations of such gases such as CO, CO_2, NO_2, H_2S, NH_4, SO_2 etc. and their relation to transport and energy production and consumption in densely populated residential areas, and heavily industrialized regions are of highest importance due to their erosive character especially when combined with high levels of humidity and in extreme cases also immersion in water
- Water: referring to local, regional and global hydrological risk (e.g. floods, droughts) assessment, prediction and management systems and expanded applications of integrated water resource management for sustained development
- Noise/Vibrations: commonly identified in urban environments with transport (mainly road transport) is both annoying and reduces quality of life of citizens, but in the context of cultural heritage objects the exposure to long-term ground and air vibrations, especially at low frequencies, may cause physical destructions to cultural heritage in long terms
- Weather: monitoring basic meteorological parameters (temperature, humidity, pressure wind speed and wind direction) are key to determining and predicting risk of erosions as well as chemical changes to material that cultural heritage objects are composed of, especially when combined with other types of pollutions
- Climate change: delivering reliable climate information of a quality needed for predicting, mitigating and adapting to climate variability, including for better understanding of the global carbon cycle, offering access to observational data for climate monitoring and services in support of adaptation to climate variability and change, facilitating a comprehensive global observation and analysis system in support of monitoring based decision-making and environmental treaty obligations to World Climate Research Programme

(WCRP)[7], Intergovernmental Panel on Climate Change (IPCC)[8] and United Nations Framework Convention on Climate Change (UNFCCC)[9].

- Natural and man-made disasters: involving all phases of the risk management cycle associated with hazards. This includes timely exchange of relevant information with globally-coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating and responding to hazards, also means of wide dissemination of information. Information and knowledge processing lead to modelling of incident progress and possible prediction of risks of their occurrence, with likely impacts on cultural heritage.
- Biodiversity: worldwide biodiversity observation network to collect, manage, share and analyse observations of the status and trends of the world's biodiversity, and enable decision-making in support of the conservation and improved management of natural resources. Indirectly contributes to protection of cultural heritage by creating green zones insulating them from urban pollutions and reducing impacts from climate change, in some cases leading to possible reduction of possible impacts from natural/industrial disasters.

Considering the vast number of possible sources of information that have possible usability in ARCH and that might be considered for integration into its processes and tools, few examples of such sources of environmental data are described in the following sub-sections. It does not mean an exhaustive SotA analysis, considering the vast range of technologies and platforms available on the market, both commercial and private ones, developed in EU funded projects as well as commercially available from major industries, SMEs and academia. They range from long range and general overview, like satellite observations, to locally deployable sensor nodes for monitoring of specific areas, extrapolating also to larger ones by combining multiple sensors with innovative modelling algorithms.

3.2. Earth Observation for environmental monitoring

Current green social networking platforms are immature and mainly exist in the form of blogs where people write articles/ideas and others comment, suggest, etc. No connection with actually monitored data exists, no involvement of or connection with responsible authorities and organisations is introduced. On the other hand, a number of initiatives that try to overcome these limitations exists. The Global Earth Observation System of Systems (GEOSS) [66] is a framework with the purpose to link together existing and planned environment observing systems around the world and support the development of new systems where gaps currently exist, by promoting common technical standards. This will offer decision makers a variety of tools and access to a 'global' database. GEOSS offers a single Internet access point for users seeking environmental data, imagery and analytical software packages relevant to all parts of the globe, based on Earth Observation sensors. Its purpose is to enhance the coordination of efforts to strengthen individual, institutional and infrastructure capacities, particularly in developing countries, to produce and use Earth Observations and derived information products. Compliant with GEOSS standards, ARCH sensing system will offer interfaces to environmental

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7 World Climate Research Programme (WCRP): https://www.wcrp-climate.org

8 Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch

9 United Nations Framework Convention on Climate Change (UNFCCC): https://unfccc.int

organizations either to retrieve (aggregated) user-driven measurements enhancing their models.

3.3. EU environmental monitoring by European Environmental Agency (EEA)

The most advanced and comprehensive environmental observation approach is "Eye on Earth" [64] platform recently deployed by the European Environment Agency and developed using Microsoft Fusion Engine. It is an environmental information portal currently supporting air quality monitoring and water quality in bathing sites across Europe using limited amounts of data from local environmental observatories. For example, the 'Water Watch' service allows users to rate beaches and to share their comments with others. The portal has not progressed much since its launch, in the sense that the only new set of environmental information added is that of air stations. Its usability is basic and not interactive enough to attract general users. Interface is based on web search for a given map of the beach and its custom rating. ARCH sensors' platform will take advantage of data stored in Eye-on-Earth platform, combining it with various other sources of information including from dedicated sensors developed in ARCH, by having at its disposal vast amounts of RAW and processed data being able to produce more reliable value-added data processing and modelling applications etc.

3.4. Relevant EU funded projects

Various research and development activities have been funded either by the European Research Funding Framework, National Research Funding and proprietary in-house developments related to Environmental monitoring. The research is being driven by European Commission Environmental monitoring programme[10] of recurring, systematic studies that reveals the state of the environment. The specific aspects of the environment to be studied are determined by environmental objectives and environmental legislation. The purpose of environmental monitoring is to assess the progress made to achieve given environmental objectives and to help detect new environmental issues. Part of those activities is public funding of projects aimed at diverse activities related to monitoring environment and climate change effects. As of November 2019, there have been more than 814 projects[11] funded by Horizon 2020 program alone that are related to environment and climate change.

One of the most relevant ones is 'EveryAware', an FP7 ICT project aimed to integrate all crucial phases (environmental monitoring, awareness enhancement, behavioural change) in the management of the environment in a unified framework, by creating a new technological platform combining sensing technologies, networking applications and data-processing tools. It involved, through case studies, as many citizens as possible through low cost and high usability.

10 EC Environmental monitoring program: https://ec.europa.eu/jrc/en/research-topic/environmental-monitoring

11 Projects funded by Horizon 2020 program and related to environment and climate changehttps://cordis.europa.eu/search/en?q=contenttype%3D%27project%27%20AND%20(programme%2Fcode%3D%27H2020-EU.3.5.%27%20OR%20programme%2Fcode%3D%27H2020%27)%20AND%20applicationDomain%2Fcode%3D%27env%27&p=1&num=10&srt=Relevance:decreasing

It mentions use of participatory sensing, gathering subjective opinions about local environmental issues to evolve into socially-shared opinions, for subsequently driving behavioural changes and offer effective communication of desirable environmental strategies to the general public and to institutional agencies.

Another important one is INSPIRE[12] Directive, creating a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure enables sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries.

3.5. Sensors and sensor networks

The previously mentioned platforms and systems, despite vast amounts of data, they still do not offer sufficient level of information for ARCH to offer sufficient amount of sensor data, based on which information and knowledge could be produced to the levels required by (local) authorities for the protection of cultural heritage objects and areas. Satellite systems, despite covering wide range of pollutants, do not give sufficient spatial resolution. Participatory climate monitoring systems like Netatmo Weathermap [67], give access to vast amount of sensor data, but limited to basic thermodynamic parameters (temperature, humidity and pressure, in smaller number of cases only to wind and rain as well) lacking info about various air pollutants at local scales. Various EU funded projects have built environmental monitoring platforms, but they are generally small-scale deployments with areas covered that do not include cultural heritage areas, often due to restrictions of access.

Therefore, ARCH project will also be required to make its own deployments of sensor monitoring in specific areas of interest. Those will take advantage of the SotA sensors for monitoring diverse pollutants, use most innovative embedded sensor technologies from collaborating industries, often not yet available on the market (e.g. new long-range embedded sensor nodes from Analog Devices). Many of such technologies will be integrated in such small factors that they will be possible to be deployed on micro-UAVs in (semi)autonomous manner, thus more acceptable by national Aerospace Agencies for operating in populated urban environments.

In terms of sensing technologies, there is a vast number of sensing elements and sensor nodes that are on the market that all constitute the Internet of Things[13] hype. Increased level of miniaturisation of embedded computers allowed to create micro sensing devices that may also have control capabilities. Very soon, probably they will have also reasoning abilities when Artificial Intelligence[14] becomes a practical reality.

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12 INSPIRE: https://inspire.ec.europa.eu/
13 Internet of Things consortium: https://iofthings.org/
14 Association for the Advancement of Artificial Intelligence: http://www.aaai.org/

3.6. Industrially-driven participatory sensing platforms

There are various types of environmental platforms produced by industry and usually associated with e.g. climate sensors produced by them. Since it would be impractical to perform a comprehensive market analysis, we decided to focus on only those technologies that we will integrate with for the purpose of the ARCH project, with aim to progress further with the SotA of those developments and/or provide added value applications and services. Such an approach will also follow in other sections, such as when describing sensing technologies.

One of the most prominent industrially drive approaches taking advantage of the Participatory Sensing is NetAtmo Weathermap[15]. It is an online repository of climate data collected from NetAtmo (https://www.netatmo.com/) sensors deployed by people who purchased those and agreed to voluntarily contribute data from their sensors to public community, in return, getting access to accurate and timely information in almost any location on Earth. As a result, the Weathermap gathers information from nearly 35.000 sensor nodes, making the data available (certainly in compliance with GDPR, i.e. removing any identifiable private information) via easily usable NetAtmo-API[16].

3.7. 3D scanning and modelling of cultural objects and areas

The 3D scanning of cultural heritage has been around for more than a decade, originally driven by professional systems. Since the introduction of the Microsoft Kinect (version 1) in 2010 for Xbox and in 2012 for PCs along with an SDK[17] for MS Windows, such technologies started to pick up a momentum and used by many non-expert citizens. Apple systems also have such sensors available with most famous one being the Structure[18] sensor. Since then, several consumer and professional software technologies have been launched. The most prominent is Autodesk ReCap[19] (previously Autodesk ReMake[20]) with a suite of 3D model management applications such as 3D Studio MAX[21], Maya[22], etc. Other commonly used software tools include: Agisoft Megasoft[23] (previously Photoscan), Artec Studio[24], Meshlab[25], community-built Blender[26] and many other ones.

Models produced by any of the above-mentioned applications can be easily manipulated and imported into a majority of Gaming Engines, thus enabling developers to produce Virtual and Augmented Reality environments taking advantage of such models, such as Virtual Museums[27], Galleries[28], both for fixed computing platforms and mobile ones like smartphones alike.

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15 NetAtmo Weathermap: https://weathermap.netatmo.com/
16 NetAtmo API: https://dev.netatmo.com/en-US/resources/technical/reference/weatherapi
17 MS Kinect SDK: https://developer.microsoft.com/en-us/windows/kinect
18 Structure sensor: https://structure.io/structure-sensor
19 Autodesk ReCap: https://www.autodesk.com/products/recap/overview
20 Autodesk ReMake: https://www.autodesk.com/products/remake/overview
21 Autodesk 3D Studio MAX: https://www.autodesk.com/products/3ds-max/overview
22 Autodesk Maya: https://www.autodesk.com/products/maya/overview
23 Agisoft Megasoft: https://www.agisoft.com/
24 Artec Studio: https://www.artec3d.com/3d-software/artec-studio
25 Meshlab: http://www.meshlab.net/
26 Blender: https://www.blender.org/
27 SCAN4RECO Virtual Museum: https://www.scan4reco.eu/content/scan4reco-virtual-museum
28 RFSAT Virtual Gallery: https://www.rfsat.com/index.php/en/results/3d-gallery.html

The most well-known 3D Gaming Engines offering free development access are: Unity[29], Unreal Engine[30], CRYENGINE[31] from CryTek.

[29] Unity: https://unity.com/
[30] Unreal Engine: https://www.unrealengine.com/en-US/feed
[31] CRYENGINE: https://www.cryengine.com/

4. Information and knowledge management

Information and knowledge management constitute an intelligence layer, where sensor data, pre-processed information, and individual knowledge are combined into a general knowledge of the state and the evolution of the environment. In doing this, ARCH exploits the latest advances in semantic annotation and analysis of citizen environmental sensor data, machine reasoning and learning, knowledge representation and engineering from sparse, incomplete and uncertain information supported by ontological engineering geared to environmental purposes. Novel algorithms will enable ARCH to identify possible inter-relationships among various parameters with purpose-built risk assessment, situation prediction and forecasting services. Examples of such tools include prediction and simulation of ageing effects that based on known condition of cultural heritage objects and detected environmental conditions could help in predicting progressing ageing of objects and their deteriorations, thus enabling decision makers to determine best ways of preventing such effects. Instrumental to this is use of participatory sensing techniques, where citizens who often have access to own sensors deployed at their local environment, offer invaluable source of data that even if of lower quality, may supplement data coming from sparse meteorological and/or purpose deployed monitoring stations. Integration with diverse networks of natural disaster monitoring and predictive further enhances the preciseness of effects that can be linked to climate change effects.

4.1. Ageing simulation of chemical changes and geometrical erosions

Ageing depends on material composition, object usage, and other physical, biological, and chemical parameters. Ageing phenomena often play a key role in realistic rendering. Their absence results to non-realistic surfaces, looking too clean and smooth. Each specific ageing process is considered according to [84][85] as a challenging task in computer graphics, because of the often-complex underlying physics involved and the need for providing designers with usable tools. Capturing ageing in computer graphics is simulated by modelling object morphology changes such as cracks, fractures, patina, corrosion, erosion, burning, melting, decay, rotting and weathering.

4.1.1. Artificial ageing

The ageing process depends on material composition, object usage, weathering conditions, and a large number of other physical, biological, and chemical parameters. Some ageing phenomena of-ten play a key role in realistic rendering (except when the desired result is specifically a brand-new virtual object). Their absence results to non-realistic surfaces, looking too clean and too smooth. To solve these problems, artists either compose complex textures manually or through other techniques [91]. Ageing also can describe a number of methods used in computer graphics to simulate object morphology changes due natural influences, such as cracks, fractures, patina, corrosion, erosion, burning, melting, decay, rotting and withering. Those approaches consider effects which influence the geometry of an entire object, instead of the surface appearance alone [92].

In the SCAN4RECO project, a State-of-the-Art renderer was employed for visualization [86]. While the simulation of fracture physics has been studied in computer graphics [87], reproducing fracture patterns observed in real-world materials remains a difficult problem. In [88] a highpoly mesh is dynamically produced locally to adaptively capture details wherever it is required by the simulation. Crack patterns observed in materials arise due to small-scale interactions between elastic strain, plastic yielding, and material failure. Stress gradients can be very large near the crack tip where the stress field often approaches singularity. In [89] the surface of wood is defined by values assigned to tetrahedral mesh vertices. Changes in the surface are achieved by value changes. CERTH has built on this background in SCAN4RECO to model cracks, whereby [90] demonstrates how a Bayesian optimization method can determine the parameters of a fracture model patterns based on examples.

4.1.2. Simulation techniques

Simulation is one of many techniques used for deriving sample results. Specifically, photo-realistic rendering techniques are capable of rendering images that predict the appearance of yet to be manufactured objects [93]. Physical, chemical, biological, environmental, and weathering effects produce a range of 3D model, shape, and appearance changes. To be able to visualise all these effects we need a novel simulation technique for geometrically and visually stimulating these processes to create visually realistic scenes [96].

4.1.3. Multi-fragment rendering

Depth-ordered fragment determination is a standard stage in developing numerous appealing and plausible visual effects for interactive 3D games and graphics applications. A variety of algorithms ranging from photorealistic rendering, such as global illumination, order-independent transparency for forward, deferred, volumetric shading and shadowing to volume visualization and processing of flow, molecular, hair and solid geometry require accurate multi-fragment processing at interactive speeds. [94] presents a thorough survey and comparison of multi-fragment methods. In this work we have adapted S-buffer [95], a two-geometry-passes A-buffer implementation on the GPU, that overcomes the limitations of both linked-lists and fixed-array techniques by taking advantage of the fragment distribution and the sparsity of the pixel-space.

4.1.4. Simulated ageing based from aging of physical samples

The SCAN4RECO project addressed also effects of ageing on both metals and paints, whereby experiments performed by OF-ADC, UNIVR and OPD focussed on assessing effects of ageing on paints and metals respectively. Both CERTH and RFSAT have taken advantage of those results in determining future evolution of the model containing such materials in their simulations. In case of CERTH, deep-learning algorithms and neural networks were used to provide future prediction based on images of real samples taken at different time intervals. In case of RFSAT two methods have been used and compared. One performed similar analysis to CERTH's by directly working on images of real aged samples. The alternative method focussed more on the analysis of actual physical effects of ageing, physicochemical reactions with the environmental elements (e.g. gases and liquids), combined with environmental parameters (e.g. pressure, temperature and humidity) having direct impact on actual speed of deteriorations through changes to material composition, such as reactions of metals with oxygen, ionised particles of different reactive atoms and their compounds, such as anhydrides that combine with water and form acids.

4.2. Disaster simulations

Mainly, two types of natural disasters are being considered in ARCH: floods and earthquakes. The first one will concern our pilot case of Hamburg city and the second one will be analysed for the area of Camerino town, in Central Italy, a region prone to seismic hazard.

During the last decade, an enormous amount of work on mathematical modelling has been performed (see [99]). The advent of more capable computing machines has paved the way to the use of mathematical models in all aspects of engineering, including hydraulics and, more specifically, flood propagation. It must be said that this effort started already during the ‘80s and that pioneer works can be traced back to the ‘60s and earlier [100]-[105].

The progress of flood propagation models is linked directly to:

i) Understanding the flow processes relative to the problem

ii) Formulation of appropriate mathematical laws

iii) Development of numerical techniques to solve them and

iv) Validation of model output against experimental and real-life data.

Flood and Earthquake simulations software have been around for many years already. Several institutions have developed their own simulation software that take advantage of past incidents. Flood models help simulating the progress of, say, a fluvial flooding, which may help in planning protection and evacuation measures. In case of earthquakes, shake models based on assumed epicentre, assumed magnitude, assumed soil structure and assumed type of earth movement allow assessing possible damage to buildings and settlements, which may help in planning prevention and mitigation measures. Systems using real-time sensing can predict next events to a certain level of accuracy and time in advance. In the case of earthquakes, the early warning time ranges from seconds to minutes. A flooding can be anticipated with longer advance time, especially when it is caused by physical damages to dams or similar protective systems, or if it is a fluvial flooding caused by torrential rainfalls in upstream regions. Some research claims also the ability to predict seismic activities based on statistical data even six months earlier[32]. However, in this case the prediction of epicentre, magnitude, type of movement and potential damage has a much larger degree of uncertainty than in the case of a sensed real quake event. Certainly, observations of different indicators may lead to different level of certainty and ability to predict time in advance before the event. Software can also predict how far the water can flow inside the land depending on its structure, elevations and built structures. As for earthquakes, structural building analysis helps in determining possible damages that might occur when facing an incident of a given scale.

In terms of available commercial software, one of most known ones comes from Autodesk which offers River and Flood Analysis Module for Civil 3D 2019[33], Civil infrastructure design and documentation software. Regarding ground shaking simulations, the biggest authority in

[32] https://www.theguardian.com/environment/2014/sep/21/scientists-predicting-earthquakes-advance
[33] River and Flood Analysis Module for Civil 3D: https://www.autodesk.com/products/civil-3d/overview

this area is USGS[34]. Structural damage simulations have been performed also by Fraunhofer EMI working on risk and resilience analyses, especially in urban developments[35], while Camerino city has been using simulation methods from University of Camerino [106].

4.3. Participatory Sensing and Decision Making (e-Governance)

There are many systems already deployed by different organizations and local authorities for dealing with only very specific environmental problems, whether it is air or water quality, noise, soil contamination etc., despite the fact that they face in reality multiple problems. Extending their systems to cover additional environmental parameters is both technologically tiresome and significantly costly. An attractive way to overcome these problems is by exploring the opportunities lying in increasing the engagement of the public in measurement acquisition as well as in creating a dialogue between the public and relevant authorities and non-governmental agencies.

Priorities concentrate on three core thematic areas:

1. Participatory sensing: citizens participate in environmental monitoring
2. Dialog & collaborative decision making between authorities & citizens
3. Integrated collection and free sharing of environmental data and knowledge in line with Infrastructure for Spatial Information in Europe (INSPIRE) and Shared Environmental Information System (SEIS) provisions.

Our significant novelty is the exploration of the latest advancements in social collaborative environments and related Information Technologies, applying them in the context of building environmental awareness, active monitoring and protection. Social computing and online communities are changing the fundamental way the people share information and communicate. Individuals increasingly take cues from one another and communities, rather than from institutional sources like corporations.

Any DSS system needs to follow the INSPIRE and SEIS provisions, GEOSS policies and objectives in a wide range of environmental areas, integrating with a vast range of already existing environmental observatories including satellite observation systems (GEOS), bringing in diverse systems deployed also by local authorities and NGO's in addition to general Europe-wide initiatives. There is a recognizable importance of the Europe-wide initiative of the European Environmental Agency (EEA) and the development of the Eye-on-Earth system.

Significant added value can be offered to such initiatives through the development of supplementary technologies, like mass citizen engagement, involvement of local communities, social knowledge building, collaborative decision making, voting etc. Flexibility of integration with existing sensing networks, both controlled by authorities and individual users, would be combined with a powerful range of data analysis and risk assessment applications, coupled with a range of information and alerting services using public channels as well as direct citizen notification

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[34] USGS ground shaking simulation: https://earthquake.usgs.gov/learn/topics/shakingsimulations/
[35] Urban risk and resilience (FhG-EMI): https://www.emi.fraunhofer.de/en/business-units/security/research.html

system thus contributing to a better understanding of the spatiotemporal changes of environmental parameters.

5. Progress Beyond the State of Art

ARCH partners are either using DSS (typically, the city partners) or have developed DSS for CCA and related purposes in other projects (typically, the R&D partners). We start this section by briefly characterising some of these DSS and conclude it by discussing outcomes and conclusions indicating expected progress beyond the State of the Art (BSotA) as sketched in the project's work plan.

5.1. DSS developed by or in use by ARCH partners

One of the major R&D results of the EU H2020 Network of Excellence project CIPRNet[36] is the prototype of a DSS for the risk forecast of Critical Infrastructure (CI) elements, CIPcast. The DSS CIPcast addresses different players involved in the emergency management operations, like CI operators, Civil Protection, and Public Administration. CIPcast solves the problem of estimating the threats to which each element of CI is subjected due to extreme events (either of geophysical or meteo-climatological origin), the damage that they could inflict, the subsequent reduction or loss of functionality of all CI involved (also through cascading effects) and the related consequences on society (citizens, goods, land etc.). Since 2013, ENEA has continually improved CIPcast (with some support of CIPRNet project partners, including Fraunhofer), its functionality has been extended, and it has been opened to new areas of application. Since 2017, ENEA and INGV use CIPcast regularly at the Italian node of the European Infrastructure Simulation and Analysis Center[37] (EISAC) and has now reached a high Technological Readiness Level (TRL 7).

In the EU H2020 project RESIN[38], several project partners, including Fraunhofer and Tecnalia, developed a suite of DSS tools for Climate Change Adaptation in urban areas. All these tools have been employed in four city case studies (for Bilbao, Bratislava, Greater Manchester, and Paris), managed by ICLEI, and results of their applications have been used by the cities for their adaptation planning and risk analyses. Fraunhofer has developed a modular method for qualitative and quantitative risk analysis, called IVAVIA. The method is documented in a published Guideline document. For supporting some parts of the IVAVIA method, Fraunhofer has developed special IT tools. A graphical Impact Chain Editor supports automatic layout of Impact Chain diagrams (qualitative part of IVAVIA). The aggregation and weighting of indicator data for estimating numeric risk values for geographical areas is supported by a browser-based tool. The tool can generate maps of a city and smaller geographical units (districts or grid cells), coloured according to the risk categories that correspond to the computed risk values. The frontend of the tool has been developed by Fraunhofer and the numeric part by Tecnalia. For RESIN, Tecnalia has also developed a database of adaptation options, categorised by the type of hazard and the entities exposed to the hazard, such that suitable adaptation options can be quickly identified. The database is available online, a user account is required. A workflow

[36] Critical Infrastructure Preparedness and Resilience Research Network – CIPRNet: https://www.ciprnet.eu
[37] Italian node of the European Infrastructure Simulation and Analysis Center: http://www.eisac.it
[38] Climate Resilient Cities and Infrastructures (RESIN): http://www.resin-project.eu

support tool, developed by four of the RESIN R&D partners, connects the RESIN tool suite and automates some parts of the risk analysis and adaptation planning workflow.

For the EU project RAMSES[39], Tecnalia has developed a Transition Handbook and Training Package for supporting cities in decision-making for urban adaptation. The Free and Hanseatic City of Hamburg (FHH) maintains a portfolio of geoportals, all based on a geographical information system called ATLAS, which is being developed, deployed and maintained by Hamburg's Landesbetrieb Geoinformation und Vermessung (State Geoinformation and Surveying Office). A public geoportal of Hamburg contains basic geographical information visible for everyone[40]. Hamburg's ministries and offices use private versions of ATLAS. The version in use at Hamburg's cultural heritage preservation office contains additional geo-tagged information on several thousand of Hamburg's monuments.

5.2. Outcomes and conclusions indicating expected progress BSotA

For supporting the decision-making in CCA for urban historic areas, the ARCH consortium plans to leverage on previously co-created and tested tools (e.g., from the projects RESIN, RAMSES, and CIPRNet). Connections to the related area of Disaster Risk Reduction are also planned. Here, the Disaster Resilience Scorecard for Cities[41], developed by UNDRR (formerly UNISDR) shall be assessed for potential adaptation to the requirements in ARCH.

Where city partners already employ DSS (like Hamburg's ATLAS system), extensions or enrichments need to be considered instead of developing a completely new DSS. Enrichments include new types of information and data, e.g. 3D models of buildings and areas. Enrichments are supported by the use of environmental sensing technology as described in Section 0 of this report. Extensions may include new analysis or information functions. For example, the ATLAS instance in use at the CH department of Hamburg does not yet contain information on materials of heritage buildings, nor 3D models. Enrichments of the system could include detailed information on materials used in specific buildings. Extensions could be the addition of functions for handling 3D models of specific buildings or entire areas (importing, viewing, searching, exporting 3D models) that have been acquired using sensor technology.

The authors consider that it is crucial to assess the existing DSS and data infrastructures of the involved cities in order to agree with a co-creation approach enrichment and/or extension of a suitable existing DSS or development of a new, specialised DSS. All these approaches are suitable to introduce innovation into urban adaptation and resilience building processes.

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[39] Reconciling Adaptation, Mitigation and Sustainable Development for Cities (RAMSES): http://ramses-cities.eu
[40] Hamburg's public geoportal: https://geoportal-hamburg.de/geoportal/geo-online/
[41] Disaster resilience scorecard for cities – UNDRR: https://www.unisdr.org

6. Conclusions

We began this report with a summary of the development and history of decision support systems in the last 50 years. Much of the early research was dedicated to understanding what DSS could be, what support they could provide, and what limitations they have. Several different methodologies for designing DSS have been reported, including model-driven, data-driven, knowledge-driven, and communication-driven DSS. Whatever methodology is employed for DSS, a few most essential properties and rules need to be fulfilled:

- The DSS recommends, the human decides. Decisions cannot be left to the machine alone, and the use of DSS must never be an excuse for poor decision-making of the human decision-taker.
- This implies that the human user needs to understand the way the recommendation has been generated, what the limitations of the DSS are, and how certain the DSS recommendation is.

In the main part of the report, we presented an overview of computer-based decision support systems for ARCH's core application domains, namely climate change adaptation (CCA) and cultural heritage preservation and conservation. All decision-making in these domains relies on data and information derived from these data or other sources. Therefore, the overview also covers the range of available and necessary technology for eliciting required data, like environmental monitoring and 3D object/areas scanning, and information and knowledge management systems for processing the elicited data and information derived thereof.

We concur with the view of the RESIN project that decision-making in the fields of CCA and CHP is a 'wicked problem', involving variance by the diversity of involved stakeholders and limitations by lack of sufficient and quantifiable data. In the last core section, we characterised DSS in use or developed by ARCH partners and discussed first ideas for kicking off co-creating DSS beyond the current State of the Art.

7. List of Figures

8. List of Tables

9. References

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10. Annex

10.1. Annex A– Glossary of specialist terms

Term	Explanation	Source
Cooked data	Data that has been processed, as opposed to the RAW data.	[64]
Cultural Heritage Conservation	All measures and actions aimed at safeguarding tangible cultural heritage while ensuring its accessibility to present and future generations. Conservation embraces preventive conservation, remedial conservation and restoration. All measures and actions should respect the significance and the physical properties of the cultural heritage item.	[54]
Decision Support System	A computer system that supports the structured process of activities that support decision makers and other stakeholders in coping with and resolving problems they are faced with.	-
Participatory Sensing	Concept of communities or other groups of people contributing sensor information to form a body of knowledge.	[63]
RAW data	Also referred to as source data or atomic data, is data that has not been processed. It is distinct from information to the effect that the latter one is the end product of data processing.	[64]
Wicked problem	A problem that is categorised by a great number of uncertainties on stakeholders involved, boundaries of the problem, long term developments, organisation and responsibilities, and more.	[37]

10.2. Annex B – Key resources

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This publication covers several decades of developments of and insights in using DSS. The basic properties of and issues with DSS can be looked up in this survey.

[2] Wijnmalen D., V. Kamphuis, R. Willems, “*Decision Support*,” in: EU H2020 Project RESIN Deliverable D1.1 “Reviews: Concepts and Approaches (six state of the art reports).” University of Manchester, Manchester, UK, 30.11.2015.
Download from: http://www.resin-cities.eu/resources/sota/decisionsupport/
This newer and more specialised report views the State of the Art in DSS for CCA from the perspective of their utility in a framework for action.

[3] ISO14092, “*Adaptation to climate change — Requirements and guidance on adaptation planning for local governments and communities*,” working document for forthcoming standard of ISO/TC 207/SC 7/WG 12, Switzerland, 2019
This is a forthcoming standard that should be consulted in ARCH as soon as it has been published.

ARCH

ARCH State-of-the-Art Report 5

Mainstreaming gender in building cultural heritage resilience

Deliverable No.	D7.1 – Part 5
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Table of Contents

List of Abbreviations

Abbreviation	Meaning
DRM	Disaster risk management
EU	European Union
ICOMOS	International Council on Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
LGBTI	Lesbian, gay, bisexual, trans and intersex people
RVA	Risk and vulnerability assessment
SDGs	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organisation

Executive Summary

This state-of-the-art report investigates the relevance of gender issues for the research project ARCH, focusing on the resilience of historic areas to hazards, including climate-related hazards. This thematic area can be broken down into multiple intersecting fields, i.e. cultural heritage protection and use, disaster risk management and climate adaptation. The primary aim of this report is to provide the ARCH research team with a better understanding of the relevance of gender mainstreaming in general, and the specific gender issues relevant to their field of work.

Our discussion situates gender mainstreaming in the context of social justice, using the dimensions recognition, distribution and procedure as an analytical framework. We find that, although justice in general and gender mainstreaming in particular is considered within key high level frameworks that govern cultural heritage management, disaster risk management and climate adaptation, it has often not been explicitly defined or made operational. Further, gender blindness persists at an operational level. Our discussion points towards possible measures that may better support consideration of gender in research and practice, with respect to building cultural heritage resilience.

Gender Statement

This report has been developed with regard to the guidance provided in the ARCH Project Handbook (D1.2, Part 7) with respect to gender aspects in publications and research. It includes definitions of concepts relevant to gender mainstreaming, recommendations that are applicable to the ARCH research focus, and a list of suggested resources to support gender mainstreaming within approaches and methodologies relevant to the project focus. It is recommended that this document be reviewed by the entire research team, with a view to improving gender mainstreaming in all work packages.

1. Introduction

This state-of-the-art report has been prepared for the European Commission-funded research project ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards. The ARCH project will develop decision support tools and methodologies with a view to improving the resilience of cultural heritage to hazards, including those resulting from a changing climate. The research team includes local government staff from the 'pilot' cities of Bratislava, Camerino, Hamburg, and Valencia, and will focus in particular on the needs and capacities of these locations, however results will also be extrapolated for use of other local governments elsewhere in Europe.

1.1. Background and aims of this report

This report investigates the relevance of gender issues for the research project ARCH, focusing on the resilience of historic areas to hazards. This thematic area (essentially the intersection of multiple fields: among them, cultural heritage management, disaster risk reduction and climate adaptation) is explored here in the context of governance at the municipal level, given that the project is specifically targeting action at this level, and that practitioners working within local government are members of the research team. The primary aim of this report is to provide the ARCH research team with a better understanding of the gender issues relevant to their field of work, with a view to refining their strategies and methodologies to better address these issues[1]. Within the fields of cultural heritage management, disaster risk reduction and climate adaptation, it is apparent that gender, and more broadly, a perspective that foregrounds issues of social justice, remains under-explored and lacking in mainstream acceptance. In light of this, a further aim of this report is to communicate to the research team the value of considering gender at all, and to introduce key terms from the literature on gender to an audience likely less familiar with them. On a related note, our discussion points towards possible measures that may better support consideration of gender in research and practice, as well as highlighting needs for further research, which it is hoped may also be of value to researchers and local government staff outside the ARCH research team.

1.2. Relation to other state-of-the-art reports and ARCH deliverables

This report is one of a series of six designed to provide the research team with a sound basis upon which to develop and refine their approaches, with the other five addressing:

- Historic areas, conservation practices and relevant regulations/policies
- Disaster risk management, emergency protocols and post-disaster response

[1] Given that this is an applied research project (with an interest in uptake of research results in practice, as well as supporting team members working in local government to progress their own local policies, plans and strategies), the scope of this investigation similarly bridges research and practice. We consider the issues at hand not only in terms of how they are discussed in existing literature, but also in regard to how local government decision-makers and practitioners can better incorporate a gender-responsive perspective into their practical work.

- Building back better
- Decision support frameworks and technologies
- Existing standards and regulatory frameworks

Gender is a cross-cutting issue that cannot be isolated to a specific strand of research or project deliverable, meaning this report and its findings are of relevance to all research team members and their tasks. Every ARCH work package leader has already written a gender statement describing how they plan to address gender issues for their planned work overall, and will need to write one for every future deliverable to explain how gender issues have been addressed in practice. The overall gender statements have been prepared based on guidance included in the ARCH Project Handbook (D1.2). It is recommended that the overall gender statements be revisited after reading this report in order to incorporate additional relevant concepts and strategies.

1.3. Structure of this report

This introductory section (Chapter 1) is followed by an explanation of the methodology used in Chapter 2. Chapter 3 introduces key concepts underpinning gender issues in relation to the resilience of historic areas, including the central concept of gender mainstreaming. Chapter 4 explores gender mainstreaming with respect to the project's key thematic areas, broken down along the lines of urban planning, cultural heritage[2], and disaster risk management. For each of these sub-themes, shortcomings and obstacles in the field are identified, gaps in the literature noted where further work is needed, and possible solutions are put forward. Chapter 5 reflects on the value of gender mainstreaming for the ARCH project team. In conclusion, Chapter 6 summarises the key issues, their implications for building the resilience of historic areas (with respect to policy-making and research), and their significance for the ARCH project.

[2] Literature covering the specific topic of gender mainstreaming in conservation and regulation of historic areas was found to be limited, hence we explore this topic with reference to the broader – but nonetheless closely related – fields of urban planning and cultural heritage management, each of which has a significant body of literature.

2. Methodology

The content of this report is based on an extensive literature review conducted over approximately two months. The literature review was guided by the following objectives:

- To identify and explore concepts and key definitions underpinning consideration of gender issues in general, such as gender equality, gender awareness and gender mainstreaming.

- To identify and explore key gender issues in connection with the ARCH project themes of cultural heritage management, disaster risk management and climate adaptation, including existing obstacles to gender mainstreaming in these fields, as well as possible solutions for researchers and local government practitioners.

- To identify gaps, limitations and needs for further work in the available literature.

In order to achieve the above aims, both academic literature and grey literature from government agencies, community groups and non-governmental organisations, was consulted. The literature review was conducted in two steps. First, existing literature on gender and cultural heritage, urban planning, resilience, and disaster risk management (including risk and vulnerability assessment, emergency response and recovery/reconstruction) were sought through internet-based research using engines such as Google Scholar and Science Direct. The search used combinations of the following keywords: "gender", "disaster", "risk", "cultural heritage", "culture", "urban planning", "women", "emergency response", "gender-sensitive", "cities", "building" + "back" + "better" and "post-disaster recovery". For each keyword search, the first 20 entries were considered.

Secondly, documents were scanned and selected for further analysis according to:

- The language of publication. Only documents written in English and Spanish were taken into account due to the authors' language skills.

- Geographical scope. Documents selected were either European-focused studies or offered content that could be easily extrapolated or applied to the European context, that is with a global perspective[3].

- Date of publication. We prioritised documents published within the last decade. Some older sources were however included where they can be considered seminal texts, e.g. the first appearance of a key term.

The sources resulting from the internet-based research were supplemented with additional sources either cited therein, recommended by colleagues knowledgeable on the topic, or located in online repositories hosted by key agencies working in the fields under investigation.

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[3] Considerable literature addressing the Global South was discarded for its lack of applicability, however some such sources are relevant, e.g. for their usefulness in framing the concept of gender mainstreaming, which first emerged in the field of international development and hence is more established there than in a European context.

All consulted literature (a total of over 80 documents) was gathered in a matrix and classified according topic, specific sub-themes, type of document, and geographical scope.

3. Key concepts

This section lays out key concepts and definitions arising from the literature review that are central to our discussion, as well as specifically highlighting their relevance to the ARCH project. Since several of the key concepts discussed in this report are addressed in other reports in the series (e.g. cultural heritage, disaster risk reduction, resilience), we focus here on defining those with direct relevance to gender issues.

3.1. Unpacking gender

Before exploring the thematic areas of relevance to the ARCH project, some discussion of key concepts in relation to gender issues in general, and in particular the relevance of gender mainstreaming, is warranted here.

3.1.1. Gender as a justice concern

The purpose of considering gender issues at all in a research project (or indeed any other sphere of work or life) is primarily one of justice and equal rights, recognising that people of different genders have historically not received equal treatment, and that this discrepancy persists today. Gender equality refers to:

> *…equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration, recognizing the diversity of different groups of women and men [1].*

Gender equality is an aspiration also enshrined in the Sustainable Development Goals (SDGs), specifically SDG 5: 'Achieve gender equality and empower all women and girls' [2]. While the term 'equality' is often used interchangeably with 'equity', the preferred terminology within the United Nations has been gender equality since 1995. This is because gender equity 'denotes an element of interpretation of social justice, usually based on tradition, custom, religion or culture, which is most often to the detriment to women' [3]. It is also worth noting that gender is not the same as sex: the latter being biologically determined, while the former concerns identity, socialisation and the corresponding behavioural expectations that accompany this. According to the World Health Organisation (WHO), 'gender refers to the roles, behaviours, activities, attributes and opportunities that any society considers appropriate for girls and boys, and women and men' [4]. While gender interacts with the 'binary' categories of biological sex[4], it is not equivalent to these. More recently, understandings of gender have been expanding to include sexual orientation, encompassing lesbian, gay, bisexual, transsexual, and intersex identities (commonly delineated as LGBTI[5]). It is important to be aware of this expanded field,

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[4] In the context of gender, binary 'refer to the norms derived from the simplistic idea of a dichotomy of two mutually exclusive and biologically defined sexes to whom different roles and behaviour are traditionally ascribed' [74].

however the review conducted for this report found that much of the literature continues to focus on differences between men and women, which has affected the scope of discussion possible here.

Gender is of course not the only factor relevant to social justice, and a gender perspective makes little sense unless part of a broader consideration of the needs and capacities of disadvantaged social groups – whether in terms of age, income, ethnicity or employment status. More broadly, a justice perspective is also important in relation to the concept of resilience in theory and practice. Fainstein posits that resilience is an extremely broad and inherently ambiguous concept which can serve to obscure existing inequalities or create new ones, or simply reinforce an unjust status quo, depending on how it is defined and corresponding measures enacted [5]. In this regard, she notes that C.S. Holling's model of 'evolutionary resilience' (developed in the 1970s) is notable for its rejection of resilience as a return to some pre-existing equilibrium, rather defining it as a form of system transformation. The Intergovernmental Panel on Climate Change (IPCC)'s latest contribution on the subject continues in the same vein, defining (social and ecological) resilience as:

> *The capacity of a social ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation* [6]

However, so far, the IPCC has failed to explicitly link resilience and justice in a definition. Fainstein points out that the logic of the evolutionary model falls short in its implementation: typically generating complex maps of systems and interrelations while failing to identify entry points for human agency and insufficiently addressing power relations which are central to the existence of inequalities – instead obscuring 'who gets what'. To illustrate the consequences of failing to address questions of power distribution, Fainstein cites the example of reconstruction in New Orleans following Hurricane Katrina, where a combination of private market forces and participation resulted in rebuilding 'pretty much as it was for those with resources, while many of those lacking financial or social capital were unable to return or rebuild - although they were not prohibited from doing so.' [5]

The glossary developed by the UK-based Climate Just platform also cities the IPCC definition, but adds:

> *Building resilience needs to account for: the degree to which the community comes into contact with a hazard capable of causing harm; the amount of inherent susceptibility to harm in that community; and the extent to which people in the community are able to make adjustments in order to avoid negative consequences* [7].

Importantly, this definition makes explicit that impacts are experienced by *people*, which is somewhat obscured by the IPCC's reference to an abstract 'system'. However, a weakness of this formulation is that it refers to a homogeneous 'community' without acknowledging different needs, capacities and levels of power within it. This absence is addressed elsewhere in the Climate Just glossary, where the (closely-related) concept of adaptation is defined with respect to justice, as follows:

Socially just adaptation: a set of policies and actions responding to current climate variability and anticipating the future climate change and its impacts designed to ensure that neither the impact of climate change nor the policies and actions themselves exacerbate existing or create new inequalities across different groups in the urban society [8].

Recent work by the European Environment Agency has also taken up this definition in examining social vulnerability to climate change across Europe [9]. We propose a robust definition of resilience for the ARCH project, making room for a justice perspective that would help to accommodate gender mainstreaming as a relevant objective, as follows:

*The capacity of a social ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation. Building resilience needs to account for: the degree to which the community comes into contact with a hazard capable of causing harm; the amount of inherent susceptibility to harm in that community; and the extent to which people in the community are able to make adjustments in order to avoid negative consequences**, recognising existing imbalances in power distribution in that community and ensuring that neither the impact of the hazard, nor the policies and actions themselves exacerbate existing or create new inequalities across different groups.***

3.1.2. A framework for understanding justice

Social justice is a relatively abstract concept, and in order to make it useful for analysis needs to be broken down into constitutive parts. Examining justice in relation to access to ecosystem services, McDermott et al. divided justice into three dimensions: distributional, procedural and contextual [10]. **Distribution** concerns who gets what – who has access to benefits and who bears the burden of costs. **Procedural** refers to decision-making – who has the right to participate in the decisions that result in the distribution of benefits and costs. **Contextual** justice is about the conditions that affect people's access to both benefits and costs, as well as their ability to participate in decision-making – essentially bridging the first two dimensions. It includes the barriers that impede this access – which may be physical, socio-economic, institutional, or perception-based [11]. Other scholars have pointed to another dimension, **recognition**, which concerns whose needs and interests are perceived as valid in the first place [12]. Breaking justice down in this way can help us understand how this rather abstract concept translates into practical matters. Another important dimension is Crenshaw's '**intersectionality'**, which posits that disadvantage can rarely be attributed to a single cause, but needs to be understood in the context of the various socially constructed categories to which an individual is assigned [13].

'...intersectionality holds that knowing a woman lives in a sexist society is insufficient information to describe her experience; instead, it is also necessary to know her race, sexual orientation and class, as well as her society's attitude toward each of these memberships. It is only through analysing how these complex concepts intertwine and interlink that we are able to understand the gendered experiences of both men and women in different contexts.' [14]

The concept of intersectionality is important in acknowledging gender aspects of justice concerns. Although a person's gender may be just one factor of a constellation of sources of disadvantage, it is a factor that often serves to exacerbate the level of disadvantage. The intersectionality of gender with factors such as age, class and ethnicity, has been recognised by the United Nations Research Institute for Social Development (UNRISD), which has led the field of gender and development for some years, and was a focus of the Gender and Development Programme (2000-2009), as a contribution to implementing the 2030 Agenda for Sustainable Development [15]. Ryder has highlighted the potential of intersectionality to bridge the (to date largely separate) research communities of disaster vulnerability and environmental justice [16]. However, in general the dimensions of contextual justice and intersectionality have been explored in the literature to a lesser extent. We find these two dimensions to be useful for framing our discussion, however less so as analytical tools. Hence, for the purpose of our later analysis, a three-dimensional framework, taking into account the aspects of gender-based justice that concern 1) recognition, 2) distribution and 3) procedure, will be adopted.

3.1.3. Achieving gender equality in practice

A fundamental starting point for integrating justice concerns (with a view to improving gender equality) into the design of any project or programme is to recognise difference among the people whose needs are to be addressed. Here, the 'recognition' element of justice introduced above is significant, because only once gendered differences are recognised (and made visible, overcoming 'gender blindness'[6]) can they begin to be addressed. As pointed out in guidance materials for UN-Habitat's City Resilience Profiling Programme:

> *'projects assumed to follow neutral approaches usually fail to address specific needs of gender groups and the constraints they face. The result is that concerns may be overlooked and inequalities can be increased.'* [17]

Making gendered needs visible is inherent to a comprehensive process of 'gender mainstreaming', a phenomenon that originated in development policy adopted by the UN in 1995 and was later taken up by the European Union (EU) and member states [18]. Gender mainstreaming can be understood as:

> *'the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for explicitly making the concerns and experiences of women, as well as of men, an integral part of design, implementation, monitoring and evaluation in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated'* [19].

While gender mainstreaming is a process, rather than a tangible outcome, its success may be demonstrated by a range of indicators. Gender diversity, i.e. a balanced representation of genders in an organisation is sometimes incorrectly pointed to as evidence of gender equality, when in fact it is just one possible indicator of a wider process of gender mainstreaming.

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[6] According to the European Institute for Gender Equality, 'gender blindness is the failure to recognise that the roles and responsibilities of men/boys and women/girls are given to them in specific social, cultural, economic and political contexts and backgrounds. Projects, programmes, policies and attitudes which are gender blind do not take into account these different roles and diverse needs, maintain the status quo and will not help transform the unequal structure of gender relations' [78].

4. Gender mainstreaming

In this section we examine the concept of gender mainstreaming with respect to sustainable urban planning, cultural heritage, disaster risk management and climate adaptation.

4.1. Gender in sustainable urban planning

Urban planning has a major impact on people's lives, since it essentially defines many aspects of access to facilities and services, workplaces, housing, public open spaces and cultural institutions; including their locations, physical characteristics of the space around them, and the nature of the journey to reach them. Furthermore, it sets a physical structure and a configuration of spaces that influences the relationships between people who use these spaces. Since people have different kinds of needs and capacities, not everyone uses the same space in the same way. Urban planners therefore have a responsibility to analyse and understand these different needs and capacities, to ensure that the design of public spaces and infrastructures will respond to them effectively, and that everybody will be able to benefit and enjoy the city on an equal basis. In this sense, urban planning and associated regulations have the capacity to foster social cohesion and inclusion or, on the contrary, to maintain or even exacerbate exclusion or inequalities between different groups.

4.1.1. Gender differences in use of space

With respect to gender differences, an established body of literature (with key texts published since the early 80s)[7], has drawn attention to the ways the cities we live in have been shaped and designed according to the values of a patriarchal society, disregarding differences between men and women as derived from their assigned gender roles[8]. Due to the sexual division of labour[9], women have historically been assigned reproductive tasks and generally relegated to the domestic realm, while men have been in charge of 'productive tasks' and more visible in public space [20], [21]. This means in practice that women, because of their historical roles as caregivers, are the ones who usually take care of dependants (children, seniors, and people with disabilities); who accompany them; go shopping for daily needs; and take care of household maintenance, organisation, and administrative errands [22]. This often entails

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[7] See, for instance [20], [79].

[8] Although gender is not just about men and women, differences between the needs, capacities and treatment of men and women are historically significant and remain a contemporary issue warranting further work. It is important to note that there is an emerging body of literature on more complex conceptions of gender, including LGBTI communities, however the majority of the literature available to the authors at the time of writing focuses on male and female, hence this is also a focus of the discussion here.

[9] Gender (or sexual) division of labour refers to the way each society divides work among men and women, boys and girls, according to socially-established gender roles or what is considered suitable and valuable for each sex. Within the division of labour, there are several types of roles: productive, reproductive, community managing, community politics, and the so-called 'triple role', which typically belongs to women and covers reproductive, productive and community work [3].

complex, polygonal routes[10] in the city that, depending on the location of the facilities where certain activities take place and the distance between them, may involve expenditure of considerable time. In turn, this may affect the possibilities of women to access jobs that are located far from those facilities or may require reduction of paid working time to adapt to the demands of caring. As a result, women's economic independence may be affected. For these reasons, studies have shown that land-use zoning, mono-functional areas, separation of places of employment from residential areas, lack of dependent-care facilities (either close to the residential areas or to the employment places) and inefficient transport systems disproportionally affect women [23] (see also Box 1 below).

4.1.2. Urban planning for an inclusive city

Related research into gender sensitive urban planning has investigated security in public space. Although violence against women and girls (including sexual violence and harassment) often takes place in domestic settings, it may also occur in public spaces [24], or women and girls may adopt self-protection strategies to avoid a perceived threat. In some cases, this might mean restricting their own movements, limiting their social lives, giving up leisure activities, or even resigning from a job or participation in political life. Such fear ultimately prevents enjoyment of the right to the city and its benefits. Corresponding strategies to enhance urban safety (both real and perceived) include ensuring adequate lighting, urban signage, promoting visual permeability (i.e. sightlines through spaces) and avoiding blind facades or large building setbacks[11]. Given that the ARCH project focuses on European historic city centres, where medieval urban layouts with narrow streets and blind alleys could potentially be perceived as unsafe, it is relevant to consider perceptions of safety among diverse gender groups which may affect their access to cultural heritage places.

[10] For more information, see: http://genderedinnovations.stanford.edu/case-studies/transportation.html#transport-challenge

[11] These are mainly urban design recommendations for safer cities. For a more comprehensive set of measures, including legislation and regulation initiatives, public transport policies, education and awareness-raising campaigns, and partnerships across sectors, see [24].

Box 1: Forbidden city map. Bilbao, Spain.

A tool for social participation and inclusion of women in urban planning processes [25].

From 2009 to 2011, the Council of Women for Equality in Bilbao conducted a participatory process involving diverse women from the eight districts of Bilbao to identify public spaces where they felt unsafe. The objective of this activity was to place value on women's perception of their urban environment and to promote their participation in municipal decision-making processes related to urban planning, in order to design a safer and more inclusive city for all. The initiative resulted in a detailed diagnosis of hotspots in each district and corresponding proposals to improve them (many of them relating to public lighting, cleaning, gardening and maintenance) which were submitted to the Works and Services Department of the municipality. The proposals were in turn included in an action plan that the Department has been implementing ever since, in close dialogue with the Council of Women for Equality. As of November 2019, nearly 100% of the actions had been completed and an update of the forbidden city map is under discussion [26], since new hotspots may have arisen since the study was initiated.

More information at:
https://www.bilbao.eus/cs/Satellite?c=Page&cid=3000082641&language=es&pageid=3000082641&pagename=Bilbaonet%2FPage%2FBIO_contenidoFinal

Overall, mainstreaming gender in urban planning means to acknowledge the aforementioned status quo and act accordingly: promoting the participation of different gender groups during planning and decision-making processes, assessing their diverse needs, perceptions and interests, and fostering safe spaces that support them in different and varied everyday contexts. As some of the studies consulted suggest, these needs could be addressed, for instance, through a polycentric urban structure and a 'city of short distances'[12], supporting an efficient mix of spaces that allow leisure, caregiving, shopping and service use, paid work and family duties, where dependants could easily move through the neighbourhood and deal with everyday tasks on their own. If a city's existing fabric does not already support these diverse needs, then redevelopment of key areas may be an option. This presents a challenge for neighbourhoods and sites of heritage value, as they are typically subject to specific strategic planning and regulatory conditions, (e.g. planning restrictions on change of use or built form, management plan requirements imposed locally, nationally or by bodies such as UNESCO), limiting both physical and land use changes.

In terms of high level frameworks, the importance of gender mainstreaming in urban planning has increasingly been acknowledged in the last years. For example, the *European Charter for Equality of Women and Men in Local Life*, drafted by the Council of European Municipalities

[12] Dense and compact city including housing, supply with goods and services, education and work, cultural events, sports and sufficient green areas and open spaces, where distances among them can be covered on foot or easily by public transport.

and Regions in 2006 and endorsed by 1700 signatories in 35 countries[13], calls upon the responsible bodies to integrate a gender perspective into all activities of local and regional governments in order to advance equality of women and men. One of the main sections of the Charter is dedicated to planning and sustainable development, including articles on urban and local planning, and mobility and transport:

> *Article 25 – Urban and Local Planning*
>
> *The Signatory recognises the importance of its spatial, transport, economic development and land use policies and plans in creating the conditions within which the right to equality of women and men in local life may be more fully achieved.*
>
> *The Signatory commits itself to ensure that, in drawing up, adopting and implementing such policies and plans, (…) the specific needs of women and men, in relation for example to employment, access to services and cultural life, education and family responsibilities, based on relevant local and other data, including the signatory's own gender assessments, are properly taken into account* [27].

The Charter is not a binding document, but signatories are encouraged to prioritise actions and implement them progressively. In this regard, for example, cities like Vienna, Umeå or Castellón[14] have already comprehensively integrated a gender perspective into their urban master plans, while many others like Córdoba or the region Île de France have taken steps towards implementing fairer public transport systems[15].

For the purposes of this report, it is significant that, while the literature consulted and the case studies analysed bring up many actions and strategies to mainstream gender at the general city level[16], analysis of or detailed information about specific measures to be applied in heritage areas remains scarce. There has also been limited exploration of the ways in which cultural heritage protection status and its related regulation may prevent or restrict measures to improve gender equality in urban space, or on how women and men are affected differently by some of the unintended consequences of cultural heritage recognition (e.g. World Heritage status), among them tourism booms, gentrification, increases in housing costs and subsequent displacement of residents, etc. This leaves space for further research.

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[13] As of November 2017, according to information from the Observatory for the European Charter for Equality of Women and Men in Local Life. Available at: http://www.charter-equality.eu/the-charter/le-texte-de-la-charte-en.html

[14] See, for instance, Castellon's master plan, available at: https://s3-eu-west-1.amazonaws.com/urbanismo/INFORME+DE+IMPACTO+DE+GE%CC%81NERO.pdf

[15] For more information, see good practice cases on the Council of European Municipalities and Regions (CEMR) website: http://www.charter-equality.eu/exemple-de-bonnes-pratiques/equality-in-the-urban-planning-administration.html?ref_id=166

[16] See, for instance, guidelines from the city of Vienna to mainstream gender in urban planning and urban development [70], structured around gender mainstreaming as 1) a comprehensive planning strategy, 2) in master plans, concepts and visions of urban design, 3) in land use and development planning, 4) in public space planning, and 5) in housing construction and public service buildings.

4.1.3. Current obstacles and needs for further work

The following are some of the obstacles identified with regard to mainstreaming gender in the sustainable urban planning of historic areas:

- Lack of disaggregated data according to gender, age, ethnic background, ability, etc. of the differential access to and use of historic areas, and associated lack of analysis[17].
- Lack of assessment of dependent-care infrastructure[18] availability around cultural heritage assets.
- Absence of disaggregated data and qualitative information on levels of representation and participation of different gender groups in formal and informal decision-making processes and structures regarding urban planning and management of historic areas.
- Lack of specific operational recommendations on applying gender mainstreaming measures in heritage/protected areas.

Needs for further research include:

- Comprehensive and comparative analysis of gender sensitive urban planning policies and initiatives implemented in European cities, assessing enablers of the process, impacts, factors of success, transferability and key lessons.
- Studies on how to adapt general gender sensitive plans and measures to historic areas, e.g. to better understand gender differences in mobility patterns not only at the city level but specifically in historic areas.
- Analysis of negative impacts of cultural heritage protection status (e.g. gentrification) from a gender perspective, and proposed strategies to address them.
- Research on the specific interests, perceptions and needs of different gender groups when accessing, using, living and or working in (or in close proximity to) historic areas.
- Comprehensive analysis of gender-sensitive safety measures in historic areas.

4.1.4. Policies and solutions

The following recommendations to improve gender mainstreaming in heritage areas are intended for policymakers within local government, as well as researchers and consultants supporting them:

- Establish mechanisms that allow for the voices and associated concerns of different gender groups to inform and take part in policy-making.
- Implement specific measures for the different needs of people in the design and maintenance of public space, applying a gender analysis[19] in every project [28].
- Promote gender parity at technical and executive levels in urban planning departments.

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[17] Cultural statistics are not systematically disaggregated by sex: gender statistics on culture are often collected only in certain cultural fields or through research initiatives and/or for individual projects.

[18] Facilities for the care of people with a certain degree of dependence, e.g. children, the elderly or people with disabilities.

[19] See definition of gender analysis in the Glossary, and guidance on how to conduct one at https://eige.europa.eu/gender-mainstreaming/methods-tools/gender-analysis

- Evaluate the impact of policy implementation on different population groups, disaggregating data by characteristics including gender.
- Build core gender capacities of staff through the establishment of gender units within municipalities, and provision of regular institutional training.
- Define indicators and monitoring plans at the local level to verify the outcomes of gender mainstreaming in the built environment.
- Gather disaggregated data on the socio-economic characteristics of the population in city centres (since vulnerability is multi-dimensional, it is important to understand who lives in or near and uses historic areas).
- Allow flexibility in the definition of new uses for cultural heritage buildings. Tap into the opportunity of adaptive reuse processes to prioritise uses that facilitate daily life activities over private interests or tourist needs. In a city centre with a high number of cultural heritage buildings, the selection of uses does have an impact in women lives.
- Make sure that public facilities are easily accessible by public transport.
- Aim for mixed use neighbourhoods, including open, public cultural heritage sites accessible by foot.
- Ensure dependant-care facilities are provided in or close to heritage sites.
- Promote the conservation and rehabilitation of cultural heritage buildings outside the city centre, to make cultural heritage accessible also to people with limited access to the city centre.
- Foster the interim reuse of abandoned/underused heritage buildings by women or vulnerable groups, as a measure of conservation.

Box 2: Gender mainstreaming in urban planning. Vienna, Austria.

Vienna is considered a frontrunner city in mainstreaming gender in urban planning. Its two guides ‘Gender Mainstreaming Made Easy’ and ‘Gender Mainstreaming in Urban Planning and Development’ are useful for urban planners across Europe and beyond.

The city opened its Women’s Office in 1992 and developed one of the first gender-sensitive neighbourhoods in Europe in 1997, the famous Frauen-Werk-Stadt. Two more phases of the project were built in 2004 and 2009. This residential complex aims to allow people to carry out all their daily life activities without commuting. It was designed from the point of view of women to include public spaces and facilities (e.g. childcare) that support reproductive work, and diverse housing types adaptable to different family models [29]. Ever since, Vienna has been integrating gender into all the city’s strategies. The city employs gender experts internally and multipliers all over the city. As the report *Gender Equal Cities* indicates:

> *…all public space designed and built by the city is done so with gender in mind. The outcome is an urban landscape that benefits everyone: parks are lit effectively to provide safety and access; social housing is architecturally designed with flexibility for different family situations; pavements are wider for parents and the elderly; street crossings are longer and pedestrians are prioritised* [19].

4.2. Gender and cultural heritage

4.2.1. Background

There is not a single way of defining what constitutes cultural heritage, since it exists in a diverse sociocultural context, where people have different perceptions of history and culture that may generate diverse (and even opposing) interests. Put another way, cultural heritage can include and reflect the diverse identities of a territory or a place, but this depends very much on who and what is valued, and how power is distributed. In a diverse community, it may be that certain subjects are left out of the dominant heritage narrative, for instance indigenous societies or afro-descendants [30]. The same has happened historically to women: cultural heritage generated by women and what women consider cultural heritage have been invisible and disregarded in many places for many years [31]. It was only as recently as the sixties and seventies that feminist movements started to point out how rarely women are depicted in so-called “authorised" heritage assets. After initially highlighting the rarity of women in art history and artistic production, the focus has evolved during the last decades into exposing the lack of female representation in cultural practices[20], exhibitions, history books, school curricula, collections, street names or statues in public spaces [32]. Our literature review shows that governments have made concerted efforts since to address the promotion of gender equality within museums, targeting more equal representation in collections and exhibitions [33], however there is still work to be done.

4.2.2. Whose heritage is it?

As Laurajane Smith observes, heritage is not gender neutral: ‘it is gendered in the way it is defined, understood and talked about, and, in turn, in the way it reproduces and legitimizes gender identities and the social values that underpin them’ [34] . She points out that traditionally, gender has been overlooked in heritage debates, implying a passive ‘masculinisation’ of heritage where it is typically women who are excluded not only from representation, but also the discussion [34]. Others note that the process of ascribing heritage value (‘heritagisation’[21]) itself legitimises some identities while excluding others [35]. This means it is relevant to consider not just who has access to places of heritage significance, but also who is responsible for creating and presiding over ‘official’ heritage in the first place[22]. In this regard, Jiménez-Esquinas questions who decides what is valuable, what we need to conserve and to what we should dedicate our resources and our labour, and advocates for the presence of women in decision-making processes that define heritage policies and what they serve to protect [32]. Many contributors to the debate on the gendered nature of heritage agree that policymakers, managers of cultural institutions and academics should be open to revising

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[20] As the Council of Europe´s document *Draft conclusions on the Work Plan for Culture 2019-2022* shows, the disparities in the access of women to creation and production resources, as well as their underrepresentation in leadership and decision-making positions related to culture and cultural heritage is still an issue. Therefore, the institution establishes gender equality as a priority in view of its contribution to cultural diversity [80].

[21] Heritagisation refers to the transformation of objects, places and practices into cultural heritage as values are attached to them, essentially describing heritage as a process [81].

[22] As Jiménez-Esquinas points out, while it is relatively easy to get disaggregated data about of museums and cultural heritage visitors, it is difficult to find information about who manages heritage.

and re-signifying cultural heritage to include neglected gender identities, with a view to reducing discrimination [32], recognising that authorised heritage discourses risk may 'reproduce, at the local, national and international level, gender-blind selection and interpretation criteria of cultural heritage' [36].

Re-characterising existing heritage places and creating 'new' ones from a gender perspective is likely to be a time-consuming process beyond the scope of ARCH, a three year research project. Yet it is worth reflecting on here in relation to the project's stated objective for collaborative research, specifically the importance of diversity in stakeholders that the city partners plan to engage – for the duration of the project and beyond. Moreover, historic centres in European cities are diverse, today more than ever. In such a heterogeneous context, it is legitimate to pose the question of whether the heritage sites selected for study by the ARCH project in Valencia, Bratislava, Hamburg and Camerino reflect 'particular and partial histories and myths, male-defined landscapes and gendered national identities' [37]. More specifically, given that place attachment is a relevant factor for social cohesion, municipalities rightly have an interest in ensuring that the heritage places they invest in protecting and managing reflect the values and concerns of their diverse local residents, in the interest of a more socially cohesive and resilient community.

The 2014 UNESCO report *Gender equality, heritage and creativity* [33] highlights the relevance of analysing heritage from a gender perspective. On the one hand, a gender perspective may help to broaden the definition of cultural heritage and, on the other, specific actions linked to the management of cultural heritage (interpretation, transmission, safeguarding or management) can serve to promote gender equality. To put this into practice, the report offers interesting examples of gender sensitive practices, e.g. a gender-responsive labour policy introduced by the management of a World Heritage national park in Brazil.

From a legal perspective, a particularly interesting case for this report is the recently-enacted law to protect the Valencian *Huerta* (orchard), passed on March 2018 by the Spanish National Government [38]. The law aims to protect the orchards not as a 'frozen, museological tableau', but rather a living and sustainable space from the economic, social and environmental perspective. The text acknowledges female and male farmers as an intrinsic part of the Huerta heritage, and refers to them as key players in its preservation and conservation. In that regard, and as a measure of conservation, the law foresees an action plan for revitalising the Huerta, which explicitly appeals for the promotion of equality in farm co-ownership, for equal access to management mechanisms of the orchards and participation in production. Furthermore, the text urges promotion of the visibility of female-targeted dissemination activities oriented to raising awareness of the social and environmental values of the Huerta. Given that the Huerta territory will be a focus of the ARCH project's work with the city of Valencia, it is particularly relevant for the project team to consider the existing gender inequalities inherent in this heritage landscape, and the mandate for addressing them introduced by this new legislation. In that context, a practical example is an oral history project on the role of women farmers in this region, as a way of claiming, registering and transmitting their knowledge and personal experiences, which are undoubtedly part of this heritage landscape [39]. In general, however, the literature consulted for this report has identified limited case studies where gender has been comprehensively mainstreamed in the interpretation, communication, safeguarding or protection of cultural heritage – presenting an opportunity to contribute to this body of knowledge.

Box 3: Women's History Walks, Nicosia, Cyprus.

In 2016, in response to the invisibility of women in the urban landscape of Nicosia, the NGO Centre for Gender Equality and History (K.I.I.F.) started organising free city tours around places of historic significance for women or related to historic female figures, aiming to transform a space lacking any reference to women into a space of fair recognition.

After extensive research and observation, points of interest were selected (such as a Women's Bazar dating back to the 14th century, or the first girl's school established in Cyprus) and the first walk, titled 'Reviving the Invisible History of Women – A Walk in another Nicosia' organised. The group of volunteers involved in the initiative (including historians, researchers and activists) chose a point of interest and explained the history behind it, establishing a dialogue with participants. These included traditional communities of Cyprus such as Greek Cypriots, Turkish Cypriots, Maronites, Armenians, etc., and new communities such as immigrants and refugees. As a result, and as stated on the Sustainable Cities Platform, women and girls from different cultures and backgrounds are now *'able to recognise role models in the landscape of their city and understand that, as women, they did have a contribution into the making of their city and local society'*. Furthermore, by drawing on multicultural and multi-communal perspectives of history, the History Walks help '*not only building a culture of mutual respect and equality but also a culture of peace and social inclusion'* [40].

More information at:
http://www.sustainablecities.eu/transformative-actions-database

4.2.3. Current obstacles and needs for further work

Many of the challenges for mainstreaming gender in cultural heritage arise from a simple lack of visibility, specifically:

- Lack of data on involvement of women in heritage conservation institutions, practises and policies.
- Lack of information on the presence of women in the realm of heritage management, specifically in bodies where decisions on what is valuable and what institutional measures are needed to preserve and interpret a specific heritage asset are taken.
- Lack of information about and examples of gender sensitive conservation practises, especially regarding tangible heritage.
- Lack of gender-impact assessments for projects on adaptive reuse of cultural heritage.

Needs for further work include:

- Interdisciplinary research on gender equality in heritage and the creative industries is necessary, alongside more targeted actions, at the national and international level, to support gender-responsive policies and strategies in culture [25].

Regarding LGBTI heritage, Fernández-Paradas suggests further research on [35]:

- Protection of LGBTI heritage
- Mapping places of LGBTI memory
- Intangible LGBTI heritage
- Lack of protection and destruction of LGTB heritage

- Further research on gender mainstreaming practises in conservation and preservation of tangible cultural heritage.

4.2.4. Policies and solutions

Public participation in the definition, management and governance of cultural heritage should be promoted in order to facilitate an inclusive legal framework that encompasses views from a diversity population, including diversity of gender. In turn, this can reinforce a broader identification with and attachment to cultural heritage by all community members, fostering broader support for its preservation. To do this, adequate participation mechanisms for the institutional and social engagement of diverse gender groups in conservation and valorisation of cultural heritage plans need to be guaranteed, for example through:

- Incorporating strategies in conservation policies to mainstream gender equality, so that the historically absence of diverse genders in heritage and history can be claimed and amended.
- Increasing the participation of women in cultural life, by promoting a balanced representation of men and women in all cultural areas.
- Increasing the number of landmarks and public spaces named in honour of women whose accomplishments and contributions to the history and the city may have been previously overlooked.
- Considering women's and men's needs and desires with respect to family care as well as the specific needs of the elderly and people with different degrees of functional ability in adaptive reuse of cultural heritage processes.
- Incorporating strategic impact assessments covering environmental, economic, social, and dimensions in adaptive reuse projects, including specific gender indicators and targets.

4.3. Gender in disaster risk management and climate adaptation

4.3.1. Background

Two fields are relevant to our discussion in this section: the first disaster risk management (DRM) and the second climate adaptation. Both in theory and practice, these are two distinct fields, not only with distinct bodies of literature and research communities, but also in a governmental context – often 'silo-ed' between separate departments. However, the two fields are linked by a concept central to a discussion of gender mainstreaming and more broadly social justice: that of social vulnerability[23], which can be defined as 'a state resulting from interaction of socio-economic and environmental characteristics, such as personal sensitivity, economic deprivation or housing conditions, affecting how prone to harm from climate-related

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[23] Further, some scholars have posited that the DRM community has historically been more accommodating of a people-centred perspective, arising from the social sciences and focusing on present-day conditions and how people are affected by these, while the climate adaptation community has emerged from the natural sciences and tends to focus on quantitative data, systems thinking and impact projections [9].

events people and communities are' [41] cited in [9][24]. For the purposes of this report, we find it useful to structure the discussion according to the phases of DRM, while also acknowledging the significance to the discussion of climatic trends that may not result in disaster, but nonetheless generate impacts.

In general, the significance of gender in both the impacts of disasters (including climate-related disasters), and responses to them, remains under-explored in academic literature [42] as well as under-represented in political agendas [43]. In addition, much of the literature on gender focuses on developing countries, where the consequences of hazardous environmental events tend to be more extreme. Due to a higher incidence of poverty and more prevalent social inequalities in the developing world, impacts of extreme weather events and other disasters also tend to be acutely felt by vulnerable groups, in many cases women and girls[25].

Still, the importance of gender mainstreaming within DRM is already recognised at an international level within key high-level frameworks, e.g. the UN's Sendai Framework for Disaster Risk Reduction 2015-2030. Within the Sendai Framework (a global agreement to strengthen focused action on disaster management and resilience, adopted in 2015), the need to mainstream gender in disaster risk reduction and emergency response actions (for the sake of equitable resilience) is recognised in several sections. For instance, the relevance of gender is outlined in **Section III** - **Guiding Principle d)** which states:

> *"Disaster risk reduction requires an all-of-society engagement and partnership. It also requires empowerment and inclusive, accessible and non-discriminatory participation, paying special attention to people disproportionately affected by disasters, especially the poorest. A gender, age, disability and cultural perspective should be integrated in all policies and practices, and women and youth leadership should be promoted. In this context, special attention should be paid to the improvement of organized voluntary work of citizens."* [44]

The imperative to adopt gender-equitable and universally-accessible response, recovery, rehabilitation and reconstruction approaches, as well as to develop early warning sentences in a participatory manner, are highlighted in **Section IV-Priorities for Action**, within **Priority 4 "Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction**". Lastly, women are identified as key stakeholders in **Section IV - The role of stakeholders, in order to develop gender-sensitive disaster risk reduction policies.** However, the Framework stops short of providing guidance on how to operationalise these principles and priorities.

The process of disaster risk management can be divided into three broad phases: 1) before (improving disaster preparedness, including assessing risk and vulnerability), 2) during (emergency response) and 3) after (post-disaster recovery) – all with a view to reducing both the possibility of a disaster occurring, as well as the adverse impacts in the event that one does occur. The three dimensions of social justice introduced earlier in Part 3 provide an analytical

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[24] For a discussion of the different concepts of social vulnerability arising from the DRM and climate adaptation communities, see [9].

[25] Much of the literature addressing the Global South concerns socio-economic conditions that differ considerably from those of Europe, however some patterns and approaches may be usefully extrapolated to a European context – where social inequalities also exist, but have often been less explicitly acknowledged.

framework to examine the cycle of disaster risk management and link it to gender mainstreaming: namely, recognition (whether gender is included at all in planning for and managing disaster risk), distribution (who experiences the 'costs' or impacts of a disaster and to what extent) and procedure (who is involved in decision-making, leadership and implementation of disaster risk management), as will be explored below. Below we look at the distributional dimension in more detail (i.e. gendered impacts) as well as considering all three dimensions in relation to DRM: firstly disaster preparedness, then response and recovery.

4.3.2. Disaster preparedness

A key element of disaster preparedness is to undertake a risk and vulnerability assessment (RVA) in order to understand the nature and distribution of risks that may result in negative impacts – whether these result from climatic hazards or other causes. The Intergovernmental Panel on Climate Change (IPCC) updated its concept of risk in its fifth assessment report (IPCC AR5), defining it as a product of interactions between exposure, vulnerability and hazards (see Figure 1)[26]. The IPCC AR5 refers to social and distributive justice in several places, however fails to offer a coherent definition of 'equity' or associated concepts in relation to climate impacts [9]. Leaving these terms undefined and open to interpretation, as well as without advice on how to make them operational, is problematic – as it likely means they will not be effectively addressed in practice. In this regard, the work conducted by the Joseph Rowntree Foundation's Climate Just project is of interest for its efforts to deepen commonly-accepted definitions and frameworks from a justice perspective, for example the framework developed by Lindley et al. (see Figure 1), which positions climate disadvantage (rather than risks and impacts in general) as central to the analysis.

The conceptual framework used to conduct an RVA is an important starting point, as it determines whether difference between social groups is even recognised in the first place, which will directly influence what kind of data is gathered and analysed– and the results upon which decisions are made. These results will also depend on the quality of the indicators selected, and the spatial scale on which the analysis is conducted: i.e. neighbourhood level data will be more revealing of population composition – who is living or working in risky areas – than data aggregated at a borough, city-wide or regional level [9]. The procedural element also demands attention here. Who is involved in conducting the RVA, who is involved in the planning of measures once risks are assessed? [45][46][47]. Not only does the representation of diverse social groups in general support more democratic outcomes that are likely to address a wider range of interests and concerns, but there is also evidence to suggest that gender diversity in decision-making bodies may improve economic resilience, as Young et al. have explored [48].

According to the IPCC, vulnerability can be understood as a combination of exposure and sensitivity, which interact to determine adaptive capacity[27] (i.e. the social and economic ability

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[26] For more on this, see ARCH state-of-the-art report 2: Disaster risk management, emergency protocols, and post-disaster response.

[27] Note that adaptive capacity is more commonly used by the climate adaptation community, while the DRM community tends to use the concept of coping capacity. A discussion of the differences between the two is beyond the scope of this paper, however can be found in the IVAVIA Guideline (Impact and Vulnerability Analysis

to cope with impacts). Considering these concepts in regard to the needs of LGBTI people in emergency response and recovery plans in Australia, Dominey-Howes et al. point out that both vulnerability and capacity are predicated on social marginality and relative levels of access to resources and power:

> *'While vulnerability highlights the external structural conditions that expose different, often marginalised, social groups to hazards, capacity focuses on the knowledge, resources, skills and networks of solidarity…that are mobilised as coping strategies during crisis.'* [49]

The framework pictured at Figure 1 suggests one way to address these structural conditions, where vulnerability is broken down according to sensitivity (e.g. health and age), 'enhanced' exposure (environmental elements e.g. quality of housing, access to green space), and adaptive capacity (e.g. income, language skills, time spent living in the neighbourhood) – the latter in turn split into abilities to prepare, respond and recover (i.e. the three DRM phases) [9].

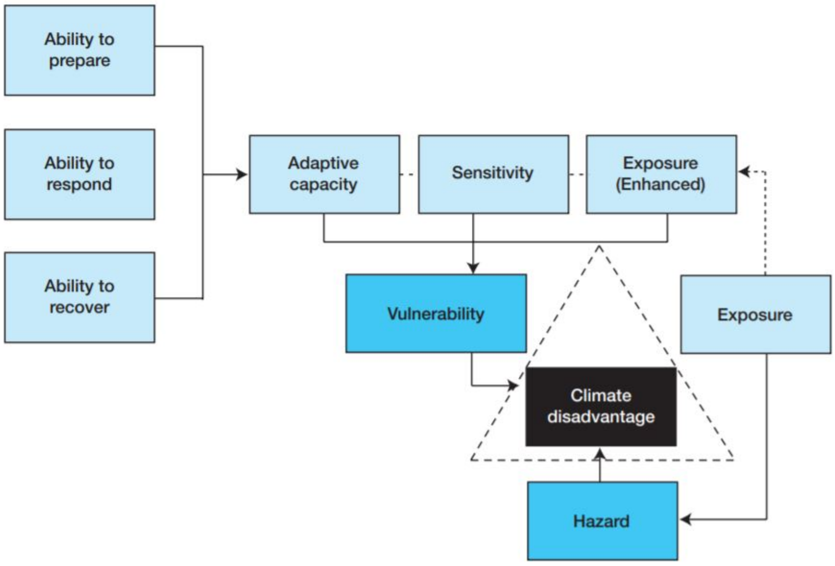

Figure 1: Conceptual framework for assessing socio-spatial vulnerability and climate disadvantage. Source: [41]**.**

A comprehensive RVA using gender-disaggregated data is hence capable of illustrating gender-based differences in vulnerability, which take into account not just sensitivity and exposure (dimensions which often assume a greater vulnerability of women) but also gendered capacities – whether they are physical or material capacities, social or organisational, or even motivational or attitudinal [50]. For example, in relation to post-flood recovery in the UK, Akerkar and Fordham found that women and men mobilised different strategies to cope: the former focused on care, the later focused on control [51]. In this regard, while they might be under-represented in formal disaster response planning and implementation, women are also often 'first responders' when disaster strikes, tending to the needs of their families and communities, and coping with adverse effects on the livelihoods of everyone around them [52].

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of Vital Infrastructures and built-up Areas) produced by the RESIN project and available here http://www.resin-cities.eu/fileadmin/user_upload/Resources/Design_IVAVIA/IVAVIA_Guideline_v3_final__web.compressed.pdf

Box 4: How to develop a gender-sensitive RVA?

The United Nations Development Programme and UN Women have developed the guidance *Gender and disaster risk reduction in Europe and Central Asia: A Workshop Guide for Facilitators*, which includes pointers for undertaking a gender-sensitive RVA, as follows:

- *Analyse the vulnerabilities of women and men, and their capacities for dealing with disasters.*
- *Understand women's and men's ability to cope with disasters, in local settings.*
- *Directly inform local and national-level action plans on how to prepare for disasters.*
- *Identify who is most vulnerable and why.*
- *Identify whose capacities need to be developed and what relief services are needed.* [50]

4.3.3. Emergency response and post-disaster recovery

Emergency response deals with the immediate, short term impacts of a disasters, while post-disaster recovery addresses the longer term ones. Disaster impacts on people (as distinct from – though of course related to – impacts on buildings, physical infrastructure or the natural environment) are not evenly distributed. Where social inequalities already exist, these are likely to be made worse by disaster impacts, unless compensatory measures are taken – however a disaster may also provide opportunities to redress existing inequalities [53]. In general terms, impacts on people can be divided into physical damage, material loss, disruption of wellbeing, and (closely related to the latter) psychological and ontological impacts.

Physical damage (injury or death)

Physical damage (to people) concerns personal injury or death. In this regard, at a global level, women, children and elderly are disproportionately affected by disasters, which is due to existing cultural and social norms rather than biological differences [44] [54] [55]. Women and girls tend to have less access to or control over assets, including the resources necessary to cope with hazardous events, such as information, education, health and wealth, and in this sense their vulnerability is in general relatively greater than that of men [42]. They may be at risk of experiencing violence or sexual assault in the time of instability following a disaster, or they may perceive such a risk and avoid places of service provision, such as emergency shelters, as a result.

A number of studies at the international level have found that women are more likely than men to die after a large scale disaster [42] [55] [56]. At a global level, and specifically in developing countries, women's higher vulnerability to environmental hazards has been linked to the pre-existing gender inequalities, which are magnified when a disaster occurs [54] [57]. These inequalities reflect disparities of economic and political power between women and men, which may manifest in aspects such as baseline health state [56] or access to resources (including education) leaving women in a weak position to deal with additional stresses. The global situation is however not necessarily transposable to women's mortality rates in Europe, where gender disparities are not usually so extreme. In fact, studies in Portugal, Switzerland and Italy have indicated a reversal of the trend, i.e. a higher incidence of male fatalities in case of extreme floods and landslides [57][58] which may reflect gender-connected responsibilities and lifestyles or a gendered predisposition to take risk. For instance, in the study examining flooding in Italy by Salvati et al., many fatalities occurred along roads and were motor-vehicle related, with a majority (65%) of victims men [57]. Similar results were obtained in Greece [59] and the USA [60]. Apart from the fact that mortality is just one of several possible impacts arising from a disaster, these apparent inconsistencies at European and global level highlight the complexity of the interplay between gender and disaster impacts, and the need for further research to understand this. In addition, Young et al. examining the related field of risk and decision-making, suggest that inconsistent findings may arise since the majority of literature on gender and risk considers biological sex rather than gendered (masculine or feminine) attributes [48].

Material loss

Disasters interrupt business, destroy productive resources and infrastructure, and make the lives of workers harder both during and after the crisis period [61]. In some contexts, it may be relevant to assess material losses linked to lives and livelihoods at the scale of the household or business (as they relate to paid and unpaid work), in addition to damage at larger scales, e.g. to housing and infrastructure.

Well-being disruption

According to Enarson, women's well-being is affected by disasters in four main ways. First of all, their economic security may decrease if productive assets are damaged or destroyed and in the case of becoming sole earners, their household entitlements may decline and/or small-businesses be impacted. Gender stereotypes may limit their work opportunities as well. Secondly, the situation may add to the burden of an existing caregiving role. Thirdly, women's working conditions in the household and paid job could also deteriorate (for example, if child-care services are disrupted). Lastly, in some situations women may take more time to recover from major economic losses than men, being less mobile than male workers and sometimes excluded from government-led financial recovery assistance programmes [61].

Psychological and ontological damage

Disasters can alter the psychological and ontological state of their victims, leading to feelings of displacement, loss and instability. Haney and Gray-Scholz conducted a study to determine the role of gender in experiences of post-disaster ontological security in Canada [62]. The findings indicate that women are more likely to experience disrupted ontological security after a disaster, especially linked to the loss of familiar landmarks or routines, as a result of having stronger emotional and social ties than men to their residential neighbourhood. Since places of cultural heritage significance are often associated with high levels of place attachment, it is relevant to take into account how damage to or loss of a historic site may psychologically impact members of a local community, and how in turn such impacts may be experienced differently among different gender groups.

4.3.4. Service provision

Gender mainstreaming is relevant to the relief services and support provided during disaster response and recovery efforts, both in terms of access to these services and participation in their provision. Gender-based stereotypes abound in this field, with men seen as active ‘heroes’ and women as (passive) carers, or themselves needing care[28]. High level recognition of the role of women as ‘first responders’ in disaster response and recovery (e.g. in the 1979 Convention on the Elimination of all Forms of Discrimination against Women) has done little to change this [63]. In a study on the subject nearly 20 years later, Scanlon found that the emerging picture was one of male-dominated emergency organisations taking action in a society in which women were depicted as unable to cope in the wake of disaster, needing to be supported or managed by men, or left to carry out traditional female roles such as childcare. Men, prompted to join emergency agencies, left the family at home to take on rescue duties and were charged with making decisions about evacuation and relief – often based on inaccurate perceptions of victims’ needs. Today, women remain under-represented as practitioners in the field, making up a minority in rescue teams on the ground and leadership roles, even in regions such as Scandanavia, where significant progress has been made in gender mainstreaming [64].

While in some cases, lack of information, education or engagement with preparedness activities may mean that women do not know how and when to act in case of a disaster [65] other studies suggest that when women are involved in emergency response, casualties are dramatically reduced [66], suggesting that improving gender diversity in DRM – and addressing the barriers to lack of female representation – is a desirable goal. Hemachandra et al. identified ten factors hindering women’s participation in decision-making processes related to disaster risk governance, divided into four main categories (socio-cultural factors, socio-economic factors, individual characteristics, and legal and institutional factors) which are depicted below in Figure 2 [67].

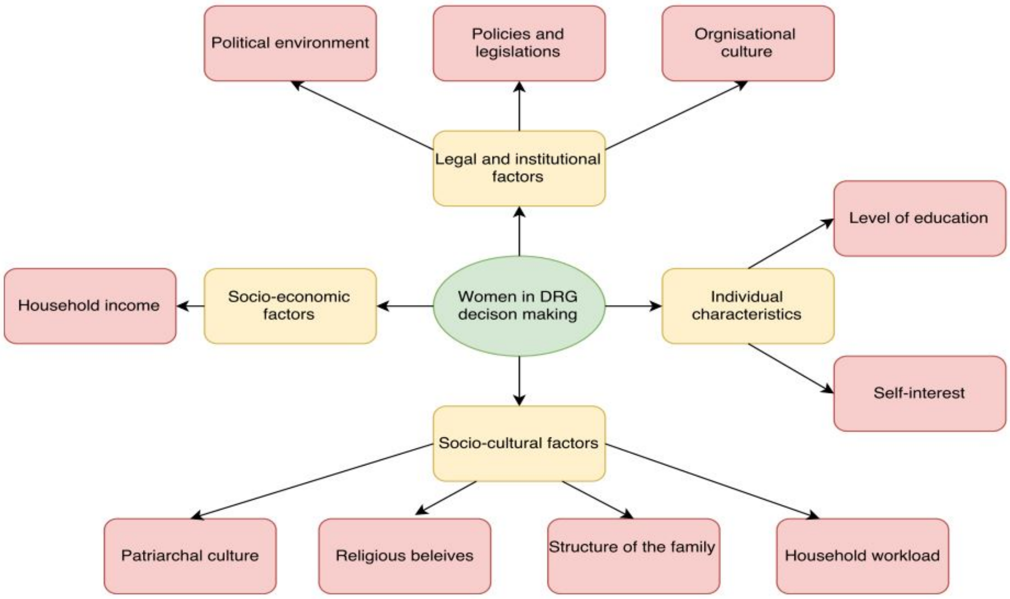

Figure 2: Factors affecting the role of women in DRM decision-making. Source: [67].

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[28] It is important not to forget that gender goes beyond simple binarism (see Glossary) and so far, much of the work addressing gender in disaster response has been limited to binary genders, leaving aside the role of non-binary or non-conforming groups (i.e.LGBTI) in the picture [44].

Gender-blindness in service provision may lead to ineffective or inefficient delivery of aid. Examining emergency response and recovery plans during and after bushfires and flooding in Australia, Dominey et al. found that lesbian, gay, bisexual, trans and intersex (LGBTI) people risk exclusion (even if inadvertent) in regard to both participation in service provision and access to services, due to a 'blindness to difference' in policies and practices that vaguely endorses inclusion without defining this concept or making it operational. As they point out:

> *'Equal treatment does not equate with identical treatment, but should instead seek equity, which recognises that not every social group has the same access to social, political and material means, and attempts to redistribute rights and resources in order to provide a "level playing field".' [11]*

This oversight can also affect men, who are frequently reluctant to seek help or may lack sources of informal support through social networks, consequently at risk of failing to receive adequate care – e.g. as evidenced by the over-representation of elderly men in deaths related to heatwaves in the US [68].

Without measures to better assess and deploy gender-specific needs and capacities, emergency response will fail to be as effective and coordinated as needed, limiting the roles of women and men in ways that can reduce the capacity of both for recovery and self-care. In sum, gender-sensitive service provision and gender diversity within planning, decision-making and implementation of response and recovery efforts are likely to result in more effective and efficient processes – in the interest of a more resilient community. Scanlon's observation over two decades remains relevant today:

> *'A shared understanding of the dynamics of gender discrimination at the decision-making level will have benefits for community resilience. Such understanding would include social and structural issues and the complex psychological, financial, and physical challenges that communities and individuals face in disasters. Leaders at every level of emergency management have influence and therefore, the potential to address aspects of gender equity. In order to shift organisational culture towards a more inclusive and representative model, positive action and decision-making by community leaders and senior management staff is key.'* [69]

4.3.5. Current obstacles and needs for further work

In summary, obstacles to mainstreaming gender in DRM include:

- Lack of awareness that impacts are gendered.
- Lack of quantitative and qualitative data to measure gendered impacts, needs and capacities, and corresponding need to improve the statistical infrastructure to collect and analyse this data beyond project-level [50]. For more on this in relation to RVA, see Box 3 above.
- Gender-blindness in DRM programmes. Key stakeholders in post-disaster reconstruction are not always aware of gendered vulnerabilities and these are typically not monitored in the reconstruction process.
- Lack of capacity within government and other organisations tasked with DRM to undertake gender analysis.

- Persistence of gender stereotypes in the field, limiting the capacity for mainstreaming gender in the active participation in response and recovery.

Needs for further research include [43]:

- Studies that test and validate indicators corresponding to exposure, sensitivity, capacity, vulnerability and risk disaggregated by sex, age, socio-economic status etc.
- Longitudinal studies both across the DRM cycle and sometime after the event to better understand disaster dynamics, long-term impacts and how they are experienced by different genders;
- More research is necessary not just on the experiences and needs of women, but those of other genders including LGBTI in disaster situations [11].

4.3.6. Policies and solutions

- Concepts such as 'vulnerability', 'resilience' and 'community' should be carefully defined in developing disaster risk policies and supporting tools, as a key step towards recognition of their complexity. An adequate definition would explicitly recognise the relevance of power structures that affect the uneven distribution of the costs of disasters and benefits of actions to address them.
- Gender experts should be consulted by adaptation and disaster risk management teams at all levels of government [43].
- The RVA process should allow for disaggregating data according to sex and other factors, making visible those who are marginalized and particularly at-risk, not just women, but also ethnic minorities, those with chronic disabilities or health problems, etc., as well as identifying women and other social groups who support and care for at-risk individuals.
- The whole DRM cycle should make provision for participation, such that vulnerable groups are represented and empowered to take part (including women and LGBTI people, and organisations representing them).
- Gender mainstreaming in DRM programmes should be monitored and evaluated for success.

Morchain et al. offer additional specific recommendations for designing and conducting gender transformative VAs (RVAs) as follows [47]:

> *Choose a VA methodology with a landscape-wide contextual understanding of vulnerability and the root causes behind it.*
>
> *Include women's organisations, women's groups or leaders within mixed organisations when conducting VAs.*
>
> *Create a non-threatening environment for women to express their views.*
>
> *Be aware of limitations and time constraints.*
>
> *Improve women's access to information and knowledge prior to meetings.*

Keep men informed and encourage their involvement in women-focused activities.

Build the capacity of women to take on specific roles and responsibilities in the VA process.

Move beyond gender-disaggregated data. Given that inequality stems from the intersection of different social identities (i.e. gender, status, ethnicity, class, age), it is important to investigate their interaction in order to gain a comprehensive understanding of the underlying causes of women's vulnerability.

5. Relevance of gender mainstreaming for the ARCH project

A gender perspective offers added value to the ARCH project for reasons that are essentially not much different to those for conducting gender mainstreaming in any other sphere of work. Other benefits are more specific to the project's research focus, specifically on resilience-building at the intersection of cultural heritage management and disaster risk reduction. The key benefits arising from our review are outlined below.

Considering gender supports quality assurance

In the context of urban development policymaking and planning, understanding the different needs and capacities of individuals is a critical step towards making an informed decision. A gender-blind approach fails to acknowledge these differences and is likely to result in decision-making based on inaccurate information. This is of particular relevance to the ARCH project, given that the research team will develop models, methods, tools and datasets to support decision-making.

Resources can be better targeted when population needs are differentiated

Similarly, understanding the needs of different population groups, based on characteristics including gender, can help ensure that resources are targeted more efficiently and effectively to meet these needs [19] [70]. This is a salient point for decision-makers and technical staff working within local government who are increasingly facing resource and capacity constraints – and a key target group for the ARCH project.

An inclusive research design can help make results more relevant, useful and usable

ARCH is an applied research project with an overt interest in research outputs (including tools and methods) being taken up and utilised in practice. An awareness of (and efforts to actively address) the different needs, capacities and perceptions of end users (of all genders) can support the relevance, usefulness and applicability of these outputs to the target group. Further, the team has committed to conduct its research through a process of 'co-creation', based on principles of equality and inclusiveness. These principles cannot be effectively made operational without also committing to gender mainstreaming.

An equitable, cohesive society is a more resilient one

Addressing inequalities in living conditions, access to resources, and participation in decision-making is essential to building social cohesion and reducing social exclusion and conflict. Since socially cohesive communities are more likely to respond better in the event of a disaster or climate hazard (for example, in terms of access to social capital), justice (and as part of that, gender equality) is a valid objective in efforts to build resilience [9] (as discussed earlier at Part 3.1.1).

Further, sites of cultural heritage significance are also important contributors to social cohesion [71], [72], serving to reflect and shape community identity, as well as fostering feelings of attachment and security – all of which can contribute to coping capacity in terms of longer-term recovery from a disaster or extreme weather event [51]. These sites are themselves loaded with values and assumptions that reflect predominant social norms. Recognising the 'gendered' nature of cultural heritage sites (see Part 4.2) can be a factor in supporting a shared community identity that is inclusive, contemporary, and acknowledges a range of perspectives.

6. Conclusion

We set out to explore the relevance of gender in the thematic areas central to the ARCH research project: cultural heritage management, disaster risk management and climate adaptation. Key concepts and definitions have emerged as part of this review, as discussed earlier in Part 3, with a full list in the Glossary. Among the most important of these are the relationship of social justice to these three thematic areas, and the concept of 'gender mainstreaming'. With regard to the ARCH project, gender mainstreaming can be understood as the process of making visible and explicit the concerns of all genders in the research design, implementation, monitoring and evaluation, as well as in the local planning and policy implementation that will be pursued in parallel by the ARCH city partners. This report itself makes a contribution to that process, by sensitising the research team to the relevance of gender in their work areas. The concept of social justice (and its connection to resilience) provides an essential framing for this process, because gender mainstreaming serves the purpose of achieving greater equality between genders. This needs to be understood in the context of improving social justice in general, and as part of a broader recognition that power and access to resources are not evenly distributed to all individuals – with efforts needed to redress this imbalance. Three dimensions of social justice were identified as useful for our analysis of gender mainstreaming, namely recognition, distribution and procedural justice. While our analysis did not explicitly address the contextual and intersectional dimensions of justice, these are nonetheless relevant and could inform future research, including as part of the ARCH project. As Ryder points out, intersecting causes of disadvantage (among them gender) are particularly crucial to understanding experiences of disaster vulnerability, suggesting a need to disaggregate data by multidimensional indicators (e.g. gender, age, race, income) which few studies have managed to date [16]. As a minimum, the three-dimensional analytical framework used for this paper is recommended for use by the ARCH research team for their future work, however efforts to further explore gender's intersections with other elements are encouraged.

Gender mainstreaming by definition is not confined to any single discipline or thematic field, and likewise the literature reviewed highlights challenges relevant to all thematic areas of the ARCH project. With regard to '**recognition'**, it is clear that visibility is key when it comes to gender. This means embarking on research armed with conceptual frameworks and definitions that foreground social justice concerns (among them gender equality), and the differentiated needs and capacities of individuals, particularly those who are marginalised. Concepts however are evidently not in themselves enough, as much of the literature pointed to a lack of guidance in how to make these operational. Some guidance does exist on how to incorporate a gender perspective into specific processes of relevance to the ARCH team, e.g. urban planning, technological development and DRM, and selected resources are listed in an Annex to this document. The research team could also consider making its experience available to future researchers and funding bodies in the form of recommendations or key lessons learnt. Another aspect of visibility is data, with data disaggregated by sex (as well as other characteristics such as age, ethnicity, income level, etc.) being an essential basis[29] on which to make policy decisions that address differentiated needs and capacities. Since research partners will gather data from the four pilot cities, disaggregation should be built into data requests. A more sophisticated disaggregation would consider gender rather than sex, pointing to the need for new instruments and indicators.

Concerning '**distribution'**, for our purposes this primarily concerns the distribution of the costs (i.e. impacts) of climate change and disasters, as well as the benefits of measures taken to address these – and how these are unevenly experienced across communities. Here, it is important firstly that methodologies developed by the ARCH project to assess risk and vulnerability enable and encourage the collection of disaggregated data at a spatial scale small enough to make explicit differences among populations (e.g. neighbourhood level), and secondly, that approaches planned to reduce disaster risk build in mechanisms to consider how different population groups will benefit. For specific approaches such as 'adaptation pathways' it would, for example, be recommended to include consideration of gendered vulnerabilities (including coping/adaptive capacity) into the criteria used to assess and select a particular pathway. In regard to the management of cultural heritage sites, mainstreaming gender could involve collection of disaggregated data on visitors and users, and/or surveys to better understand their needs, as well as developing awareness-raising campaigns that include imagery representative of a range of gender identities and use inclusive language. Redevelopment, refurbishment or adaptive re-use of heritage sites also offer opportunities to address gender inequalities, and planning and design guidelines should be consulted in such cases (e.g. the guide developed by the City of Berlin – see Annex).

The '**procedural'** element of justice is an important one in the context of a project that intends to 'co-create' tools and solutions to support decision-making, which are intended for use by people beyond the life of the project. This suggests as a minimum that working groups (whether within the research team, or more broadly with stakeholders in each partner city) should be gender diverse, and ideally include periodic input from a gender officer or advisor, where the partner organisations employ such a person – or from an external organisations that represents the interests of women and the LGBTI community. More specifically, people of all genders should have the opportunity to have their voices heard at internal and public meetings and events, which can be partly achieved through effective moderation.

Given that gender mainstreaming in general has been limited to date in most fields, there is equally a lack of evaluation on the outcomes and benefits it has delivered in practice. In addition, there are few studies that investigate gender mainstreaming at the specific thematic intersection that ARCH seeks to explore. On both fronts, it would likely be a valuable and novel contribution to this knowledge gap if the ARCH project succeeds in integrating a gender perspective into its research design and implementation. It would also likely be an important contribution to the practice of 'co-creation' in research, as a means of actively addressing the structural imbalances in power that typically persist in diverse research/practice teams.

[29] In fact, sex-disaggregated data should be seen only as a starting point, since disaggregation by gender, which would require more complex indicators and instruments, would enable a more sophisticated analysis of gender-specific elements.

7. List of Figures

8. List of Boxes

9. Glossary

Cultural heritage: is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations [71].

The term cultural heritage encompasses several main categories of heritage:

- Tangible cultural heritage:
    - movable cultural heritage (paintings, sculptures, coins, manuscripts)
    - immovable cultural heritage (monuments, archaeological sites, and so on)
    - underwater cultural heritage (shipwrecks, underwater ruins and cities)
- Intangible cultural heritage: oral traditions, performing arts, rituals
- Natural heritage: natural sites with cultural aspects such as cultural landscapes, physical, biological or geological formations
- Heritage in the event of armed conflict

Dependent-care infrastructure: Facilities for the care of people with certain degree of dependence, e.g. children, elderly or people with disabilities.

Gender: Gender refers not to our biological sex as male or female, but to our socialisation as either woman or man. Our gender often impacts our behaviour and thus the ways we move around, interact and exist in the city. It is associated with the behavioural expectations established around what it means to be masculine or feminine [19].

Gender refers to the roles, behaviours, activities, attributes and opportunities that any society considers appropriate for girls and boys, and women and men [4].

Gender analysis: The European Commission defines gender analysis as 'the study of differences in the conditions, needs, participation rates, access to resources and development, control of assets, decision-making powers, etc., between women and men in their assigned gender roles' [73].

Gender analysis provides the necessary data and information to integrate a gender perspective into policies, programmes and projects. As a starting point for gender mainstreaming, gender analysis identifies the differences between and among women and men in terms of their relative position in society and the distribution of resources, opportunities, constraints and power in a given context. In this way, conducting a gender analysis allows for the development of interventions that address gender inequalities and meet the different needs of women and men [1].

Gender binary (binarism): model referring to the norms derived from the simplistic idea of a dichotomy of two mutually exclusive and biologically defined sexes to whom different roles and behaviour are traditionally ascribed [74].

Gender-blindness: Gender blindness is the failure to recognise that the roles and responsibilities of men/boys and women/girls are given to them in specific social, cultural, economic and political contexts and backgrounds. Projects, programmes, policies and attitudes which are gender blind do not take into account these different roles and diverse needs, maintain the status quo and will not help transform the unequal structure of gender relations [75].

Gender (or sexual) division of labour: The division of labour refers to the way each society divides work among men and women, boys and girls, according to socially-established gender roles or what is considered suitable and valuable for each sex. Within the division of labour, there are several types of roles:

- Productive roles: Activities carried out by men and women in order to produce goods and services either for sale, exchange, or to meet the subsistence needs of the family.
- Reproductive roles: Activities needed to ensure the reproduction of society's labour force. This includes housework like cleaning, cooking, childbearing, rearing, and caring for family members. These tasks are done mostly by women.
- Community managing role: Activities undertaken primarily by women at the community level, as an extension of their reproductive role, to ensure the provision and maintenance of scarce resources of collective consumption such as water, health care and education. This is voluntary unpaid work performed during "free" time.
- Community politics role: Activities undertaken primarily by men at the community level, often within the framework of national politics. This officially recognized leadership role may be paid directly or result in increased power or status.
- Triple role: This refers to the fact that women tend to work longer and more fragmented days than men, as they are usually involved in three different roles: reproductive, productive and community work. [1]

Gender equality: refers to the goal when all human beings, men and women, are free to develop their personal abilities and make choices without the limitations set by stereotypes, rigid gender roles, discrimination and prejudices, when women and men fully enjoy their human rights. It means that the different behaviours, aspirations and needs of women and men are considered, valued and favoured equally [75]. It concerns the equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration, recognizing the diversity of different groups of women and men [1].

Gender equity is the process of being fair to men and women, boys and girls. It refers to differential treatment that is fair and positively addresses a bias or disadvantage that is due to gender roles or norms or differences between the sexes… [taking] into account the different needs of the men and women, cultural barriers and (past) discrimination of the specific group [75].

Gender mainstreaming: Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for explicitly making the concerns and experiences of women, as well as of men, an integral part of design, implementation, monitoring and evaluation in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated [19].

Gender responsive: refers to policies and approaches that entail identifying needed interventions to address gender gaps in sector and government policies, plans and budgets; considering gender norms, roles and relations for women and men and how they affect access to and control over resources; and considering women's and men's specific needs, although these nuances are not always clear cut. Changes are planned or made that respond to the inequities in the lives of men or women within a given social setting and aim to remedy these inequities [19].

Gender sensitive: refers to policies and approaches that take into account gender perspectives and assess gender impacts and incorporate them into strategies; policies and approaches consider gender norms, roles and relations but does not address inequality generated by unequal norms, roles or relations. While it indicates gender awareness, no remedial action is developed [19].

Heritage Urban Landscape approach: The Historic Urban Landscape is a sustainable analytical approach for the assessment, conservation and management of urban areas, understood as a historic layering of cultural and natural values, extending beyond the notion of 'historic centre' or 'ensemble' to include the broader urban context and its geographical setting. This wider context includes the site's topography, geomorphology and natural features; its built environment, both historic and contemporary; its infrastructures above and below ground; its open spaces and gardens; its land use patterns and spatial organization; its visual relationships with its overall setting; and all other elements of the urban structure. It also includes the social and cultural practices and values, human activities as well as economic processes, the unique characteristics of any one place and the intangible dimensions of heritage as related to diversity and identity, all of which establish the basic role of the city as an agent for communal growth and development" [76].

Heritagisation: refers to the transformation of objects, places and practices into cultural heritage as values are attached to them, essentially describing heritage as a process [33].

Quality gender data: Data that is reliable, valid and representative, free of gender biases, with good coverage (including country coverage and regular country production), and is comparable across countries in terms of concepts, definitions and measures. Quality data should have the features of complexity (meaning that data from different domains in women's lives can be cross-referenced and cross-tabulated), and granularity (where the data can be disaggregated into smaller units by race and ethnicity, age and geographic location, as well as sex) [77].

Resilience: The capacity of a social ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation [6]. Building resilience needs to account for: the degree to which the community comes into contact with a hazard capable of causing harm; the amount of inherent susceptibility to harm in that community; and the extent to which people in the community are able to make adjustments in order to avoid negative consequences, taking into account existing imbalances in power distribution in that community and ensuring that neither the impact of the hazard, nor the policies and actions themselves exacerbate existing or create new inequalities across different groups [7].

Sex-disaggregated data: Data is that collected and tabulated separately for men and women. For example, primary school attendance rates for boys vs. girls [77].

Socially just adaptation: a set of policies and actions responding to current climate variability and anticipating the future climate change and its impacts designed to ensure that neither the impact of climate change nor the policies and actions themselves exacerbate existing or create new inequalities across different groups in the urban society [8].

Vulnerability: the structural conditions, including physical, social, cultural, economic and political systems that render people and communities susceptible to the impacts of hazards, and which make it possible for a hazard to become a disaster [49]**.**

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11. Annex A – Key resources

Title / summary of contents	Year	Author	Link
Oxfam's Vulnerability and Risk Assessment (VRA) tool is a guidance package that explicitly aims to jointly identify and analyse root causes of vulnerabilities for distinct social groups and later design programmes and risk reduction initiatives accordingly, ensuring that they are equitable, gender-sensitive and effective. While it originates in a development cooperation context, the guidance on conducting inclusive workshops that seek to identify complex social vulnerabilities, are of broader relevance to researchers seeking to address similar aims.	2016	Daniel Morchain and Frances Kelsey (Oxfam)	https://policy-practice.oxfam.org.uk/our-approach/toolkits-and-guidelines/vulnerability-risk-assessment
Gendered Innovations: Engineering Checklist and Engineering Innovation Processes is intended for researchers, project directors and evaluators, grant writers, and funding organizations addressing the development of technologies and related products, services, infrastructures, or processes. The checklist provides a set of key questions for incorporating sex and gender analyses into engineering—as a basis for developing Gendered Innovations. The guidance on processes offers a framework for incorporating knowledge on sex and gender into the engineering design process. Both are based on the Fraunhofer - project "Discover Gender", which was funded from the German Ministry for Research from 2004-2006.	2011	Stanford University	http://genderedinnovations.stanford.edu/methods/engineering_checklist.html http://genderedinnovations.stanford.edu/methods/innovation.html
Gender mainstreaming made easy This manual contains practical advice and checklists that will make gender mainstreaming within a municipal administration easier. Its aim is to focus municipal employees' attention on the living and working conditions of women and men when planning, budgeting for, implementing and assessing measures.	2011	Förster et al.	https://www.wien.gv.at/menschen/gendermainstreaming/pdf/gender-mainstreaming-made-easy.pdf

Title / summary of contents	Year	Author	Link
Gender Mainstreaming in Urban Development A range of criteria and guidelines for decision-making in gender-sensitive planning at various levels. The first part addresses the similarities and differences between gender mainstreaming and gender planning as employed in the Berlin context. Suggestions regarding the design of planning processes are next, supplemented by criteria for the evaluation of different levels of planning in the urban context. These criteria are intended to stimulate and encourage those involved in the planning process to approach each new project with an eye towards a creative examination of the advantages that gender mainstreaming can provide.	2011	Women's Advisory Committee of the Senate Department for Urban Development in cooperation with Department of General Affairs, Ministry of Urban Development	https://www.stadtentwicklung.berlin.de/soziale_stadt/gender_mainstreaming/download/gender_englisch.pdf
Gender Equality, Heritage and Creativity: This report draws together existing research, policies, case studies and statistics on gender equality and women's empowerment in culture provided by the UN Special Rapporteur in the field of cultural rights, government representatives, international research groups and think-tanks, academia, artists and heritage professionals. It includes recommendations for governments, decision-makers and the international community, within the fields of creativity and heritage.	2014	UNESCO	https://en.unesco.org/news/gender-equality-heritage-and-creativity-now-available-chinese-spanish-english-and-french
Making Disaster Risk Reduction Gender-Sensitive / Policy and Practical Guidelines Policy and practical guidelines for national and local governments to further implement the Hyogo Framework for Action (the predecessor of the Sendai Framework for Disaster Risk Reduction). It includes guidelines on gender-sensitive risk assessment, gender-sensitive early warning systems, and examples of indicators for DRM as a whole.	2009	UNISDR, UNDP and IUCN	https://www.unisdr.org/files/9922_MakingDisasterRiskReductionGenderSe.pdf

Title / summary of contents	Year	Author	Link
Gender and disaster risk reduction in Europe and Central Asia This guide is designed for facilitators and trainers working to incorporate gender perspectives in disaster risk reduction (DRR) programmes and initiatives. It is structured as a series of 4 training modules with guiding questions and worksheets. Although intended for trainers, it may also be useful for self-guided learning on the gendered impacts of disasters, and corresponding indicators. It includes a unit on gender analysis in disaster settings, which may help guide incorporation of a gender perspective in a post-disaster needs assessment. Module 4 deals specifically with indicators and Gender-responsive monitoring in implementing the Sendai Framework for DRR and the SDGs	2018	UNDP, UN WOMEN	https://www.eurasia.undp.org/content/dam/rbec/docs/Gender%20and%20disaster%20risk%20reduction%20in%20Europe%20and%20Central%20Asia%20-%20Workshop%20guide%20(English).pdf

ARCH State-of-the-Art-Report 6

Existing standards and regulatory frameworks

Deliverable no.	D7.1
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Table of Contents

List of Abbreviations

Abbreviation	Meaning
AWI	Approved new Work Item
CD	Committee Draft
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CWA	CEN Workshop Agreement
DIN	German Institute for Standardisation
DIS	Draft International Standard
EN	European Standard
ETSI	European Telecommunication Standards Institute
FDIS	Final Draft International Standard
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
ITU	International Telecommunication Union
JTC	Joint Technical Committee
NP	New Proposal
SyC	System Committee
WD	Working Draft
WG	Working Group
WSC	World Standards Cooperation

Executive Summary

The aim of this report is to disseminate knowledge about existing standards and standardisation activities among the project partners and to raise awareness of possible missing standards. Thus this document will present and summarize the current 'resilience of historic areas' standardisation landscape, specifically taking into consideration aspects related to climate change, and will list and briefly assess the standards relevant for the ARCH project.

In summary, it can be said that a great variety of technical committees, and the organisations behind them, are committed to the 'resilience of historic areas' and related issues such as climate change, hazards and disaster or crisis management. An extensive list of standards has been identified following the ARCH kick off meeting, including keyword identification and the exchange with project partners. The standards search has been conducted by the use of the standards database Perinorm. An initial classification of the project-relevant standards was carried out and 107 standards have been considered within the scope of the further activities of the ARCH project (T2.6 "Standardisation activities"). Standards have been categorised following their thematic classification. The vast majority of the standards assessed as being relevant for the project belong to the categories 'Climate change', 'Management systems', 'Heritage', 'Resilience' and 'Cities and communities'. Much less relevant standards are included in the categories 'Techniques' and 'Drones'.

Furthermore, the analysis of the standards has provided an important basis for the forthcoming work in Task 2.6 where the main objective is to develop a standardisation strategy for the ARCH project and to initiate new standardisation activities. The results of this report will be compared with the identified project needs for standardisation in order to support the identification of the standardisation potential within ARCH and thus close the gap in existing standardisation processes (D2.4).

1. Introduction

1.1. Background information and aim of this report

This part of the deliverable D7.1 titled 'A report describing the existing standards and standardisation activities' has the objective to gather and disseminate knowledge about relevant existing standards and standardisation activities amongst project partners and to support awareness raising regarding potentially missing standards under the topic: 'resilience of historic areas'. Thus this document presents the current 'resilience of historic areas' standardisation landscape, specifically taking into consideration climate change aspects and investigating the standards and technical committees relevant for the ARCH project. The list of standards includes aspects such as resilience, historic areas, heritage, disaster management systems and climate change, as these are the topics requested by the project partners. However, the focus of this standards' research is on formal standards established by recognised standardisation organisations, such as ISO at international, CEN at European and DIN at German national level. However, since other reports deal with relevant regulations/policies, we are focusing on standardization documents here.

1.2. Relation to other SotA reports and deliverables

This report is one of a series of six SotA reports.

- SotA 1: Historic areas, conservation practices, and relevant regulations / policies.

Connection to this report: Harmonized standards are possible results of mandates.

- SotA 5: Gender aspects in conservation and regulation of historic areas, disaster risk management, emergency protocols, postdisaster response techniques, and techniques for building back better.

Connection to this report: Our report takes into account the SotA 5 guidelines with regard to gender aspects.

This deliverable is connected to the activities carried out in WP2 'Outreach'. More specifically to the following deliverable: D2.4 Standardisation Strategy and conducted activities.

1.3. Structure of this report

This document is structured as follows. Firstly, section 3 provides an introduction about the structure of the standardisation system. The following part (section 4) provides basic information about the current status of the 'resilience of historic areas' standardisation landscape and describes briefly the context in which this document has been developed, while it explains the methodology used for the analysis of the relevant standards. The results of the standards research are placed in section 4.3. Section 5 gives a brief overview in which work packages, or aspects of the project, the results of this report may be used. The final part of the document (section 6) draws conclusions regarding the general status of the standardisation landscape of 'resilience of historic areas' and the identified list of standards.

2. Definitions

No key concepts and specialist terms to be covered in the report.

3. Standardisation system

The standardisation system comprises of organisations responsible of standardisation activities conducted on national, European as well as international level (see Figure 1). European and international standards are developed according to the national delegation principle, with each country sending a delegation of experts to represent the national standpoint. In Germany's case, DIN sends the delegation. This standpoint is drawn up in national committees that "mirror" the committees at European (CEN, CENELEC, ETSI) or international level (ISO, IEC, ITU). Stakeholders can thus work together in their own native language. The national delegation principle gives stakeholders a direct line to European and international standardisation, while at the same time supporting self-regulation by industry.

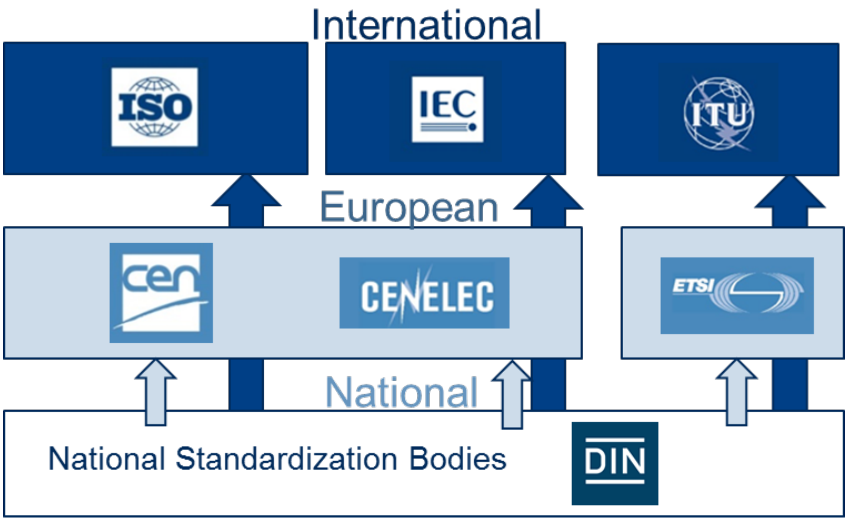

Figure 1: Standardisation system structure

3.1. European standardisation

The European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (CENELEC) as well as the European Telecommunication Standards Institute (ETSI) carry out the standardisation work on European level. Common standards applied across the whole of the European single market ensures protection of consumers and interoperability of products, encourage innovation and technological development. CEN and CENELEC provide the platform for European standardisation.

The following European Technical Committees (TC) are the most relevant ones to be considered in the context of ARCH:

- CEN/TC 346 Conservation of cultural property
- CEN/TC 391 Societal and citizen security

- CEN/TC 389 Innovation management
- CEN/TC 250/SC 8 Eurocode 8: Earthquake resistance design of structures
- CEN/TC 442 Building information modelling

3.2. International standardisation

The International Organisation for Standardisation (ISO) as well as the International Electrotechnical Commission (IEC) are the responsible standardisation organisations at global level. The United Nations specialized agency in terms of information and telecommunication technologies is the International Telecommunications Union (ITU). ISO, IEC and ITU established the World Standards Cooperation (WSC) in 2001, in order to strengthen and advance their voluntary consensus-based international standards systems.

Currently 164 national standards bodies are ISO members. This means 'Codes of practices' have to be established in order to allow a smooth operation of the standardisation process on international as well as on European level. Therefore the Vienna and Dresden Agreements have been concluded. Those agreements between CEN and ISO (Vienna), CENELEC and IEC (Dresden) got the objective, to carry out work at one level of standardisation (where possible), and use parallel voting procedures to achieve simultaneous adoption as ISO/IEC and EN standards.

The following International Technical Committees (TC) are the most relevant ones to be considered in the context of ARCH:

- ISO/TC 292 Security
- ISO/TC 207 Environmental management
- ISO/TC 20 Aircraft and space vehicles
- ISO/TC 182 Geotechnics
- ISO/TC 46 Information and documentation
- ISO/TC 279 Innovation management
- ISO/TC 268 Sustainable development in communities

3.3. Types of standards

A standard is a consensus based document that is approved by a recognised body, like for example the German Institute for Standardisation (DIN), which is an official member of the European and international standardisation system. It provides rules, guidelines or characteristics for activities or their results, reflecting the state-of-the-art. It should be based in the consolidated results of science, technology and experience, aiming at the promotion of the optimum community benefits.

A published standard is the last stage of a process that commonly starts with the proposal of new work within a technical committee. Here are some abbreviations used for marking a standard with its status:

- NP New Proposal (e.g. ISO/NP 22300)
- AWI Approved new Work Item (e.g. ISO/AWI 22342)
- WD Working Draft (e.g. ISO/WD 22340)
- CD Committee Draft (e.g. ISO/CD 22341)
- DIS Draft International Standard (e.g. ISO/DIS 22383)
- FDIS Final Draft International Standard (e.g. ISO/FDIS 37123)
- prEN Draft European Standard (e.g. prEN 16163)
- FprEN Final Draft European Standard (e.g. FprEN 17135)

Different standardisation documents are available, e.g. ISO, EN, CEN/TR, CEN/TS, CWA. Each of them represents a different level of consensus. While developing a European Standard (EN), the standstill policy applies. This means that during work on a European standard and after its publication, CEN/CENELEC members agree not to publish national standards which are not in line with it. This is done to prevent any situation occurring during the preparation or after publication of a standard which could impair or undermine harmonization. National standards which are in conflict or duplicate EN standards have to be withdrawn. One special type of EN is the mandated European Standard (Harmonised EN), which is applied in the context of the New Legislative Framework (a.k.a. New Approach) and developed on the basis of a mandate from the European Commission to set out the Essential Requirements for the product or service that are specified in an EC Directive. These Essential Requirements deal in particular with the health and safety of users and other fundamental matters. Harmonised Standards do not have a special designation, except from a note in the foreword.

A European Technical Specifications (CEN/TS) aims to aid market development and growth for products or methods that are still in the development and/or trial phase, and European Technical Reports (CEN/TR) provide specifications of a recommendatory and explanatory nature. Special specifications, which are developed with the rapid consensus of expert stakeholders (no full consensus needed), can be found in CEN Workshop Agreements (CWA) or Publicly Available Specification (PAS), a standardisation document that closely resembles a formal standard in structure and format but which has a different development model. All document types differ in their development procedures and binding forces.

4. Standardisation landscape

4.1. Search methodology

The research on relevant standards was conducted by DIN with the help of the ARCH project partners taking part in T7.1. The whole identification and evaluation process is visualized in Figure 2.

As a result out of this information sharing and as a first step to the analysis of existing standards and standardisation activities, keywords have been collected from ARCH partners through a questionnaire taking into consideration any keyword that might be relevant to identify standardisation documents related to the project (see process overview in Figure 2). DIN summarised these keywords in a list and added terms that could be relevant for further analysis.

The standards search was conducted with the database Perinorm. Perinorm is the world's leading bibliographic database containing technical standards published by more than 200 standards publishing organisations in 23 countries.

Beside the standards of the organisations DIN, CEN, CENELEC, ISO and IEC other technical documents, regulations and reports on national, European and international level have been considered. Especially in the case of national standards due to language barriers mostly those that were providing at least an English title were considered.

Next, the standards were clustered into different categories to ensure avoiding redundancy and to enhance the clarity and efficiency of the analysis.

Project partners were asked to assess the individual relevance and importance of each identified standard with regard to their activities. This has been done through assessing the standards' scope's and contents' overlap with tasks being implemented or foreseen within the ARCH project. The project partners classified each standard individually and the results have been analysed and merged in order to produce a broad assessment result. The project partners were asked the following question: Does the standard have an impact on ARCH (yes/no/don't know)? Priority during disagreements on the assessment was given to the majority of yes or no answers.

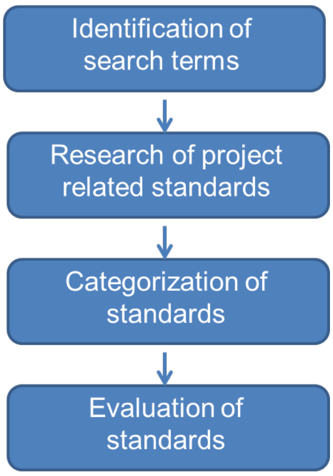

Figure 2: Search methodology

The standard's analysis resulted in a comprehensive list of standards and in an overview of technical committees relevant for the ARCH project.

4.2. Categorisation of standards

To conduct the standards research and analysis, the project partners of T7.1 prepared a list of relevant search terms. At the same time, the identified words have been assigned to one of the below relevant to the ARCH project categories (see Table 1). The categories were chosen according to the keywords given by the grant agreement and the project partners of task 7.1.

Table 1: Categories with keywords/ search terms

Categories	Keywords/ search terms
Resilience	organisational resilience resilience guidelines adaptation options adaptation planning adaptation monitoring adaptive capacity coping capacity
Climate change	climatology and climate change climate impacts climate change adaptation climate services extreme weather events air pollution
Drones	unmanned aircraft system
Techniques	geo-information and spatial data analysis environmental monitoring autonomous systems 3D scanning vulnerability and risk analysis
Heritage	heritage preservation tangible and intangible cultural heritage structural properties of materials materials conservation simulation heritage
Management systems	risk management disaster risk reduction disaster and/or emergency management security management systems management system management of urban areas
Cities and communities	infrastructure societal security sustainable cities

The identification of existing standards and ongoing standardisation activities resulted in a list of 107 standards and other technical documents, regulations and reports on national, European and international level which are to a certain extent important for the ARCH project. Figure 3 shows the distribution (absolute numbers) of relevant standards per category in percentage.

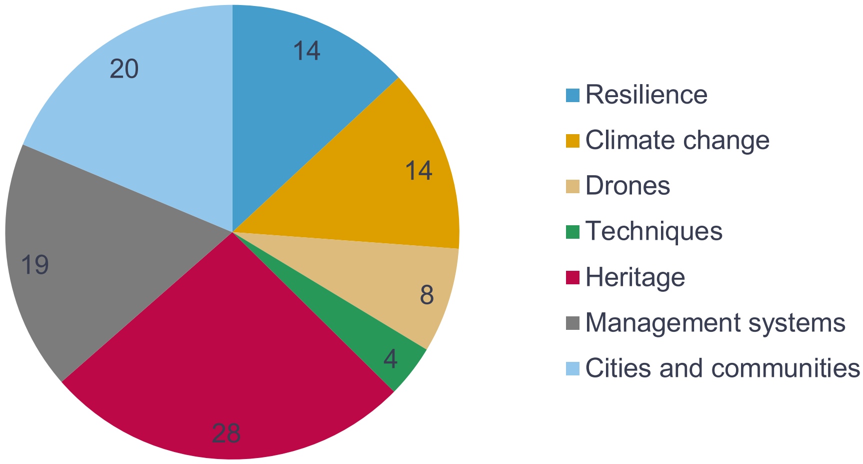

Figure 3: Relevant standards per category

The chart below (Figure 4) shows the total amount of initially identified standards per category in comparison to the relevance of the standards in each category. Standards were clustered as relevant, not relevant as well as potentially relevant. The latter refers to an undecided rating - some project partners felt like the standard is relevant and others did not. In total 107 standards are relevant for the ARCH project (90 standards under "Relevant" and 17 standards under "Potentially relevant").

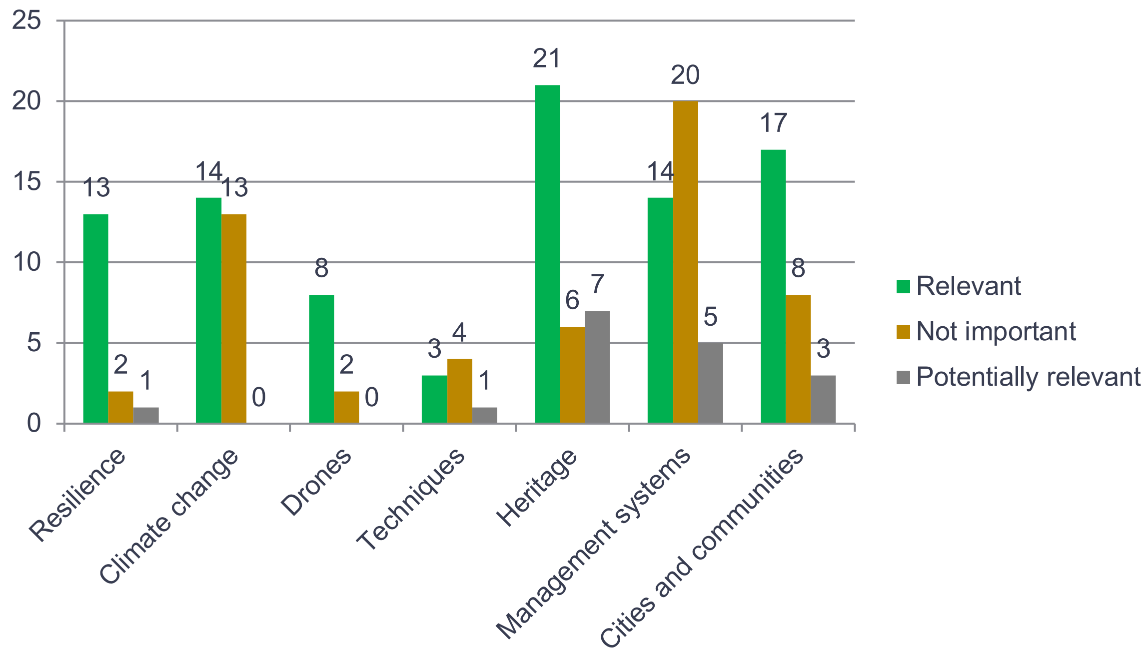

Figure 4: Evaluation results

The chart in Figure 3 shows that there are quite a lot relevant standards and standardisation activities within the categories of 'Resilience' 'Climate change', 'Heritage', 'Management

Systems' and 'Cities and Communities'. The reason for that could be that these topics have drawn high attention within the landscape of EU legislation and society in general as well as research in the last couple of years, e.g. through the EU Climate Action or the UN Sustainable Development Goals[1].

The categories 'Drones' and 'Techniques' are somehow special in that context because the topic was quite restricted in the frame of cities and heritages. Most of the standards found are guidelines, which mean that the respective documents contain specific information, principles or frameworks. The second most common document types are requirements, which mean that they enable the users to develop and implement policies, objectives, or programs.

4.3. Tables with ARCH relevant standards

The overview of relevant standardisation documents and current standardisation activities in this section is structured as follows: Number of document (Document No.), title of document (Title), abstract/summary of the document in English (Abstract) if available and publication date of the document (Date of publication).

In addition, the evaluation contains standards which were suggested by project partners as relevant standards from newly defined relevant fields at the end of the identification and evaluation process.

The following tables contain standards which were considered relevant for the project. Standards which are potentially relevant are marked in grey.

[1] https://ec.europa.eu/clima/citizens/eu_en, https://sustainabledevelopment.un.org/, https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-02-19-165

4.3.1. Standards - Category 'Resilience'

The analysis of existing standards for the category 'Resilience' resulted in the identification of 15 relevant or potentially relevant standards, which are listed in the following table. Identified standards that are of high or potential relevance for the work in ARCH are e.g. the CWA 17300 series City resilience development. It defines an operational framework for cities which will provide guidance on local resilience planning, a path and requirements for an information system in the resilience-building process.

Table 2: List of identified standards – Category 'Resilience'

Document No.	Title	Abstract	Committee	Date of publication
ISO 22319	Security and resilience — Community resilience — Guidelines for planning the involvement of spontaneous volunteers	ISO 22319:2017 provides guidelines for planning the involvement of spontaneous volunteers (SVs) in incident response and recovery. It is intended to help organisations to establish a plan to consider whether, how and when SVs can provide relief to a coordinated response and recovery for all identified hazards. It helps identify issues to ensure the plan is risk-based and can be shown to prioritize the safety of SVs, the public they seek to assist and incident response staff. ISO 22319:2017 is intended for use by organisations with responsibility for, or involvement in, part or all of the planning for working with SVs. It is applicable to all types and sizes of organisations that are involved in the planning for, and management of, SVs (e.g. local, regional, and national governments, statutory bodies, international and non-governmental organisations, businesses and public and community groups).	ISO/TC 292 Security	2017-04-00

ISO 22326	Security and resilience — Emergency management — Guidelines for monitoring facilities with identified hazards	This document gives guidelines for monitoring hazards within a facility as a part of an overall emergency management and continuity programme by establishing the process for hazard monitoring at facilities with identified hazards. It includes recommendations on how to develop and operate systems for the purpose of monitoring facilities with identified hazards. It covers the entire process of monitoring facilities. This document is generic and applicable to any organisation. The application depends on the operating environment, the complexity of the organisation and the type of identified hazards.	ISO/TC 292 Security	2018-10-00
ISO 22327	Security and resilience — Emergency management — Guidelines for implementation of a community-based landslide early warning system	This document gives guidelines for monitoring hazards within a facility as a part of an overall emergency management and continuity programme by establishing the process for hazard monitoring at facilities with identified hazards. It includes recommendations on how to develop and operate systems for the purpose of monitoring facilities with identified hazards. It covers the entire process of monitoring facilities.	ISO/TC 292 Security	2018-10-00
ISO/DIS 22392	Security and resilience — Community resilience — Guidelines for conducting peer reviews	This document gives guidelines for organisations to design, organize, conduct, receive feedback from, and learn from a peer review of their disaster risk reduction (DRR) policy and practices. It is intended for use by organisations with the responsibility for, or involvement in, managing such activities including policy and preparedness, response and recovery operations, and designing preventative measures (e.g. for the effects of environmental changes such as those from climate change). It is applicable to all types, structures and sizes of organisations such as local, regional and national governments; statutory bodies; non-governmental organisations; businesses; and public and community groups. The focus of this document is on how to initiate, conduct and learn from a peer review to enhance DRR but the peer review process can also be applied to enhance resilience and risk reduction.	ISO/TC 292 Security	2019-05-00

ISO 22395	Security and resilience — Community resilience — Guidelines for supporting vulnerable persons in an emergency	This document gives guidelines for organisations to identify, involve, communicate with and support individuals who are the most vulnerable to natural and human-induced (both intentional and unintentional) emergencies. It also includes guidelines for continually improving the provision of support to vulnerable persons in an emergency. It is intended for use by organisations with the responsibility for, or involvement in, part or all of the planning for working with vulnerable persons in an emergency.	ISO/TC 292 Security	2018-10-00
ISO 22315	Societal security — Mass evacuation — Guidelines for planning	ISO 22315:2014 provides guidelines for mass evacuation planning in terms of establishing, implementing, monitoring, evaluating, reviewing, and improving preparedness. It establishes a framework for each activity in mass evacuation planning for all identified hazards. It will help organisations to develop plans that are evidence-based and that can be evaluated for effectiveness. ISO 22315:2014 is intended for use by organisations with responsibility for, or involvement in, part or all of the planning for mass evacuation. It is applicable to all types and sizes of organisations that are involved in the planning for mass evacuation, such as local, regional, and national governments; statutory bodies; international and non-governmental organisations; businesses; and public and social groups. ISO 22315:2014 covers planning for mass evacuation in order to gain a more effective response during the actual evacuation. It will assist organisations to meet their obligation of saving human life and reducing suffering.	ISO/TC 292 Security	2014-12-00
ISO/DIS 22396	Security and resilience — Community resilience — Guidelines for information exchange between organisations	This document provides guidelines for information exchange. It includes principles, a framework and a process for information exchange. It identifies mechanisms for information exchange that allow a participating organisation to learn from others' experiences, mistakes and successes. It can be used to guide the maintenance of the information exchange arrangement in order to increase commitment and engagement. It provides measures that enhance the ability of the participating organisation to cope with disruption risk. This document does not cover technical aspects, but focuses on methodology issues.	ISO/TC 292 Security	2019-03-00

DS 3001	Organisational resilience: Security, preparedness, and continuity management systems — Requirements with guidance for use	This Standard specifies requirements for an organisational resilience (OR) management system to enable an organisation to develop and implement policies, objectives, and programs taking into account legal requirements and other requirements to which the organisation subscribes, information about significant hazards and threats that might impact it and its stakeholders', and protection of critical assets (physical, intangible, environmental, and human).This Standard applies to risks and/or their impacts that the organisation identifies as those it can control, influence, or reduce.	S-457 (n)	2009-10-24
CWA 17300	City Resilience Development — Operational Guidance	This CEN Workshop Agreement (CWA) defines an operational framework for cities which will provide guidance on local resilience planning and support their efforts in building resilience. This document is intended to be used by policy and decision-makers at city level and councilors working on climate change adaptation and resilience in their city, as well as by any other city stakeholder working on resilience (for example, but not limited to: critical infrastructure managers, service providers, emergency services, the media, civil society associations, non-governmental organisations, academic and research institutions as well as consultancies).	CEN European Committee for Standardisati on	2018-08-00
CWA 17301	City Resilience Development — Maturity Model	This CEN Workshop Agreement provides a framework for describing the ideal path in the resilience-building process of a city. This framework is based on the maturity stages through which a city should proceed. This document is intended to be used by policy and decision-makers at city level and councilors working for resilience in their city, as well as by any other city stakeholders working on resilience (for example, but not limited to: critical infrastructure providers, service providers, emergency services, individuals, the media, non-governmental organisations, academic and research institutions as well as consultancies).	CEN European Committee for Standardisati on	2018-08-00

CWA 17302	City Resilience Development — Information Portal	This CWA provides a list of requirements for how municipalities can equip an information system that facilitates resilience building through collaboration, communication, and engagement. This marks the functional specification of a Resilience Information Portal. The portal is a platform for communication within a local government, between a local government and its overall stakeholders, and between a local government and citizens. Requirements aim towards a broad-purpose, easy-to-use platform that provides versatility and flexibility.	CEN European Committee for Standardisation	2018-08-00
ISO/DIS 20887	Sustainability in buildings and civil engineering works — Design for disassembly and adaptability — Principles, requirements and guidance	This document provides an overview of Design for Disassembly and Adaptibility (DfD/A) principles and potential strategies for integrating these principles into the design process. DfD/A can be used to identify design approaches and potential waste-reduction solutions, to develop system-specific disassembly- and adaptibility-conscious details, and to adopt specific strategies for building structure or parts thereof (e.g. the envelope) as well as infrastructure.	ISO/TC 59 Building construction	2019-01-00
ISO 22316	Security and resilience — Organisational resilience — Principles and attributes	ISO 22316:2017 provides guidance to enhance organisational resilience for any size or type of organisation. It is not specific to any industry or sector. ISO 22316:2017 can be applied throughout the life of an organisation. ISO 22316:2017 does not promote uniformity in approach across all organisations, as specific objectives and initiatives are tailored to suit an individual organisation's needs.	ISO/TC 292 Security	2017-03-00
ISO 22380	Security and resilience — Authenticity, integrity and trust for products and documents — General principles for product fraud risk and countermeasures	This document establishes general principles for an organisation to identify the risks related to various types of product fraud and product fraudsters. It provides guidance on how organisations can establish strategic, business countermeasures to prevent or reduce any harm, tangible or intangible loss and cost from such fraudulent attacks in a cost-effective manner. This document is intended to promote common understanding in the field of product-related fraud risk and its countermeasures.	ISO/TC 292 Security	2018-08-00

ISO 22300	Security and resilience — Vocabulary	This document defines terms used in security and resilience standards.	ISO/TC 292 Security	2018-02-00

4.3.2. Standards - Category 'Climate Change'

The standards analysis for the category 'Climate Change' resulted in a list of 14 standards that might be relevant for the project work are e. g. the CEN/CENELEC Guide 32 that addresses aspects of climate change adaptation in European standardization documents; and the ASTM E 3032 'Standard Guide for Climate Resiliency Planning and Strategy' that refers to efforts by entities, organisations, or individuals to prepare for or adjust to future extreme weather and related physical conditions.

Table 3: List of identified standards – Category 'Climate Change'

Document No.	Title	Abstract	Committee	Date of publication
DIN SPEC 35810	Stakeholder Engagement — Guidelines for decision making processes dealing with climate change	This DIN SPEC (PAS) provides guidance and recommendations in stakeholder engagement in climate change decision-making. This DIN SPEC is applicable to organisations from the public and private sectors, including federal and local governmental agencies, companies, firms, industries, communities and non-governmental organisations. It is developed in a user-friendly manner, setting out principles and instructions in a straightforward step-by-step guide with which organisations can engage stakeholders in the decision-making process. DIN SPEC 3581 has been prepared within the research project REGKLAM (Regional Climate Change Adaptation Program for the Dresden model region; FKZ: 01 LR 0802), which was funded by the German Ministry for Research and Education (BMBF).	German Institute for Standardisation	2014-11-00

DIN SPEC 35811	Scenario Planning — Guidelines for decision making processes dealing with climate change	DIN SPEC 35811 will assist (small and medium sized) enterprises from all fields to adapt to future challenges. It is applicable to companies, industries, and private and public sector organisations. Companies without a strategy department are especially set to benefit from the application. Within a scenario process companies identify future challenges that might shape their business, such as climate change, demographic change, or technological change. They develop possible pictures of the future, based on these, derive potential adaptation measures. In this multistep process, the companies are optionally accompanied by consultants. The process itself can be implemented either individually or within a group of companies. Furthermore, the PAS is related to the ISO 14000 Standard series on environmental management systems, especially DIN EN ISO 14001. DIN SPEC 35811 has been prepared within the research project REGKLAM (Regional Climate Change Adaptation Program for the Dresden model region; FKZ: 01 LR 0802), which was funded by the German Ministry for Research and Education (BMBF).	German Institute for Standardisation	2014-08-00
CEN/CENELEC Guide 32	Guide for adressing climate change adaptation in standards	This Guide provides guidance on addressing aspects of climate change adaptation in European standardisation documents. This Guide is applicable to product (including design), service, infrastructure and testing standards. For the purposes of this Guide, the definition of the term “product” has been expanded to cover all these aspects.	CEN European Committee for Standardisation	2016-04-00

ASTM E 3032	Standard Guide for Climate Resiliency Planning and Strategy	Overview- For the purposes of this guide, 'resiliency' refers to efforts by entities, organisations, or individuals to prepare for or adjust to future extreme weather and related physical conditions. The primary purpose is to reduce negative economic impacts associated with extreme weather. This guide presents a generalized, systematic approach to voluntary assessment and risk management of extreme climate related events and conditions. It helps the user structure their understanding of the climate related vulnerabilities and consequences they seek to manage. It helps the user identify adaptive actions of both an institutional (legal), as well as engineering (physical) nature. Options for analysis provide a priority ranking system to address the "worst first" risks of a municipality, local area or facility, addressing practicality and cost-benefit. Users may approach this analysis having initially undertaken a risk assessment to determine what they are seeking to manage, or use the guide to help determine the likely areas of greatest need.	American Society for Testing and Materials (ASTM)	2015-00-00
ASTM E 3136	Standard Guide for Climate Resiliency in Water Resources	Overview- Water resources in North America and other areas are subject to various impacts from chronic weather patterns, as well as more frequent extreme weather events. These include drought, flooding, changes in stream patterns, increased or decreased run-off, and changes in water quality. Water resources include both man-made and natural reservoirs, rivers, streams, groundwater, and storage ponds. The infrastructure for water supply, wastewater treatment, fire-fighting and agricultural uses are also subject to chronic weather patterns and more frequent extreme weather related events. This guide will provide an explanation of techniques users may employ to build resiliency and a planning outline for municipalities, states and private industry in order to ensure safe, future, effective availability of water resources.	American Society for Testing and Materials (ASTM)	2018-00-00
DIN SPEC 35220	Adaption to climate change — Projections on climate change and ways for handling uncertainties	This specification should encourage and support the discussion about climate protection and adaptation to climate change as one of the major challenge for all social circles.	German Institute for Standardisati on	2015-11-00
DIN SPEC 35220 Beiblatt 1	Adaptation to climate change — Projections on climate change and ways for handling uncertainties	This supplement contains an application example for DIN SPEC 35220:2015-11, in which the summer thermal insulation of buildings in the event of a heat wave is examined as an example and a vulnerability analysis is carried out. The supplement is aimed primarily at standard writers, including planners, manufacturers and other users of standards.	German Institute for Standardisati on	2018-08-00

VDI 4710 Blatt 3	Meteorological data for the building services — t,x correlations from 1991 to 2005 for 15 climatic zones in Germany	Since 1979, it has been common practice, particularly in DIN 4710, to compile the basic data of outdoor-air temperature (t) and water vapour content (x) in the form of t-x correlations. Initially, the data from 1951 to 1970 served as the basis for West Germany. When the standard was revised in 2003, in cooperation with the DWD (German Meteorological Service), the data gathered at 15 stations between 1961 and 1990 were published. The concept for the compilation of the correlation tables of air temperature and water vapour content in air, the so-called t-x correlations, so far consisted in using the respective hourly values measured over the 30 years of the currently completed climate normal period, i. e. presently from 1961 to 1990. Since the end of the nineteen-eighties, the air temperature has kept rising. To give better consideration to the obvious climate change in the air-temperature regime when planning building services, the t-x correlations have been re-calculated, and published in this VDI guideline, for the 15-year period from 1991 to 2005, which corresponds to half of the current climate normal period.	VDI Society Civil Engineering and Building Services	2011-03-00
ISO 14090	Adaptation to climate change — Principles, requirements and guidelines	This document describes principles, requirements and guidelines for adaption to climate change. This includes the integration of adaption within or across organisations, understanding impacts and uncertainties and how these can be used to inform decisions.	ISO/TC 207 Environmental management	2019-03-00
ITU-T L Supplement 24	ITU-T L.1500 — Overview of climate change effects and possible impacts	In light of the historic Paris Agreement to combat climate change and unleash actions and investment towards a low carbon, resilient and sustainable future agreed by 195 countries in Paris on 12 December 2015. This Supplement includes information on identifying and describing climate change effects that can affect the information and ommunication technology (ICT) sector and other sectors. It also provides a general introduction to the identified climate change effects and describes possible impacts of climate change effects on the ICT sector, human behaviours, human health and the energy sector.	ITU International Telecommunication Union	2016-04-00

ITU-T L.1500	Framework for information and communication technologies and adaptation to the effects of climate change	This framework identifies and defines the basis for development of the following recommendations: how countries can utilize ICTs to adapt to the effects of climate change, how to adapt the ICT infrastructure to the effects of climate change, how ICTs can help cities to adapt to the effects of climate change.	ITU International Telecommuni cation Union	2014-06-00
ITU-T L.1501	Best practices on how countries can utilize ICTs to adapt to the effects of climate change	The Recommendation describes the complexity of climate change and explains why countries need to adapt. It also describes the role of ICTs in helping countries respond to the effects of climate change by looking at how various sectors use ICTs; including the ICT sector. It is designed to be a guide for regulators and policymakers to minimize the impact of climate change and provides a 'multi-level framework for ICTs integration in climate change adaption' to assist countries in integrating ICTs in their national climate change adaptation strategies.	ITU International Telecommuni cation Union	2014-12-00
ITU-T L.1502	Adapting information and communication technology infrastructure to the effects of climate change	Recommendation ITU-T L.1502 identifies direct and indirect threats of climate change on ICT services and provides options for adaptation and mitigation. These threats include extreme rainfall, flooding, landslides, extreme wind, lightning, extreme humidity, drought, ice storms and heavy snowfall.	ITU International Telecommuni cation Union	2015-11-00
ITU-T L.1503	Use of information and communication technology for climate change adaptation in cities	This Recommendation is aimed at a broad audience of stakeholders interested in information and communication technologies (ICTs), climate change adaptation, and smart sustainable cities (SSCs), including city decision-makers and planners. Urban stakeholders, including mayors and city planners, are invited to consider novel approaches to sustainability by integrating the use of ICTs in their climate change adaptation strategies and policies. The following are the key steps: assess climate change risks and vulnerabilities, develop an action plan, identify the role of ICTs and infrastructure in the adaptation plan, implement adaptation actions, monitor and evaluate adaptation actions using ICT.	ITU International Telecommuni cation Union	2016-06-00

4.3.3. Standards - Category 'Drones'

In total 8 standards have been found that are related to the category 'Drones'. Basic information about these standards can be found in the following table.

Table 4: List of identified standards – Category 'Drone'

Document No.	Title	Abstract	Committee	Date of publication
DIN 5452-2	Unmanned aircraft systems (UAS) — Part 2: Requirements for pilots	Part 2 of DIN 5452 defines the requirements for pilots controlling unmanned aircraft systems (UAS). The use of UAS in commercial and civil application areas is considered, but not in the military field. The use of the aircraft is considered for various areas of application and application scenarios, such as flying within sight/ out of sight of the pilot.	Aerospace Standards Committee	2019-03-00
VDI 2879	Inspection of installations and buildings with UAVs (unmanned aerial vehicles)	Unmanned aerial vehicles (UAVs) are workload carrying, remote-controllable components for remote sensing used on land, in water or in the air. For the purpose of this standard, UAVs are flying drones, i.e. multicopters and remote airplanes of various designs, sizes and utilisation, which are used for remote sensing of technical objects with help of different attached sensors. The acronym UAV - for unmanned aerial vehicle - means the unmanned aircraft itself. A drone is a flying component of an UAS (unmanned aerial system) or RPAS (remotely piloted aerial system). A UAV system, in addition of the drone, also includes the predictor for controlling the drone, the sensors, systems for data transmission (ground/air or other recipients of exploration results) as well as components for operation, maintenance and transportation.	VDI Society Production and Logistics	2018-09-00
CSA ANSI/CAN/UL 3030	Unmanned Aircraft Systems	Scope 1.1 These requirements cover the electrical system of unmanned aircraft systems (UASs), as defined in this Standard, used in flight for commercial applications or flight incidental to business applications. UASs covered by these requirements are intended to be operated by certified UAS pilots as identified in the Federal Regulations, where the unmanned aircraft is less than 25 kg (55 lbs). The UAS is intended to be provided with an internal lithium ion battery that is charged from an external source. UASs are intended	Underwriters' Laboratories of Canada (ULC)	2018-09-18

		to have an operating voltage of not greater than 100 V dc, and are intended for outdoor operation.		
prEN 4709-001	Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	This document provides means of compliance with Parts 1 to 6 of Commission delegated (EU) .../... of XXX on making available on the market of unmanned aircraft intended for use in the `open' category and on third-country UAS operators proposed in the Opinion 01/2018. This includes compliance with product requirements for all UAS authorized to operate in the `open' category (class C0, C1, C2, C3 and C4 UAS) and the electronic identification system. T	ASD-STAN AeroSpace and Defence Industrie Association of Europe - Standardisation	2019-01-00
CWA 17357	Urban search and rescue (USaR) robotic platform technical and procedural interoperability - Guide	This CWA provides recommendations to enable technical interoperability (hardware, software) between urban search and rescue (USaR) robotic platforms and the equipment, sensors and tools that are attached to them. This CWA also provides guidance on the principles for enabling USaR robotic platforms (various types of them such as drones, snake-like, robots with wheels, legs, etc.) to operate in all ground search environments. In this way a generic platform can be adapted, designed and built for any possible search and rescue (SaR) scenario on the ground.	CEN European Committee for Standardisation	2019-02-00
ISO/DIS 21384-1	Unmanned aircraft systems — Part 1: General specification	This document specifies the general requirements for UAS for civil applications including commercial. This document provides the foundation and common terms, definitions and references relevant to the whole standard, the purpose of which is to provide a safety quality standard for the safe operation of all UAS through the provision of synergistic standards for manufacturing and operations.	ISO/TC 20 Aircraft and space vehicles	2019-04-00
ISO/DIS 21384-3	Unmanned aircraft systems — Part 3: Operational procedures	This document outlines requirements for UA operational procedures which, when applied together with Part 2, form a robust UA safety and quality standard. This document applies to all UA regardless of size, categorization, application or location and represents the international best practice for the safe operation of all UA.	ISO/TC 20 Aircraft and space vehicles	2018-11-00

ISO/DIS 21384-4	Unmanned aircraft systems — Part 4: Terms and definitions	This document defines terms and definitions relating to Unmanned Aircraft Systems that are widely used in science and technology.	ISO/TC 20 Aircraft and space vehicles	2019-04-00

4.3.4. Standards - Category 'Techniques'

In total 4 standards have been identified that are related to the category 'Techniques'. The list of standards can be found in the table below.

Table 5: List of identified standards – Category 'Techniques'

Document No.	Title	Abstract	Committee	Date of publication
CEN-CENELEC Guide 33	Guide for addressing environmental issues in testing standards	This Guide gives guidance about environmental improvement of testing processes described in testing standards. The intention of this Guide is to reduce the environmental impact of testing by providing guidance on how to address environmental issues in testing standards. This Guide is only applicable to the testing procedure. This Guide does not describe how sampling should be done. It should help to identify environmental impacts of sampling where it is necessary. The following is excluded from the scope: the general operating conditions of laboratories unless specified as part of the test; the life cycle of testing equipment (NOTE 1 Testing equipment is regarded as a product. For environmental issues of products see CEN Guide 4); testing that is part of the production process (NOTE 2 Testing that is part of the production process (for example functional or quality testing) is already considered under CEN Guide 4); the environmental impact of test reports (e.g. use of paper, on which the report is written). Environmental improvement of the product to be tested is not considered in this Guide but in CEN Guide 4. Climate change considerations are not part of this document and are dealt with in the "CEN/CENELEC Guide for addressing climate change adaptation in standards". Workers protection and Occupational health and safety conditions are out of scope of this Guide.	CEN European Committee for Standardisation	2016-04-00

ISO/TR 19815	Information and documentation — Management of the environmental conditions for archive and library collections	This document provides information on recent discussions and changes in recommendations and guidance on environmental management within the cultural heritage field. Conservation research on preventive methodologies and passive control provided by specific construction methods and renovations, developments in technology for controlling the environment, and energy and climate change issues are included. This document is intended for archives and libraries and other institutions with large volumes of collections that are based on paper. Archives and libraries also have collections that include film, magnetic media, leather, and other organic, inorganic or composite materials. These institutions have a unique challenge of extending the lifespan of these materials for access and use in the present and for future generations. The environment plays a key role in extending the lifespan of all of these materials. This document is intended for use in preservation planning and ongoing environmental management of permanent storage conditions for archives and library collections and applies to all collections being permanently stored for an institution.	ISO/TC 46 Information and documentatio n	2018-07-00
CEN/TR 15449-2	Geographic information — Spatial data infrastructures — Part 2: Best practices	This part of the Technical Report provides best practices regarding Spatial Data Infrastructures (SDIs), referencing to the outcomes of the projects in the frame of the European Union funding programmes. It summarises the deliverables of projects, structured according to the reference model defined in Part 1 of this Technical Report, to be made available in an on-line repository where the relevant outcomes are collected and classified in order to provide a structured sets of recommendations for implementing SDIs at the European, national and sub-national levels. This collection refers mainly to the projects funded by the European Union funding programmes: this choice is driven by the wide vision and analysis which such kind of projects can provide and the wide numbers of stakeholders which have been involved. The outcomes delivered by these relevant practices are collected into a document registry available through the CEN/TC 287 web site. This part of the Technical Report defines the processes and the content of these projects and documents registries, which will help making them more accessible and re-usable. It provides the relevant project deliverables addressing the main SDI issues as	CEN/TC 287 Geographic Information	2012-10-00

		described in the other parts of this Technical Report. The intended readership of this Technical Report are those people who are responsible for creating frameworks for SDI, experts contributing to INSPIRE, experts in information and communication technologies and e-government that need to familiarize themselves with geographic information and SDI concepts, and standards developers and writers.		
ITU-T X.1521	Common vulnerability scoring system	Recommendation ITU-T X.1521 on the common vulnerability scoring system (CVSS) provides an open framework for communicating the characteristics and impacts of information and communication technologies (ICT) vulnerabilities in the commercial or open source software used in communications networks, end user devices, or any of the other types of ICT capable of running software. The goal of the Recommendation is to enable ICT managers, vulnerability bulletin providers, security vendors, application vendors and researchers to speak from a common language of scoring ICT vulnerabilities.	ITU International Telecommuni cation Union	2016-03-00

4.3.5. Standards - Category 'Heritage'

The standards analysis for the category 'Heritage' resulted in the following list of 28 (potentially) relevant standards. Identified standards within this topic that might need special attention in the ARCH project work are e. g. the EN 15757 'Conservation of cultural property' that specifies temperature and relative humidity levels to limit climate-induced physical damage of heritages; and EN 15759-2 'Conservation of cultural heritage' that gives guidelines to improve the preservation conditions of cultural heritage buildings and their collections. The ISO 21127 'Information and documentation — A reference ontology for the interchange of cultural heritage information' exchanges information between cultural heritage institutions like museums, libraries and archives.

Table 6: List of identified standards – Category 'Heritage'

Document No.	Title	Abstract	Committee	Date of publication
VDI 3798 Blatt 1	Material cultural heritage — Identification, examination, preservation, and environmental impact	This standard broadly refers to material cultural heritage with focus on the systematic identification, examination and preservation, taking into account natural and anthropogenic environmental impacts. It provides a basis for the systematic planning, implementation and documentation of conservation and restoration measures. The standard is addressed to all those who act in the field of material cultural heritage and are responsible in research and practice, in particular owners, building and property managers, planners, architects, engineers, conservators, craftsmen as well as museums and monument authorities.	VDI/DIN-Commission on Air Pollution Prevention (KRdL) - Standards Committee	2019-05-00
EN 15757	Conservation of Cultural Property — Specifications for temperature and relative humidity to limit climate-induced mechanical damage in organic hygroscopic materials	This European Standard is a guide specifying temperature and relative humidity levels to limit climate-induced physical damage of hygroscopic, organic materials, kept in long-term storage or exhibition (more than one per year) in indoor environments of museums, galleries, storage areas, archives, libraries, churches and modern or historical buildings.	CEN/TC 346 Conservation of cultural property	2010-09-00
EN 15758	Conservation of Cultural Property — Procedures and instruments for measuring temperatures of the air and the surfaces of objects	This European Standard recommends the procedures for measuring the temperature of the air and of the surfaces of cultural property in indoor and outdoor environments, as well as specifying the minimum characteristics of instruments for such measurements. This document contains recommendations for accurate measurements to ensure the safety of objects and it is addressed to any people with the responsibility of the environment, its diagnosis, the conservation or maintenance of buildings, collections, or single object.	CEN/TC 346 Conservation of cultural property	2010-09-00
EN 15759-2	Conservation of cultural heritage — Indoor climate — Part 2: Ventilation management for the protection of cultural	This European Standard gives guidelines for ventilation management in order to improve the preservation conditions of cultural heritage buildings and their collections. At the same time, it is aimed to create an indoor environment for a sustainable use of these buildings and their collections. This standard is a	CEN/TC 346 Conservation of cultural property	2018-01-00

	heritage buildings and collections	complement to existing general standards for ventilation that are focused on human comfort. This European Standard is the second part of a standard on indoor climate in cultural heritage buildings, i.e. EN 15759-1:2011. It should be used together with the first part when considering selection of heating strategies and heating systems for cultural heritage buildings, or buildings housing collections. It may be also used when considering other issues, e. g. assessment of buildings, interiors and contents, or improvements for the energy performance.		
EN 15801	Conservation of cultural property — Test methods — Determination of water absorption by capillarity	This European Standard specifies a method for determining the water absorption by capillarity of porous inorganic materials used for and constituting cultural property. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing.	CEN/TC 346 Conservation of cultural property	2009-12-00
EN 15802	Conservation of cultural property — Test methods — Determination of static contact angle	This European Standard specifies a method for the measurement of the static contact angle of a water drop on porous inorganic materials used for and constituting cultural property. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing.	CEN/TC 346 Conservation of cultural property	2009-12-00
EN 15803	Conservation of cultural property — Test methods — Determination of water vapour permeability (δp)	This European Standard specifies a method for determining the water vapour permeability (WVP) of porous inorganic materials used for and constituting cultural property. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing.	CEN/TC 346 Conservation of cultural property	2009-12-00

EN 15886	Conservation of cultural property — Test methods — Colour measurement of surfaces	This European Standard describes a test method to measure the surface colour of porous inorganic materials, and their possible chromatic changes. No reference to the appearance of glossy surfaces is described. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing. The method is suitable for the measurement of colour coordinates of: representative surfaces of specimens, see 3.11; representative surfaces of objects, indoors or outdoors.	CEN/TC 346 Conservation of cultural property	2010-09-00
EN 15898	Conservation of cultural property — Main general terms and definitions	This European Standard defines the main general terms used in the field of conservation of cultural property with particular attention to those terms which have wide use or significance.	CEN/TC 346 Conservation of cultural property	2011-10-00
EN 16085	Conservation of Cultural property — Methodology for sampling from materials of cultural property — General rules	This European Standard provides a methodology and criteria for sampling cultural property materials for their scientific investigation. It covers, for example, how to characterize the material(s), assess the condition, determine the deterioration causes and/or mechanism(s) and decide on and/or evaluate the conservation treatment(s). Apart from sampling, this document also provides requirements for documentation, and handling of sample(s). This European Standard does not deal with the decision making process for taking a sample nor how the sample is to be used.	CEN/TC 346 Conservation of cultural property	2012-08-00
EN 16095	Conservation of cultural property — Condition recording for movable cultural heritage	This European Standard sets out the purpose and context of condition recording for movable cultural heritage and provides a framework for a condition report. It specifies the status of a condition report and its essential contents. This European Standard applies to all kinds of movable cultural heritage, whether individual objects or whole collections. It can also be used for immovable features in buildings or monuments.	CEN/TC 346 Conservation of cultural property	2012-08-00

EN 16096	Conservation of cultural property — Condition survey and report of built cultural heritage	This European Standard provides guidelines for a condition survey of built cultural heritage. It states how the condition of the built cultural heritage should be assessed, documented, recorded and reported on. It encompasses evaluation of the condition of a building or other structure mainly by visual observation, together - when necessary - with simple measurements. The relevant data and documentation on the built cultural heritage should be collected and included in the report. This European Standard can be applied to all built cultural heritage such as buildings, ruins, bridges and other standing structures. Built cultural heritage comprises both protected and non-protected significant buildings and structures. Archaeological sites and cultural landscapes are not dealt with in this standard. This European Standard does not specify how to carry out a diagnosis (3.7) of the built cultural heritage. For listed/protected immovable heritage, specific national rules for expert documentation and works may apply. This European Standard may be applied in order to: a) identify maintenance measures and the need for further investigation and diagnostics of damage; b) define procurement needs and the requirement for detailed specification; c) provide a unified method to obtain comparative data, when carrying out a condition survey for a group of buildings or a region.	CEN/TC 346 Conservation of cultural property	2012-08-00
EN 16141	Conservation of cultural heritage — Guidelines for management of environmental conditions — Open storage facilities: definitions and characteristics of collection centres dedicated to the preservation and management of cultural heritage	This European Standard defines the characteristics of specific areas dedicated to the preservation, storage, management of, and access to collections. It lists the considerations that should be taken into account to achieve optimum storage and accessibility.	CEN/TC 346 Conservation of cultural property	2012-11-00

EN 16242	Conservation of cultural heritage — Procedures and instruments for measuring humidity in the air and moisture exchanges between air and cultural property	This European Standard gives guidance and specifies procedures and instruments for the measurement of relative humidity (RH) in air, in outdoor or indoor environments. It indicates how RH can be directly measured or how it can be calculated from air temperature, wet-bulb temperature and dew-point temperature. This standard contains recommendations for accurate measurements of ambient conditions and moisture exchanges between air and cultural heritage objects. It is addressed to anyone in charge of environmental diagnosis, conservation or maintenance of buildings, collections or single objects.	CEN/TC 346 Conservation of cultural property	2012-11-00
EN 16322	Conservation of Cultural Heritage — Test methods — Determination of drying properties	This European Standard specifies a method for the determination of the drying behaviour of porous inorganic materials used for and constituting cultural property. The method may be applied to porous inorganic materials either untreated or subjected to any treatment or ageing.	CEN/TC 346 Conservation of cultural property	2013-10-00
EN 16572	Conservation of cultural heritage — Glossary of technical terms concerning mortars for masonry, renders and plasters used in cultural heritage	This European Standard describes the terminology for mortars used in the field of cultural heritage. NOTE In addition to terms used in the three official CEN languages (English, French and German), this European Standard gives the equivalent terms in Dutch, Italian, Greek, Swedish and Spanish; these are published under the responsibility of the member body/National Committee for NEN, UNI, ELOT, SIS and AENOR and are given for information only. Only the terms and definitions given in the official languages can be considered as CEN terms and definitions.	CEN/TC 346 Conservation of cultural property	2015-07-00
EN 16682	Conservation of cultural heritage — Methods of measurement of moisture content, or water content, in materials constituting immovable cultural heritage	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. It provides a basic framework to take and interpret this kind of measurements on the above cultural heritage materials that have undergone weathering, pest attack, salt migration or other transformations over time. It specifies four absolute methods (i.e. gravimetric, Karl Fischer titration, azeotropic distillation and calcium carbide); explains their characteristics, pros and cons, and gives specifications for the transformation of readings into the same unit to make measurements taken with different methods comparable. It specifies the	CEN/TC 346 Conservation of cultural property	2017-03-00

		three principal relative methods (i.e. electrical resistance, capacitance, and relative humidity in equilibrium with the material), pointing out their characteristics and uncertainties when used in the field of cultural heritage. In addition, it provides an informative overview of ten other relative methods, their characteristics, pros and cons. It gives specifications for the calibration of the various methods. It also compares the above methods in relation to their accuracy, sampling requirement, sample size, laboratory or field use, and other problems encountered in the field of cultural heritage to prevent instrument misuse, reduce uncertainties and avoid reading misinterpretation.		
EN 16790	Conservation of cultural heritage — Integrated pest management (IPM) for protection of cultural heritage	This European Standard defines Integrated Pest Management (IPM) and describes a comprehensive methodology for managing pest problems for protection of cultural heritage. This European Standard applies to objects and buildings, housing collections, such as museums, archives, libraries, historic houses and buildings, places of worship, art dealers and auction rooms, art transport and storage companies. This European Standard does not apply to caves, gardens, and parks.	CEN/TC 346 Conservation of cultural property	2016-06-00
EN 16853	Conservation of cultural heritage — Conservation process — Decision making, planning and implementation	This European Standard specifies the process of decision-making, planning and implementing the conservation of tangible cultural heritage. It applies to material expressions of tangible cultural heritage such as individual objects, collections, the built environment, historic sites, archaeological sites and cultural landscapes. NOTE This European Standard does not cover how to identify cultural heritage nor who or what competences are required to undertake decisions or other parts of the process.	CEN/TC 346 Conservation of cultural property	2017-04-00
EN 16873	Conservation of cultural heritage — Guidelines for the management of waterlogged wood on archaeological terrestrial sites	This European standard provides guidelines for safeguarding waterlogged wood on terrestrial sites of archaeological or historical significance. It deals with the protection of archaeological and historical waterlogged wood, from the time of exposure during and after excavation, until it reaches the conservation laboratory. The standard cannot be applied to the management of controlled reburial, in situ preservation, long term post excavation storage or excavations under water. Composite artefacts, and other waterlogged materials are specifically excluded from this standard.	CEN/TC 346 Conservation of cultural property	2016-11-00

EN 16883	Conservation of cultural heritage — Guidelines for improving the energy performance of historic buildings	This European Standard provides guidelines for sustainably improving the energy performance of historic buildings, e. g. historically, architecturally or culturally valuable buildings, while respecting their heritage significance. The use of this standard is not limited to buildings with statutory heritage designation, it applies to historic buildings of all types and ages. This European Standard presents a normative working procedure for selecting measures to improve energy performance, based on an investigation, analysis and documentation of the building including its heritage significance. The procedure assesses the impact of those measures in relation to preserving the character-defining elements of the building.	CEN/TC 346 Conservation of cultural property	2017-05-00
FprEN 17135	Conservation of cultural heritage — General terms for describing the alterations of objects	This document defines terms used in the field of conservation of cultural heritage for the description of alteration of objects with particular attention to those terms which are applied to many types of objects. This document applies to all types of material changes that can be observed.	CEN/TC 346 Conservation of cultural property	2019-05-00
EN 16302	Conservation of cultural heritage — Test methods — Measurement of water absorption by pipe method	This European Standard specifies a method to measure water absorption of porous inorganic materials used for and constituting cultural property by pipe method. The method may be used on porous inorganic materials which are untreated or have been subjected to any treatment or ageing. The method may be used both in the laboratory and in situ due to its non destructive nature.	CEN/TC 346 Conservation of cultural property	2013-02-00
EN 16515	Conservation of Cultural Heritage — Guidelines to characterize natural stone used in cultural heritage	This European Standard specifies a methodology for the characterization of sound or deteriorated stones by using the most appropriate analytical techniques on samples taken from the object. This European Standard contains guidelines for the selection of methods to determine mineralogical, textural, physical, chemical and mechanical properties of natural stone used in cultural heritage monuments and objects. This information is used to define rock typology and to evaluate the stone's condition with respect to its conservation as well as for understanding of deterioration processes of natural stone. Where possible existing standards are referred to and guidance provided where different specimens are required and additional methods used. The methods described are generally destructive, however,	CEN/TC 346 Conservation of cultural property	2015-04-00

		non-destructive (NDT) methods are always preferable to methods with a minimum of destruction and those are always preferable to destructive methods. Methods used for stone analysis can vary depending upon the objectives of the work. All investigation and analysis need be proportional to the significance of the building or artefact being investigated, its condition and the likely level of intervention. This European Standard will be used to determine the kind, extent, and objectives of the examination to be made.		
EN 17114	Conservation of cultural heritage — Surface protection for porous inorganic materials — Technical and chemical data sheets of water repellent product	This document specifies the information contained in the technical data sheet of the product in order to allow a preliminary selection of the most suitable products to use in a specific case of intervention.	CEN/TC 346 Conservation of cultural property	2018-11-00
ISO/IEC 15897	Information technology — User interfaces — Procedures for the registration of cultural elements	ISO/IEC 15897:2011 specifies the information that can appear in a Cultural Specification and defines the procedures for registering such specifications. The Cultural Specifications can include freeform Narrative Cultural Specifications and Repertoiremaps as described in ISO/IEC 15897:2011, POSIX Locales and Charmaps conforming to ISO/IEC/IEEE 9945, and other machine-parsable specifications such as FDCC-sets, Repertoiremaps and Charmaps following the recommendations of ISO/IEC TR 14652, and Cultural Specifications formatted using SGML or XML. The registry is in printed and electronic form. ISO/IEC 15897:2011 sets out the procedures for registering cultural elements, both as narrative text and in a more formal manner, using the techniques of ISO/IEC/IEEE 9945, and other machine-processable formats such as those specified in ISO/IEC TR 14652.	ISO/IEC JTC 1/SC 35 User interfaces	2011-10-00
ISO 21110	Information and documentation — Emergency preparedness and response	This document provides a context for emergency planning, response and recovery for all types of an archive, library or museum collections in light of other existing plans. It provides responders and other stakeholders with an outline for planning, responding and recovering. This document does not address the causes of a critical event, but the consequences and wider impacts. This document outlines a cycle for developing, exercising and reviewing a plan, and how to present a plan. It aims to encourage responders to develop their capabilities in emergency preparedness and touches on some elements of response and recovery, where relevant, by highlighting indicators of good practice.	ISO/TC 46 Information and documentation	2019-04-00

		It is not intended to be an operations manual as there is no single approach that meets the needs of every site, nor is there one single set of organisational arrangements that is appropriate to each and every type of emergency.		
ISO 21127	Information and documentation — A reference ontology for the interchange of cultural heritage information	ISO 21127:2014 establishes guidelines for the exchange of information between cultural heritage institutions. In simple terms, this can be defined as the information managed by museums, libraries, and archives. The intended scope of this ISO 21127:2014 is defined as the exchange and integration of heterogeneous scientific documentation relating to museum collections. This definition requires further elaboration.	ISO/TC 46 Information and documentatio n	2014-10-00

4.3.6. Standards - Category 'Management Systems'

The standards analysis for the category 'Management Systems' resulted in the following list of 19 standards. Identified standards within this topic that might need special attention in the ARCH project work are e. g. the CWA 16267 'Guidelines for sustainable development of historic and cultural cities' that describes the commitments of the local authority in term of sustainable management of cultural and natural heritages; the ISO/TS 22375 'Security and resilience - Guidelines for complexity assessment process ' that allows an organisation to identify potential hidden vulnerabilities of its system and to provide an early indication of risk resulting from complexity; and ISO 22325 'Security and resilience - Emergency management - Guidelines for capability assessment' that provides guidelines for an organisation in assessing its emergency management capability.

Table 7: List of identified standards – Category 'Management Systems'

Document No.	Title	Abstract	Committee	Date of publication
CEN/TS 16555-4	Innovation management — Part 4: Intellectual property management	This Technical Specification provides guidance to assist an organisation to identify, capture, and safeguard intellectual property, in order to: - provide organisations with an overview of the fundamental principles of intellectual property management, in the context of the innovation process; - promote best practices in intellectual property matters that result in efficiently acquiring	CEN/TC 389 Innovation Management	2014-12-00

		intellectual property, while increasing the organisations' ability to effectively address intellectual property owned by third parties. This Technical Specification is applicable to all types of organisation, including the public sector. Special consideration has been given to the needs of SMEs.		
ISO 56003	Innovation management — Tools and methods for innovation partnership — Guidance	This document provides a guidance for innovation partnerships. It describes the innovation partnership framework (see Clause 4 to Clause 8) and the sample corresponding tools (see Annex A to Annex E) to — decide whether to enter an innovation partnership, — identify, evaluate and select partners, — align the perceptions of value and challenges of the partnership, — manage the partner interactions.	ISO/TC 279 Innovation management	2018-03-00
ISO/DIS 22313	Security and resilience — Business continuity management systems — Guidance	This document provides guidance, where appropriate, on the requirements specified in ISO 22301:201x Security and resilience – Business continuity management systems – Requirements and provides recommendations ('should') and permissions ('may') in relation to them. It is not the intention of this document to provide general guidance on all aspects of business continuity.	ISO/TC 292 Security	2019-04-00
CWA 16267	Guidelines for sustainable development of historic and cultural cities. Qualicities	The present referent document describes the commitments of the local authority in term of sustainable management of cultural (tangible and intangible) and natural heritages. Although it is systematically clarified in the text, all the described commitments are to be considered under the heritage point of view only. If, according to the local or regional organisation, the community has no authority on some of the fields covered by the commitments, it must prove that it did everything it could to get as close as it could to the required level. The referent document establishes the criteria in order to obtain the label of this CWA "Guidelines for Sustainable Development of Historic and Cultural Cities - Qualicities®". It applies to any cultural and heritage city or territory, at the local or regional level.	CEN European Committee for Standardisati on	2011-02-01

CEN/TS 17091	Crisis management — Guidance for developing a strategic capability	This document provides guidance on good practice for crisis management to help the strategic decision makers of an organisation to plan, implement, establish, operate, monitor, review, maintain and continually improve a crisis management capability. It is intended for any organisation regardless of location, size, type, industry, structure, or sector. While it is important to be aware of human and cultural factors as they can cause stress when working as individuals and as part of groups, it is not the purpose of this document to examine aspects of these areas in detail. This document provides guidance for:- understanding the context and challenges of crisis management; - developing an organisation's crisis management capability through preparedness; - recognising the complexities facing a crisis team in action; - communicating successfully during a crisis; and; - reviewing and learning.	CEN/TC 391 Societal and citizen security	2018-10-00
CWA 17335	Terminologies in crisis and disaster management	This CEN Workshop Agreement analyses definitions of terms used in crisis and disaster management as well as the scopes of the related source. Both scopes and definitions from different sources are compiled and compared regarding several aspects such as their context and envisaged audience. Sources could be a terminology standard or web services. The focus is set in responses to large scale critical events. Small scale incidents managed by daily routine processes of stakeholders are also covered but are not the main focus of this CWA. Selected terminologies predominantly from the domains crisis and disaster management are used for the analysis and are included in the document. The CEN Workshop Agreement includes terminologies and taxonomies, but no ontologies.	CEN European Committee for Standardisation	2018-09-00
ISO 22320	Security and resilience — Emergency management — Guidelines for incident management	This document gives guidelines for incident management, including — principles that communicate the value and explain the purpose of incident management, — basic components of incident management including process and structure, which focus on roles and responsibilities, tasks and management of resources, and — working together through joint direction and cooperation.	ISO/TC 292 Security	2018-11-00
ISO 22322	Societal security — Emergency management — Guidelines for public warning	ISO 22322:2015 provides guidelines for developing, managing, and implementing public warning before, during, and after incidents. This International Standard is applicable to any organisation responsible for public warning. It is applicable at all levels, from local up to international. Before planning and implementing the public warning system, risks and consequences of potential hazards are assessed.	ISO/TC 292 Security	2015-05-00

ISO/TS 22331	Security and resilience — Business continuity management systems — Guidelines for business continuity strategy	This document gives guidance for business continuity strategy determination and selection. It is applicable to all organisations regardless of type, size and nature, whether in the private, public or not-for-profit sectors. It is intended for use by those responsible for, or participating in, strategy determination and selection.	ISO/TC 292 Security	2018-10-00
ISO/TS 22375	Security and resilience — Guidelines for complexity assessment process	This document gives guidelines for the application of principles and a process for a complexity assessment of an organisation's systems to improve security and resilience. A complexity assessment process allows an organisation to identify potential hidden vulnerabilities of its system and to provide an early indication of risk resulting from complexity.	ISO/TC 292 Security	2018-10-00
ANSI/ASIS SPC.2	Auditing Management Systems — Risk, Resilience, Security and Continuity — Guidance for Application	This Standard provides guidance for conducting resilience, security, crisis, continuity and other risk-based audits within the context of management systems and includes practical advice on conducting audits. It will provide guidance on the management of audit programs, conduct of internal or external audits of risk and resilience based management systems such as security, crisis, continuity, and emergency management, including the competence and evaluation of auditors.	American National Standards Institute (ANSI)	2014-00-00
ISO 22398	Societal security — Guidelines for exercises	ISO 22398:2013 recommends good practice and guidelines for an organisation to plan, conduct, and improve its exercise projects which may be organized within an exercise programme. It is applicable to all organisations regardless of type, size or nature, whether private or public. The guidance can be adapted to the needs, objectives, resources, and constraints of the organisation. It is intended for use by anyone with responsibility for ensuring the competence of the organisation's personnel, particularly the leadership of the organisation, and those responsible for managing exercise programmes and exercise projects.	ISO/TC 292 Security	2013-09-00
ISO 22325	Security and resilience — Emergency management — Guidelines for capability assessment	ISO 22325:2016 provides guidelines for an organisation in assessing its emergency management capability. It includes — an assessment model with a hierarchy of four levels; — eight indicators; — an assessment process, explaining how to plan, collect, analyse and report.	ISO/TC 292 Security	2016-10-00

FprCEN/TS 17091	Crisis management — Guidance for developing a strategic capability	This document provides guidance on good practice for crisis management to help the strategic decision makers of an organisation to plan, implement, establish, operate, monitor, review, maintain and continually improve a crisis management capability. It is intended for any organisation regardless of location, size, type, industry, structure, or sector. While it is important to be aware of human and cultural factors as they can cause stress when working as individuals and as part of groups, it is not the purpose of this document to examine aspects of these areas in detail. This document provides guidance for:- understanding the context and challenges of crisis management; - developing an organisation's crisis management capability through preparedness; - recognising the complexities facing a crisis team in action; - communicating successfully during a crisis; and; - reviewing and learning.	CEN/TC 391 Societal and citizen security	2018-01-00
CWA 15931-1	Disaster and emergency management — Shared situation awareness — Part 1: Message structure	The context of this CEN Workshop Agreement (CWA) is disaster and emergency management, and it aims to assist organisations involved by providing a message structure for the transfer of information between computer based systems in such a way that it can be reliably decoded. This is done by encoding the information in an XML Schema. The companion CWA-Part 2 provides a system of terms relating to disasters and emergencies and their encoding. Many of the XML fields are required to use a term from the companion CWA-Part 2, rather than free text, so that the information is well defined, and can be automatically translated into language appropriate to the user.	CEN European Committee for Standardisati on	2009-04-01
CWA 15537	Network Enabled Abilities — Service-Oriented Architecture for civilian and military crisis management	This CWA specifies services and other items mandatory or optional for a Network Enabled Abilities environment. It also includes an inventory of standards and standard-like specifications applicable to each such item. These items include recommended general principles and framework for system design, overall architectures, generic functionality to be considered, concepts, conventions and terminology in order to ensure an optimum multi-purpose interoperability, in particular of national and multi-national military and civil operations.	EN European Committee for Standardisati on	2006-04-01
ONR 49002-3	Risk Management for Organisations and Systems — Part 3: Guidelines for emergency, crisis and business continuity management — Implementation of ISO 31000	This ONR describes the emergency, crisis and business continuity management of an organisation. This system is based on risk scenarios that may occur suddenly as a residual risk despite preventive measures, unexpected and with significant effects on the organisation. The application of this ONR does not extend to the guidance and the operation of public emergency organisations such as fire brigade, police, military and	ASI/Committe e 252 Risk management, Business Continuity Management	2014-01-01

		emergency services. However, this should be taken into account in the assessment of emergency and crisis scenarios and in emergency and crisis planning for all organisations involved in emergency exercises.	and Corporate Security Management	
ITU-T E.100 Supplement 1	ITU-T E.100 series — Framework of disaster management for disaster relief system	No abstract available.	ITU International Telecommuni cation Union	2019-02-00
ISO/DIS 22328-1	Security and resilience — Emergency management — Community-based disaster early warning system — Part 1: Guidelines for implementation of a community-based disaster early warning system	This document provides guidelines for the implementation of a disaster early warning system. It provides a definition, aims to improve understanding, and describes methods and procedures to be implemented. It is applicable to communities vulnerable to disasters, without taking secondary effects into consideration.	ISO/TC 292 Security	2019-05-00

4.3.7. Standards - Category 'Cities and communities'

The standards analysis for the category 'Cities and communities' resulted in the following list of 20 standards. Identified standards within this topic that might need special attention in the ARCH project work are e. g. the ISO/TR 37121 'Sustainable development in communities - Inventory of existing guidelines and approaches on sustainable development and resilience in cities' that provides an inventory of existing guidelines and approaches on sustainable development and resilience in cities; and ISO/DIS 37123 ' Sustainable cities and communities - Indicators for resilient cities' that defines methodologies for a set of indicators on resilience in cities.

Table 8: List of identified standards – Category 'Cities and communities'

Document No.	Title	Abstract	Committee	Date of publication
ISO/TR 37152	Smart community infrastructures — Common	ISO/TR 37152:2016 outlines the basic concept of a common framework for the development and operation of smart community infrastructures. The framework describes the planning, development, operation and maintenance	ISO/TC 268 Sustainable development	2016-08-00

	framework for development and operation	methodology to facilitate the harmonization of each infrastructure as a part of a smart community and ensures that the interactions between multiple infrastructures are well orchestrated. The framework is applicable to all processes of smart community infrastructures' life cycle (from conceptual design through planning, development, operation, maintenance, redevelopment and feedback). The infrastructures to be covered are energy, water, transportation, waste management, ICT and others.	in communities	
ISO 37153	Smart community infrastructures — Maturity model for assessment and improvement	ISO 37153:2017 provides the basis, requirements and guidance for a maturity model for the assessment of technical performance, process and interoperability of community infrastructure(s) as well as its contribution to the community, and guidance for future improvements.	ISO/TC 268 Sustainable development in communities	2017-12-00
ISO 37100	Sustainable cities and communities — Vocabulary	ISO 37100:2016 defines terms relating to sustainable development in communities, smart community infrastructure and related subjects.	ISO/TC 268 Sustainable development in communities	2016-12-00
ISO 37101	Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use	ISO 37101:2016 establishes requirements for a management system for sustainable development in communities, including cities, using a holistic approach, with a view to ensuring consistency with the sustainable development policy of communities. ISO 37101:2016 can be used in whole or in part to improve the management of sustainable development in communities. Claims of conformity to ISO 37101:2016, however, are not acceptable unless all its requirements are incorporated into an organisation's management system for sustainable development in communities and fulfilled without exclusion.	ISO/TC 268 Sustainable development in communities	2016-07-00
ISO 37104	Sustainable cities and communities — Transforming our cities — Guidance for	This document provides guidance on how to implement and maintain a management system for sustainable development based on ISO 37101 principles, specifically in the context of cities, but applicable to other forms of settlement. This document:	ISO/TC 268 Sustainable development	2019-04-00

	practical local implementation of ISO 37101	— provides guidance for practical implementation of a management system for sustainable development in cities and other settlements, based on ISO 37101; — establishes a methodological framework for the systematic evaluation of the sustainable development schemes and achievements in the city or other settlements, based on the cross-analysis of the six purposes of sustainability and the 12 areas of action of ISO 37101;	in communities	
ISO/DIS 37105	Sustainable cities and communities — Descriptive framework for cities and communities	This international standard specifies requirements for a descriptive framework including an associated foundational ontology of the anatomical structure of a city or community. The descriptive framework has the following qualities: timeless, i.e., compatible with any human settlement at any time in history; acultural, i.e., valid for any culture and any type of city; scalable, i.e., valid for a metropolis, a city, a small town, or a village; and generic, so that anything we could define as a "human settlement", such as a "smart city", would have a place in this structure.	ISO/TC 268 Sustainable development in communities	2018-07-00
ISO 37106	Sustainable cities and communities — Guidance on establishing smart city operating models for sustainable communities	This document gives guidance for leaders in smart cities and communities (from the public, private and voluntary sectors) on how to develop an open, collaborative, citizen-centric and digitally-enabled operating model for their city that puts its vision for a sustainable future into operation.	ISO/TC 268 Sustainable development in communities	2018-07-00
ISO 37120	Sustainable cities and communities — Indicators for city services and quality of life	This document gives guidance for leaders in smart cities and communities (from the public, private and voluntary sectors) on how to develop an open, collaborative, citizen-centric and digitally-enabled operating model for their city that puts its vision for a sustainable future into operation. This document provides proven tools that cities can deploy when operationalizing the vision, strategy and policy agenda they have developed following the adoption of ISO 37101, the management system for sustainable development of communities. It can also be used, either in whole or in part, by cities that have not committed to deployment of the ISO 37101 management system.	ISO/TC 268 Sustainable development in communities	2018-07-00
ISO/TR 37121	Sustainable development in communities — Inventory of existing guidelines and approaches on sustainable	ISO/TR 37121:2016 provides an inventory of existing guidelines and approaches on sustainable development and resilience in cities. ISO/TR 37121:2016 focuses on resilience understood as the ability of a city, system, community, local government or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a	ISO/TC 268 Sustainable development in communities	2017-01-00

	development and resilience in cities	timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. Resilience indicators are intended to assess the extent to which cities are helping residents, businesses, institutions, and infrastructure resist, absorb, accommodate to and recover from the effects of hazards in a timely and efficient manner.		
ISO 37122	Sustainable cities and communities — Indicators for smart cities	This document specifies and establishes definitions and methodologies for a set of indicators for smart cities. As accelerating improvements in city services and quality of life is fundamental to the definition of a smart city, this document, in conjunction with ISO 37120, is intended to provide a complete set of indicators to measure progress towards a smart city. This is represented in Figure 1.	ISO/TC 268 Sustainable development in communities	2019-05-00
ISO/DIS 37123	Sustainable cities and communities — Indicators for resilient cities	This International Standard defines and methodologies for a set of indicators on resilience in cities. This ISO is applicable to any city, municipality or local government that undertakes to measure ist performance in a comparable and verifiable manner, irrespective of size and location. Maintaining, enhancing and accelerating progress towards improved city services and quality of life is fundamental to the definition of a Resilient City, so this standard shall therefore be implemented in conjunction with ISO 37120.	ISO/TC 268 Sustainable development in communities	2018-11-00
ISO/TR 37150	Smart community infrastructures — Review of existing activities relevant to metrics	ISO/TR 37150:2014 provides a review of existing activities relevant to metrics for smart community infrastructures. In ISO/TR 37150:2014, the concept of smartness is addressed in terms of performance relevant to technologically implementable solutions, in accordance with sustainable development and resilience of communities, as defined in ISO/TC 268. ISO/TR 37150:2014 addresses community infrastructures such as energy, water, transportation, waste and information and communications technology (ICT). It focuses on the technical aspects of existing activities which have been published, implemented or discussed. Economic, political or societal aspects are not analysed in ISO/TR 37150:2014.	ISO/TC 268 Sustainable development in communities	2014-02-00
ISO/TS 37151	Smart community infrastructures — Principles and requirements for performance metrics	ISO/TS 37151:2015 gives principles and specifies requirements for the — definition, — identification, — optimization, and — harmonization	ISO/TC 268 Sustainable development in communities	2015-05-00

		of community infrastructure performance metrics, and gives recommendations for analysis, including — smartness, — interoperability, — synergy, — resilience, — safety, and — security of community infrastructures. Community infrastructures include, but are not limited to, energy, water, transportation, waste, and ICT. In ISO/TS 37151:2015, the concept of smartness is addressed in terms of performance relevant to technologically implementable solutions, in accordance with sustainable development and resilience of communities as defined in ISO/TC 268.		
CWA 17381	The Description and Assessment of Good Practices for Smart City solutions	This CEN Workshop Agreement (CWA) defines requirements to describe and assess good practices of Smart City Solutions. This document is intended to support the decision-making of smart cities in the interest of their citizens, and of those who advise them, such as companies providing products and services, consultants, and associations.	CEN European Committee for Standardisati on	2019-02-00
ISO/IEC 30182	Smart city concept model — Guidance for establishing a model for data interoperability	ISO/IEC 30182:2017 describes, and gives guidance on, a smart city concept model (SCCM) that can provide the basis of interoperability between component systems of a smart city, by aligning the ontologies in use across different sectors. It includes: — concepts (e.g. ORGANISATION, PLACE, COMMUNITY, ITEM, METRIC, SERVICE, RESOURCE); and — relationships between concepts (e.g. ORGANISATION has RESOURCEs, EVENT at a PLACE). ISO/IEC 30182:2017 is aimed at organisations that provide services to communities in cities, and manage the resulting data, as well as decision-makers and policy developers in cities.1). It does not cover the data standards that are relevant to each concept in the SCCM and does not attempt to list or recommend the sources of identifiers and categorizations that cities map to the SCCM. The SCCM has been devised to communicate the meaning of data. It does not attempt to provide concepts to describe the metadata of a dataset, for example, validity and provenance of data. It	ISO/IEC JTC 1 ISO/IEC Joint Technical Commitee for Information Technology	2017-05-00

		covers semantic interoperability that is, defining the meaning of data, particularly from many sources. It does not cover other barriers to interoperability, some of which are described at 3.2.		
ITU-T Y Supplement 34	ITU-T Y.4000 series — Smart sustainable cities — Setting the stage for stakeholders' engagement	Supplement 34 to the ITU-T Y-series Recommendations is addressed to a broad audience of city decision makers and practitioners involved in the design and implementation of SSC. It is intended to be as general and inclusive as possible, applicable and relevant to any city, regardless of its size or location, in both developed and developing countries. The concepts and definitions presented in this Supplement are in alignment with the series of Supplements to the Y.4000 series.	ITU International Telecommunication Union	2016-01-00
ITU-T L.1600	Overview of key performance indicators in smart sustainable cities	Recommendation ITU-T Y.4900/L.1600 gives a general guidance to cities and provides an overview of key performance indicators (KPIs) in the context of smart sustainable cities (SSCs).	ITU International Telecommunication Union	2016-06-00
ITU-T L.1601/Y.4901	Key performance indicators related to the use of information and communication technology in smart sustainable cities	This Recommendation ITU-T L.1601 gives a general guidance to cities and provides the definitions of key performance indicators (KPIs) related to the use of information and communication technology (ICT) in the context of Smart Sustainable Cities (SSCs).	ITU International Telecommunication Union	2016-06-00
ITU-T Y.4902/L.1602	Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities	Recommendation ITU-T Y.4902/L.1602 gives a general guidance to cities and provides the definitions of key performance indicators (KPIs) related to the sustainability impact of information and communication technology (ICT) in the context of smart sustainable cities (SSCs).	ITU International Telecommunication Union	2016-06-00
PAS 184	Smart Cities. Developing project proposals for delivering smart city solutions. Guide	It gives practical guidance on how to develop project proposals for smart city solutions, using case studies to illustrate good practice in smart city procurement. The content reflects current good practice as identified by a broad range of public, private and voluntary sector practitioners engaged in developing smart city solutions.	British Standards Institution	2017-03-31

4.3.8. Standards under development

The following table lists standards related to the ARCH project that are currently under development. For some of them no detailed information is currently available.

Table 9: Standards from CEN/TC 346 Conservation of Cultural Heritage

Document No.	Title	Abstract
prEN 17121	Conservation of cultural heritage — Historic timber structures — Guidelines for the on-site assessment of load-bearing timber structures	This document gives guidelines on the criteria to be used for the on-site assessment of load-bearing timber structures in heritage buildings. It is intended for all those concerned with the conservation of heritage buildings which contain wooden elements, from the building owners or authorities who are responsible for them to the professionals employed. It should also help decision-making regarding the need for immediate measures. Its aim is to guarantee that condition survey and assessment provide the necessary data for historical analysis, structural safety assessment and planning of intervention works. This document is applicable to any kind of timber member and to any kind of historic timber structures. It is not applicable to timber members made of engineered wood based panels and glued laminated timber. This document provides a comprehensive procedure for the on-site assessment.
FprEN 15898	Conservation of cultural heritage — Main general terms and definitions	This document defines the main general terms used in the field of conservation of cultural heritage with particular attention to those terms which have wide use or significance.
FprEN 17135	Conservation of cultural heritage — Generale terms for describing the alterations of objects	This document defines terms used in the field of conservation of cultural heritage for the description of alteration of objects with particular attention to those terms which are applied to many types of objects. This document applies to all types of material changes that can be observed.
prEN 16141 rev	Conservation of cultural heritage — Guidelines for management of environmental conditions — Open storage facilities: definitions and characteristics of collection centres dedicated to the preservation and management of cultural heritage	This European Standard defines the characteristics of specific areas dedicated to the preservation, storage, management of, and access to collections. It lists the considerations that should be taken into account to achieve optimum storage and accessibility.

prEN 16163	Conservation of Cultural Heritage — Guidelines and procedures for choosing appropriate lighting for indoor exhibitions	This NWI proposes a review of CEN/TS-16163:2014 aimed at updating its contents to meet requirements for conversion in EN Standard.
prEN 17187	Conservation of Cultural Heritage — Characterization of mortars used in cultural heritage	This document specifies a methodology for the characterization of mortars by using the most appropriate analytical techniques on samples taken from cultural heritage structures and objects. This document contains guidelines for the selection of methods to determine mineralogical, textural, physical, chemical and mechanical properties of mortars used in cultural heritage structures and objects. This information is used to define mortar typology and to evaluate the mortar condition with respect to its conservation as well as for understanding of the ongoing deterioration processes.
prEN 17429	Conservation of cultural heritage — Procurement of conservation services and works	This document outlines the principles, processes and best practice for procuring conservation services and works for cultural heritage. This can embrace any conservation action or measure, whether it be a preventive measure, a remedial treatment, investigation, planning, policy, or project management, etc. The means of procuring such work will vary depending, among other things, on the scale of the work envisaged. This document is not intended to override or conflict with European and national legislation covering procurement. Rather, it is to be read alongside relevant regulations covering procurement and is technically specific to the conservation of cultural heritage. This document is intended to be used - by buyers or commissioners of conservation work (e.g. custodians, public or private individuals, collecting institutions, conservation specialists, conservation funding organisations etc.) and - by those individuals and enterprises seeking to carry out conservation work. It is not intended to be used by institutional custodians as a means of directing work to their own staff. NOTE In this document the term "object" is used for object, objects and collections.

Table 10: Standards from CEN/TC 391 Societal and citizen security

Document No.	Title	Abstract
FprCEN/TS 17091	Crisis management - Guidance for developing a strategic capability	Crises present unique challenges that can be dynamic, unpredictable and difficult to manage. To plug a gap in advice for private sector organisations, this document provides organisations with invaluable material on how to develop their crisis management capability. It will help strategic decision makers plan, implement, establish, operate, monitor, review, maintain and continually improve a crisis management capability.

Table 11: Standards from ISO/TC 292 Security and resilience

Document No.	Title	Abstract
ISO/NP 22300	Security and resilience — Vocabulary	There is no abstract available due to the current development stage.
ISO/FDIS 22301	Security and resilience — Business continuity management systems — Requirements	There is no abstract available due to the current development stage.
ISO/DIS 22313	Security and resilience — Business continuity management systems — Guidance	There is no abstract available due to the current development stage.
ISO/DIS 22328-1	Security and resilience — Emergency management — Part 1: General guidelines for the implementation of a community-based disaster early warning system	There is no abstract available due to the current development stage.
ISO/AWI 22329	Security and resilience — Emergency management — Guidelines for the use of social media in emergencies	There is no abstract available due to the current development stage.
ISO/AWI TS 22332	Security and resilience — Business continuity management systems -— - Guidance for developing business continuity procedures	There is no abstract available due to the current development stage.
ISO/WD 22340	Security and resilience — Protective security — Architecture, framework and guidelines	There is no abstract available due to the current development stage.

ISO/CD 22341	Security and resilience — Protective security — Guidance for security and crime prevention by urban design and management	There is no abstract available due to the current development stage.
ISO/AWI 22342	Security and resilience — Protective security — Guidelines for the development of a security plan for an organisation	There is no abstract available due to the current development stage.
ISO/DTR 22370	Security and resilience — Framework and principles for urban resilience	There is no abstract available due to the current development stage.
ISO/DIS 22383	Security and resilience — Authenticity, integrity and trust for products and documents — Guidelines and performance criteria for authentication solutions for material goods	There is no abstract available due to the current development stage.
ISO/DIS 22384	Security and resilience — Authenticity, integrity and trust for products and documents — Guidelines to establish and monitor a protection plan and its implementation	There is no abstract available due to the current development stage.
ISO/DIS 22392	Security and resilience — Community resilience — Guidelines for conducting peer reviews	There is no abstract available due to the current development stage.
ISO/DIS 22396	Security and resilience — Community resilience — Guidelines for information exchange between organisations	There is no abstract available due to the current development stage.

Table 12: Standards from ISO/TC 268 Sustainable cities and communities

Document No.	Title	Abstract
ISO/FDIS 37105	Sustainable cities and communities — Descriptive framework for cities and communities	There is no abstract available due to the current development stage.
ISO/PRF TS 37107	Sustainable cities and communities — Maturity framework for sustainable and smart-enabled communities	There is no abstract available due to the current development stage.
ISO/AWI 37108	Sustainable cities and communities — Business districts — Guidance for practical local implementation of ISO 37101	There is no abstract available due to the current development stage.
ISO/FDIS 37123	Sustainable cities and communities — Indicators for resilient cities	There is no abstract available due to the current development stage.
ISO/FDIS 37155-1	Framework for integration and operation of smart community infrastructures — Part 1: Opportunities and challenges from interactions in smart community infrastructures from all aspects through the life-cycle	There is no abstract available due to the current development stage.
ISO/CD 37155-2	Framework for integration and operation of smart community infrastructures — Part 2: Holistic approach and the strategy for development, operation and maintenance of smart community infrastructures	There is no abstract available due to the current development stage.

ISO/DIS 37156	Smart community infrastructures — Guidelines on data exchange and sharing for smart community infrastructures	There is no abstract available due to the current development stage.
ISO/DIS 37162	Smart community infrastructures — Smart transportation for newly- developing areas	There is no abstract available due to the current development stage.

Table 13: Standardsfrom ISO/TC 59 Buildings and civil engineering works

Document No.	Title	Abstract
ISO/DIS 20887	Sustainability in buildings and civil engineering works - Design for disassembly and adaptability — Principles, requirements and guidance	There is no abstract available due to the current development stage.

Table 14: Standards from ISO/TC 20 Aircraft and space vehicles

Document No.	Title	Abstract
ISO/DIS 21384-1	Unmanned aircraft systems — Part 1: General specification	There is no abstract available due to the current development stage.
ISO/DIS 21384-3	Unmanned aircraft systems — Part 3: Operational procedures	There is no abstract available due to the current development stage.
ISO/DIS 21384-4	Unmanned aircraft systems — Part 4: Terms and definitions	There is no abstract available due to the current development stage.
ISO/DIS 21895	Categorisation and classification of civil unmanned aircraft systems	There is no abstract available due to the current development stage.

4.3.9. Standards – Recommended by partners

The following table lists standards added by individual ARCH partners after the formal standards identification process

Table 15: ***Standards recommended by partners***

Document No.	Title	Abstract	Committee	Date of publication
IEC 31010	Risk management — Risk assessment techniques	IEC 31010:2019 is published as a double logo standard with ISO and provides guidance on the selection and application of techniques for assessing risk in a wide range of situations. The techniques are used to assist in making decisions where there is uncertainty, to provide information about particular risks and as part of a process for managing risk. The document provides summaries of a range of techniques, with references to other documents where the techniques are described in more detail.	ISO/TC 262 Risk management	2009-06-00
ISO 31000	Risk management — Guidelines	ISO 31000:2018 describes a framework and a process for managing risk. It can be used by any organisation regardless of its size, activity or sector. Using ISO 31000 can help organisations increase the likelihood of achieving objectives, improve the identification of opportunities and threats and effectively allocate and use resources for risk treatment.	ISO/TC 262 Risk management	2018-02-00
ISO/TR 31004	Risk management — Guidance for the implementation of ISO 31000	ISO/TR 31004:2013 provides guidance for organisations on managing risk effectively by implementing ISO 31000:2009. It provides a structured approach for organisations to transition their risk management arrangements in order to be consistent with ISO 31000, in a manner tailored to the characteristics of the organization.	ISO/TC 262 Risk management	2013-10-00
EN 1998-1	Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings	EN 1998-1 applies to the design of buildings and civil engineering works in seismic regions. EN 1998-1 contains the basic performance requirements and compliance criteria applicable to buildings and civil engineering works in seismic regions. EN 1998-1 gives the rules for the representation of seismic actions and for their combination with other actions. Furthermore it contains general design rules relevant specifically to buildings which are material related.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2004-12-00

EN 1998-2	Design of structures for earthquake resistance — Part 2: Bridges	This standard covers the seismic design of bridges in which the horizontal seismic actions are mainly resisted through bending of the piers or at the abutments; i.e. of bridges composed of vertical or nearly vertical pier systems supporting the traffic deck superstructure. It is also applicable to the seismic design of cable-stayed and arched bridges, although its provisions should not be considered as fully covering these cases.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2005-11-00
EN 1998-3	Design of structures for earthquake resistance — Part 3: Assessment and retrofitting of buildings	The standard contents rules for the evaluation of the seismic performance of existing structures, the selection of corrective measures and the design of repair and/or strengthening measures with additional considerations for monuments and historic buildings.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2005-06-00
EN 1998-4	Design of structures for earthquake resistance — Part 4: Silos, tanks and pipelines	This standard covers aspects of seismic design specific to pipelines and tanks on the basis of EN 1998-1 "Eurocode 8 - Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings". The design of these constructions refers to systems and plants with common risk to health, life and environment. For greater risk and for more complex structures further considerations on national level may be appropriate.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2006-07-00
EN 1998-5	Design of structures for earthquake resistance Part 5: Foundations, retaining structures and geotechnical aspects	Additional rules for the design of various foundation systems, earth retaining structures and soil-structure interaction under seismic actions in conjunction with the structural design of buildings, bridges, towers, masts, chimneys, silos, tanks and pipelines.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2004-11-00

EN 1998-6	Design of structures for earthquake resistance — Part 6: Towers, masts and chimneys	This standard contains design rules for the earthquake resistant design of tall, slender structures as e.g. towers, masts, and industrial chimneys.	CEN/TC 250/SC 8 Earthquake resistance design of structures	2005-06-00
ISO 29481-2	Building information models — Information delivery manual — Part 2: Interaction framework	This part of ISO 29481 specifies a methodology and format for describing coordination acts between actors in a building construction project during all life cycle stages. It therefore specifies a methodology that describes an interaction framework, an appropriate way to map responsibilities and interactions that provides a process context for information flow, a format in which the interaction framework should be specified. This part of ISO 29481 is intended to facilitate interoperability between software applications used in the construction process, to promote digital collaboration between actors in the building construction process, and to provide a basis for accurate, reliable, repeatable, and high-quality information exchange.	CEN/TC 442 Building Information Modelling (BIM)	2012-12-00
ISO 16739	Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries	ISO 16739:2013 specifies a conceptual data schema and an exchange file format for Building Information Model (BIM) data. The conceptual schema is defined in EXPRESS data specification language. The standard exchange file format for exchanging and sharing data according to the conceptual schema is using the Clear text encoding of the exchange structure. Alternative exchange file formats can be used if they conform to the conceptual schema. ISO 16739:2013 represents an open international standard for BIM data that is exchanged and shared among software applications used by the various participants in a building construction or facility management project. ISO 16739:2013 consists of the data schema, represented as an EXPRESS schema specification, and reference data, represented as definitions of property and quantity names and descriptions. A subset of the data schema and referenced data is referred to as a model view definition. A particular model view definition is defined to support one or many recognized workflows in the building construction and facility management industry sector. Each workflow identifies data exchange requirements for software applications. Conforming software applications need to identity the model view definition they conform to.	CEN/TC 442 Building Information Modelling (BIM)	2018-11-00

ISO 12006-3	Building construction — Organisation of information about construction works — Part 3: Framework for object-oriented information	This part of ISO 12006 specifies a language-independent information model which can be used for the development of dictionaries used to store or provide information about construction works. It enables classification systems, information models, object models and process models to be referenced from within a common framework.	CEN/TC 442 Building Information Modelling (BIM)	2007-04-00
ISO 19650-1	Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 1: Concepts and principles	This document outlines the concepts and principles for information management at a stage of maturity described as "building information modelling (BIM) according to the ISO 19650 series". This document provides recommendations for a framework to manage information including exchanging, recording, versioning and organizing for all actors. This document is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life. This document can be adapted to assets or projects of any scale and complexity, so as not to hamper the flexibility and versatility that characterize the large range of potential procurement strategies and so as to address the cost of implementing this document.	CEN/TC 442 Building Information Modelling (BIM)	2018-01-00
ISO 19650-2	Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 2: Delivery phase of the assets	This document specifies requirements for information management, in the form of a management process, within the context of the delivery phase of assets and the exchanges of information within it, using building information modelling. This document can be applied to all types of assets and by all types and sizes of organisations, regardless of the chosen procurement strategy.	CEN/TC 442 Building Information Modelling (BIM)	2018-12-00

ISO 29481-1	Building information models — Information delivery manual — Part 1: Methodology and format	ISO 29481-1:2016 specifies a methodology that links the business processes undertaken during the construction of built facilities with the specification of information that is required by these processes, and - a way to map and describe the information processes across the life cycle of construction works. ISO 29481-1:2016 is intended to facilitate interoperability between software applications used during all stages of the life cycle of construction works, including briefing, design, documentation, construction, operation and maintenance, and demolition. It promotes digital collaboration between actors in the construction process and provides a basis for accurate, reliable, repeatable and high-quality information exchange.	CEN/TC 442 Building Information Modelling (BIM)	2016-05-00

5. ARCH project issues and connections

The results in this deliverable will be mainly used for the implementation of T2.6 'Standardisation activities'. Additionally the Work Package 2 representatives such as DIN will attend most of the upcoming ARCH meetings within other Work Packages to gather information that will feed into the ongoing standardisation process, to spread awareness regarding ARCH standardisation activities and to provide additional input in the tools, methods, co-creation process and pathway development process within Work Packages 3 to 6. The standards and standardisation activities of this report will also be further observed, extended and analysed throughout the project's lifespan in order to support the future standardisation activities within ARCH. It is of great importance to reflect the state of the art standards and to incorporate the activities, results and main outcomes of the ARCH project into the European standards landscape.

6. Conclusion

This report presents the existence of a large number of standards and points to a variety of standardisation activities taking place especially at European and International level that cover the topics of crisis management, urban resilience, heritage and climate change and thus are relevant for the ARCH project. The comprehensive list of standards shows that the relevant standardisation activities are horizontally spread due to the interconnection between several thematic topics. In summary, it can be said that the result of the standardization analysis on the resilience of historic areas benefits from a large number of standards that encompass various aspects and cross-connections.

It is also noteworthy that the number of standards on 'Climate change', 'Management systems', 'Resilience' and 'Cities and communities', and 'Heritage' is relatively balanced. In this context, the categories 'Techniques' and 'Drones' are left out of the equation as the scope of the content is very limited to the city and heritage context. However, the standards currently being developed and the increasing efforts to standardise these issues show that there is a need for these standards and that the standards development organisations (SDOs) are addressing the issues in this area.

Through the work carried out under T7.1, the ARCH partners and project partners recognised the importance of standards and their justification and need for further dissemination and awareness of standardisation activities, in particular in the areas of resilience, crisis management and vulnerability assessment in the context of climate change. All standardisation efforts to improve urban resilience can lead to significant benefits in reducing climatic hazards and adverse events. Not only the existence of guides and requirements is crucial, but also their implementation at community or city level. The city representatives need to be informed and to be aware of existing standards in relation to main challenges and problematic issues their cities may face; in this way they may be able to adopt and use them when it comes to decision making processes and planning for the resilience of cultural heritage sites.

7. List of Figures

8. List of Tables

9. References

Not applicable for this report.

10. Annex – Key resources

For this report expertise about standardisation was provided by the following brochures:

Title: An Introduction to standardisation

- Author: published by DIN
- Weblink: An introduction to standardization
- Year of publication: 2016
- Brief summary about the content: How to take actively part in the standardization process as a company
- Why the resource is useful to the ARCH project: Project results need to be transferred into a standardization document
- Why the resource is useful in terms of heritage assets and resilience: It is useful to any kind of standard

Title: How to write a standard

- Author: published by ISO
- Weblink: How to write a standard
- Year of publication: 2016
- Brief summary about the content: designed to help people write clear, concise and user-friendly International Standards
- Why the resource is useful to the ARCH project: Project results need to be transferred into a standardization document
- Why the resource is useful in terms of heritage assets and resilience: It is useful to any kind of international standard

Title: CEN Guide 29

- Author: published by CEN
- Weblink: CEN Guide 29
- Year of publication: 2014
- Brief summary about the content: details the characteristics and the development processes of the 'CEN/CENELEC Workshop Agreement'
- Why the resource is useful to the ARCH project: Project results need to be transferred into a standardization document
- Why the resource is useful in terms of heritage assets and resilience: It is useful to any kind of CWA

ARCH Glossary

1. Introduction

This section contains an updated version of the ARCH project glossary, initially submitted as an annex to D1.2. The glossary is based on and extends the H2020 RESIN Glossary [1] and the CIPedia [2]. This updated version contains changes and additions based on the definitions from the state-of-the-art reports.

2. Glossary

Term	Definition	Source
Acceptable Risk	The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.	[3]
Adaptation (to climate change)	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. See also Autonomous Adaptation, Evolutionary Adaptation, Incremental Adaptation and Transformative Adaptation	[4]
Adaptation Assessment	The practice of identifying options to adapt to climate change and evaluating them, in terms of criteria such as availability, (co--) benefits, costs, effectiveness, efficiency and feasibility.	[1]
Adaptation Options	The array of strategies and measures that are available and appropriate for addressing adaptation needs. They include a wide range of actions that can be categorised as structural, institutional, or social.	[4]
Adaptation Strategies	[Adaptation Strategies] include a mix of policies and measures with the overarching objective of reducing vulnerability. Depending on the circumstances, the strategy can be set at a national level, addressing adaptation across sectors, regions and vulnerable populations, or it can be more limited, focusing on just one or two sectors or regions.	[4]
Adaptive capacity (or adaptability)	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.	[4]
Archaeological heritage	The "archaeological heritage" is that part of the material heritage in respect of which archaeological methods provide primary information. It comprises all vestiges of human existence and consists of places relating to all manifestations of human activity, abandoned structures, and remains of all kinds (including subterranean and underwater sites), together with all the portable cultural material associated with them.	[5]
	Any place where objects, features, or ecofacts manufactured or modified by human beings are found. A material thing that can be seen and touched. Belonging to, having reference to, or dealing with archæology. Any material remains of the past which offer potential for archaeological investigation and analysis as a means of contributing to the understanding of past human communities.	[6]
Architectural heritage	Architectural work; structure, building	[6]

Authenticity	Heritage asset that is materially original or genuine as it was constructed and as it has aged and weathered in time.	[71]
Autonomous Adaptation	Adaptation in response to experienced climate and its effects, without planning explicitly or consciously focused on addressing climate change. Also referred to as spontaneous adaptation.	[4]
Blue Infrastructure	See Green Infrastructure	
Building Back Better	The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment.	[7]
	This concept refers to the use of the post-disaster recovery and rehabilitation phases to build the resilience of nations and communities, through the integration of disaster risk reduction measures in the restoration of physical infrastructure and social systems and in the revitalization of livelihoods, economies and the environment. This process should take into consideration new risk zones and the population's recent experiences in responding to the impacts of natural hazards.	Adapted from [52]
Cascading Effects	A cascading failure occurs when a disruption in one infrastructure causes the failure of a component in a second infrastructure, which subsequently causes a disruption in the second infrastructure.	[8]
	A sequence of events in which each individual event is the cause of the following event; all the events can be traced back to one and the same initial event.	[9]
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization.	[4]
Climate Change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.	[10]
Climate Projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models.	[10]
Climate Model	A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties.	[10]
Climate System	The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere, and the interactions between them.	[10]
Co-benefits	The positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Co benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors. Co benefits are also referred to as ancillary benefits.	[11]

Co-creation	The joint creation and development of knowledge, models, methods, tools, services, policies, and strategies between researchers/developers and end-users from pilot cities. Depending on the specific context this can results in various levels of end-user involvement, from low (e.g. data sharing, user testing) to high (co-development of methods, prototype testing).	ARCH
Consequence	The outcome of an event affecting objectives	[12], [13]
Consequence Analysis	Consequence Analysis is estimation of the effect of potential hazardous events	[14]
Conservation-restoration	Actions and activities focused on safeguarding of (tangible) cultural heritage, respecting its significance, including providing it for present and future generations. Conservation and restoration also consist of terms: preventive restoration, remedial restoration, restoration.	[65]
Contextual Vulnerability	A present inability to cope with external pressures or changes, such as changing climate conditions. Contextual vulnerability is a characteristic of social and ecological systems generated by multiple factors and processes.	[4]
Cooked data	Data that has been processed, as opposed to the RAW data.	[55]
Coping Capacity	The ability of people, institutions, organizations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term.	[4]
	The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.	[3]
Crisis	Any incident(s), human-caused or natural, that require(s) urgent attention and action to protect life, property, or environment	[15]
Crisis Management	The coordinated actions taken to defuse crises, prevent their escalation into an armed conflict and contain hostilities if they should result.	[16]
	Holistic management process that identifies potential impacts that threaten an organization and provides a framework for building [resilience]], with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand, and value-creating activities – as well as effectively restoring operational capabilities.	[17]
Critical Infrastructure (CI)	An asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions.	[18]
	Organizations and facilities that are essential for the functioning of society and the economy as a whole.	[19]
Critical Infrastructure Dependency	CI dependency is the relationship between two (critical infrastructure) products or services in which one product or service is required for the generation of the other product or service.	[9]
Critical Infrastructure Element	Part of a CI. Can have sub elements	[9]
Critical Information	Critical information infrastructures ('CII') should be understood as referring to those interconnected information systems and networks, the disruption or destruction of which would have serious impact on	[20]

Infrastructure (CII)	the health, safety, security, or economic well-being of citizens, or on the effective functioning of government or the economy.	
Critical Infrastructure Interdependency	The mutual dependency of products or services.	[21]
Critical Infrastructure Operator	Owners/operators of ECIs means those entities responsible for investments in, and/or day-to-day operation of, a particular asset, system or part thereof designated as an ECI under the ECI Directive.	[18]
Critical Infrastructure Protection (CIP)	All activities aimed at ensuring the functionality, continuity and integrity of critical infrastructures in order to deter, mitigate and neutralise a threat, risk or vulnerability.	[18]
Critical Infrastructure Sector	Economic sectors considered critical	[9]
Cultural heritage	Cultural heritage is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations.	[22]
Cultural Heritage Conservation	All measures and actions aimed at safeguarding tangible cultural heritage while ensuring its acces-sibility to present and future generations. Conser-vation embraces preventive conservation, remedi-al conservation and restoration. All measures and actions should respect the significance and the physical properties of the cultural heritage item.	[53]
Cultural Significance	Means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups.	[69]
Cyber Security	Cyber security commonly refers to the safeguards and actions that can be used to protect the cyber domain, both in the civilian and military fields, from those threats that are associated with or that may harm its interdependent networks and information infrastructure. Cyber security strives to preserve the availability and integrity of the networks and infrastructure and the confidentiality of the information contained therein.	[23]
Damage	Damage classification is the evaluation and recording of damage to structures, facilities, or objects according to three (or more) categories.	[24]
Decision	The result of making up one's mind regarding a choice between alternatives	[25]
Decision Support	The structure process of activities that support decision makers and other stakeholders in coping with and resolving problems they are faced with.	[25]
Decision Support System	A computer system that supports the structured process of activities that support decision makers and other stakeholders in coping with and resolving problems they are faced with.	-
Dependent care infrastructure	Facilities for the care of people with certain degree of dependence, e.g. children, elderly or people with disabilities	-
Disaster	Disaster is the impact of a natural event upon a vulnerable community resulting in disruption, damage and casualties, which cannot be relieved by the unaided capacity of locally, mobilised resources.	[26]

	Disaster means any situation which has or may have a severe impact on people, the environment, or property, including cultural heritage.	[27]
	A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.	[28]
	Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.	[3]
Disaster Recovery Framework	This framework would guide governments and other implementing stakeholders in the middle and longer term recovery efforts. The framework would help in articulating a vision for recovery; defining a strategy; prioritizing actions; fine-tuning planning; and providing guidance on financing, implementing, and monitoring the recovery. Through developing a country-level disaster recovery framework, a government will be better positioned to drive a process that unites all development partners' efforts. Additionally, by developing a framework to manage recovery, a government may be able to better address longer term disaster vulnerability through coherent programs that bridge the current gap between recovery and development.	[42]
Disaster Resilience	Disaster resilience is the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.	[29]
Disaster Risk	The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period	[3]
Disaster Risk Management	The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.	[3]
Disaster Risk Reduction	The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.	[3]
Disruption	Incident, whether anticipated (e.g. hurricane) or unanticipated (e.g. a blackout or earthquake) which disrupts the normal course of operations at an organization location.	[15]
Ecosystem-based Adaptation (EbA)	The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change.	[1]
Ecosystem Service Planning	A place based approach that focuses on the creation, restoration and conservation of ecological structures to provide society with specific services from nature.	[30]
Efficiency	The good use of time and energy in a way that does not waste any.	[31]
Effectiveness	The ability to be successful and produce the intended results	[31]
Emergency	Emergency is an unexpected event, which places life and / or property in danger and requires an immediate response through the use of routine community resources and procedures.	[26]

Emergency Management	Emergency management is the body of policy and administrative decisions and operational activities which pertain to the various stages of a disaster at all levels.	[26]
	The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.	[3]
Emergency Preparedness	The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.	[51]
Emergency Response	Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.	[51]
Emergency Service	The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.	[3]
Ensemble	A collection of model simulations characterizing a climate prediction or [climate] projection.	[10]
European Critical Infrastructure	Critical infrastructure located in Member States the disruption or destruction of which would have a significant impact on at least two Member States. The significance of the impact shall be assessed in terms of cross cutting criteria. This includes effects resulting from cross sector dependencies on other types of infrastructure.	[18]
Event	Occurrence or change of a particular set of circumstances. ▪ An event can be one or more occurrences, and can have several causes. ▪ An event can consist of something not happening. ▪ An event can sometimes be referred to as an “incident” or “accident”.	[2]
Evolutionary Adaptation	For a population or species, change in functional characteristics as a result of selection acting on heritable traits. The rate of evolutionary adaptation depends on factors such as the strength of selection, generation turnover time, and degree of outcrossing (as opposed to inbreeding).	[4]
Exposure	The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected	[4]
Extreme Weather Event	An extreme weather event is an event that is rare at a particular place and time of year.	[10]
Gender	Gender refers not to our biological sex as male or female, but to our socialisation as either woman or man. Our gender often impacts our behaviour and thus the ways we move around, interact and exist in the city. It is associated with the behavioural expectations established around what it means to be masculine or feminine	[56]
	Gender refers to the roles, behaviours, activities, attributes and opportunities that any society considers appropriate for girls and boys, and women and men	[57]
Gender awareness	Gender awareness is an understanding that there are socially determined differences between women & men based on learned behaviour, which affect their ability to access and control resources. This awareness needs to be applied through gender analysis into programmes, policies and evaluation	[58]

Gender binary (binarism)	Model referring to the norms derived from the simplistic idea of a dichotomy of two mutually exclusive and biologically defined sexes to whom different roles and behaviour are traditionally ascribed	
Gender-blindness	Gender blindness is the failure to recognise that the roles and responsibilities of men/boys and women/girls are given to them in specific social, cultural, economic and political contexts and backgrounds. Projects, programmes, policies and attitudes which are gender blind do not take into account these different roles and diverse needs, maintain the status quo and will not help transform the unequal structure of gender relations	[59]
Gender (or sexual) division of labour	The division of labour refers to the way each society divides work among men and women, boys and girls, according to socially-established gender roles or what is considered suitable and valuable for each sex. Within the division of labour, there are several types of roles: • Productive roles: Activities carried out by men and women in order to produce goods and services either for sale, exchange, or to meet the subsistence needs of the family. • Reproductive roles: Activities needed to ensure the reproduction of society's labour force. This includes housework like cleaning, cooking, childbearing, rearing, and caring for family members. These tasks are done mostly by women. • Community managing role: Activities undertaken primarily by women at the community level, as an extension of their reproductive role, to ensure the provision and maintenance of scarce resources of collective consumption such as water, health care and education. This is voluntary unpaid work performed during "free" time. • Community politics role: Activities undertaken primarily by men at the community level, often within the framework of national politics. This officially recognized leadership role may be paid directly or result in increased power or status. • Triple role: This refers to the fact that women tend to work longer and more fragmented days than men, as they are usually involved in three different roles: reproductive, productive and community work	[64]
Gender-equality	Gender equality refers to the goal when all human beings, men and women, are free to develop their personal abilities and make choices without the limitations set by stereotypes, rigid gender roles, discrimination and prejudices, when women and men fully enjoy their human rights. It means that the different behaviours, aspirations and needs of women and men are considered, valued and favoured equally	[59]
Gender-equity	The process of being fair to men and women, boys and girls. It refers to differential treatment that is fair and positively addresses a bias or disadvantage that is due to gender roles or norms or differences between the sexes… [taking] into account the different needs of the men and women, cultural barriers and (past) discrimination of the specific group	[59]
Gender mainstreaming	Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for explicitly making the concerns and experiences of women, as well as of men, an integral part of design, implementation, monitoring and evaluation in all political,	[56]

	economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated	
Gender responsive	Refers to policies and approaches that entail identifying needed interventions to address gender gaps in sector and government policies, plans and budgets; considering gender norms, roles and relations for women and men and how they affect access to and control over resources; and considering women's and men's specific needs, although these nuances are not always clear cut. Changes are planned or made that respond to the inequities in the lives of men or women within a given social setting and aim to remedy these inequities	[56]
Gender sensitive	Refers to policies and approaches that take into account gender perspectives and assess gender impacts and incorporate them into strategies; policies and approaches consider gender norms, roles and relations but does not address inequality generated by unequal norms, roles or relations. While it indicates gender awareness, no remedial action is developed	[56]
Green Infrastructure	Broadly defined as a strategically planned network of high quality natural and semi natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings. **Note:** Green infrastructure may incorporate both landscape and water features, the latter of which may be termed 'blue infrastructure'. Other terms include 'green blue infrastructure' and 'green and blue infrastructure'	[32]
Grey Infrastructure	Familiar urban infrastructure such as roads, sewer systems and storm drains is known as 'grey infrastructure'. Such conventional infrastructure often uses engineered solutions typically designed for a single function.	[33]
Hazard	The potential occurrence of a natural or human induced physical event or trend, or physical impact, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources.	[4]
Heritage asset	Single buildings, structures, artefacts as well as whole historic areas (i.e. groups of buildings and structures) the value of which, from the archaeological, architectural, prehistoric, historic, aesthetic or sociocultural point of view are recognized	[34]
Heritage by appropriation	The social, or ethnologic heritage that includes landscapes, townscapes, living places and non-exceptional building ensembles.	[67]
Heritage by designation	All cultural objects that are listed, institutionalised and labelled by experts.	[67]
Heritage Urban Landscape approach	The Historic Urban Landscape is a sustainable analytical approach for the assessment, conservation and management of urban areas, understood as a historic layering of cultural and natural values, extending beyond the notion of 'historic centre' or 'ensemble' to include the broader urban context and its geographical setting. This wider context includes the site's topography, geomorphology and natural features; its built environment, both historic and contemporary; its infrastructures above and below ground; its open spaces and gardens; its land use patterns and spatial organization; its visual relationships with its overall setting; and all other elements of the urban structure. It also includes the social and cultural practices and values, human activities as well as economic processes, the unique characteristics of any one place and the	[60]

	intangible dimensions of heritage as related to diversity and identity, all of which establish the basic role of the city as an agent for communal growth and development	
Heritage site	Works of human or the combined works of nature and human, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.	[68]
Heritage values	Can be defined as the relative social attribution of qualities to things, therefore is depending on society and can change over time. Certain values can be related more specifically to the intrinsic aspects of the monument or site (design, material, and workmanship), while other values can be associated with its location and its relationship to the setting.	[70]
Heritagisation	Refers to the transformation of objects, places and practices into cultural heritage as values are attached to them, essentially describing heritage as a process	[60]
Historical integrity	Term relates to the current form of a heritage asset as a result of growth and changes over time.	[70]
Historic area	Any groups of buildings, structures and open spaces including archaeological and palaeontological sites, constituting human settlements in an urban or rural environment, the cohesion and value of which, from the archaeological, architectural, prehistoric, historic, aesthetic or sociocultural point of view are recognized. Among these `areas', which are very varied in nature, it is possible to distinguish the following 'in particular : prehistoric sites, historic towns, old urban quarters, villages and hamlets as well as homogeneous monumental groups, it being understood that the latter should as a rule be carefully preserved unchanged.	[34]
Historic urban area	Large and small, include cities, towns and historic centres or quarters, together with their natural and human-made environments. Beyond their role as historical documents, these areas embody the values of traditional urban cultures.	[66]
Historic urban landscape	This wider context includes notably the site's topography, geomorphology, hydrology and natural features, its built environment, both historic and contemporary, its infrastructures above and below ground, its open spaces and gardens, its land use patterns and spatial organization, perceptions and visual relationships, as well as all other elements of the urban structure. It also includes social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity.	[60]
Immovable Cultural heritage	Monuments, such as architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science; groups of buildings, such as groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science; and sites, such as works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.	[6]
Impact	Effects on natural and human systems (…) the term impact is used primarily to refer to the effects on natural and human systems of	[1]

	extreme weather and events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate changes of hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Note: Impacts are also referred to as consequences and outcomes	
	The direct outcome of an event	[2]
Impact Chains	Permit the structuring of cause - effect relationships between drivers and/or inhibitors affecting the vulnerability of a system. Impact chains allow for a visualization of interrelations and feedbacks, help to identify the key impacts, on which level they occur and allow visualising which climate signals may lead to them. They further help to clarify and/or validate the objectives and the scope of the vulnerability assessment and are a useful tool to involve stakeholders.	[35]
Incident	Event that might be, or could lead to, an operational interruption, disruption, loss, emergency or crisis.	[15]
Incremental Adaptation	Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.	[4]
Industrial heritage	Industrial heritage consists of the remains of industrial culture which are of historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education.	[36]
Infrastructure	Infrastructure refers to all public and private facilities which are considered to be necessary for adequate public services and economic development. In most cases, the infrastructure is divided into technical infrastructure (e.g. transport and communications facilities, energy and water supply or wastewater disposal) and social infrastructure (e.g. schools, hospitals, shopping or cultural facilities). **Note:** The definition of social infrastructure can vary as described in the social infrastructure entry which is divided into physical social infrastructure and institutional social infrastructure.	[1]
Inoperability	The degree of function loss of an object	[9]
Intangible heritage	Intangible cultural heritage is the practices, expressions, knowledge and skills that communities, groups and sometimes individuals recognise as part of their cultural heritage. Also called living cultural heritage, it is usually expressed in one of the following forms: oral traditions; performing arts; social practices, rituals and festive events; knowledge and practices concerning nature and the universe; and traditional craftsmanship.	[37]
Integrity	This term generally refers to the material completeness and sound condition of an object or site.	[70]
Landscape approach	The landscape approach is a framework for making landscape-level conservation decisions. The landscape approach helps to reach decisions about the advisability of particular interventions (such as a new road or plantation), and to facilitate the planning, negotiation and implementation of activities across a whole landscape.	[60]

Likelihood	The chance of a specific outcome occurring, where this might be estimated probabilistically.	[4]
	Chance of something happening	[13]
Maladaptation	Actions that may lead to increased risk of adverse climate related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.	[4]
Mainstreaming	Deliberate perturbation in the natural order of the things and undermines the status quo to radically expand and enhance the topic under consideration.	[30]
Mitigation	Mitigation is the limitation of any negative consequence of a particular event (refers to ISO/IEC Guide 73).	[38]
	The lessening or minimizing of the adverse impacts of a hazardous event.	[51]
Monumental heritage	Any natural or artificial objects that are fixed permanently in land and referred to in a legal description of the land.	[6]
Movable Cultural heritage	Property which, on religious or secular grounds, is specifically designated by each State as being of importance for archaeology, prehistory, history, literature, art or science and which belongs to the following categories: rare collections and specimens of fauna, flora, minerals and anatomy, and objects of palaeontological interest; property relating to history, including the history of science and technology and military and social history, to the life of national leaders, thinkers, scientists and artist and to events of national importance; products of archaeological excavations (including regular and clandestine) or of archaeological discoveries; elements of artistic or historical monuments or archaeological sites which have been dismembered; antiquities more than one hundred years old, such as inscriptions, coins and engraved seals; objects of ethnological interest; property of artistic interest, such as: pictures, paintings and drawings produced entirely by hand on any support and in any material (excluding industrial designs and manufactured articles decorated by hand); original works of statuary art and sculpture in any material; original engravings, prints and lithographs; original artistic assemblages and montages in any material; rare manuscripts and incunabula, old books, documents and publications of special interest (historical, artistic, scientific, literary, etc.) singly or in collections; postage, revenue and similar stamps, singly or in collections; archives, including sound, photographic and cinematographic archives; and articles of furniture more than one hundred years old and old musical instruments.	[6]
Natural Hazard	Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.	[3]
Natural heritage	Natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; and natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.	[6]
Participatory Sensing	Concept of communities or other groups of people contributing sensor information to form a body of knowledge.	[54]

Passive Measure	It is a type of measure which does not use energy once it has been implemented. It is normally refers to adaptation measures for buildings indoor environments.	[39]
Pre-Disaster Recovery Planning	Any planned attempt to strengthen disaster recovery plans, initiatives, and outcomes – before a disaster occurs. […] PDRP consists of a series of decisions and actions to be taken both before and after a disaster, in order to • Identify and establish shared recovery goals, objectives, and strategies – to guide post disaster decision-making, ensure that relief and recovery activities align with long-term development goals, address actual needs, and enhance resilience to future disasters. • Develop and have ready the capacity to plan, initiate, and manage – an efficient, adaptive, and well-coordinated recovery effort that progresses towards the recovery goals.	[40]
Probabilistic Climate Projection	These are projections of future absolute climate that assign a probability level to different climate outcomes. This projection provides an absolute value for the future climate (as opposed to giving values that are relative to a baseline period) that assign a probability level to different climate outcomes.	[1]
Outcome Vulnerability	Vulnerability as the end point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, and concluding with biophysical impact studies and the identification of adaptive options. Any residual consequences that remain after adaptation has taken place define the levels of vulnerability.	[4]
Pre-disaster Recovery Planning	process of institutionalizing recovery capacity that is undertaken before any actual disaster is imminent or occurs to strengthen disaster recovery plans, initiatives, and outcomes. The concept is built on the recognition that much can be done before a disaster happens to facilitate recovery planning after a disaster and improve recovery outcomes.	[40]
Preparedness	The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.	[3]
Prevention	Prevention is the outright avoidance of adverse impacts of hazards and related disasters.	[3]
Quality gender data	Data is reliable, valid and representative, free of gender biases, with good coverage (including country coverage and regular country production), and is comparable across countries in terms of concepts, definitions and measures. Quality data should have the features of complexity (meaning that data from different domains in women's lives can be cross-referenced and cross-tabulated), and granularity (where the data can be disaggregated into smaller units by race and ethnicity, age and geographic location, as well as sex)	[61]
RAW data	Also referred to as source data or atomic data, is data that has not been processed. It is distinct from information to the effect that the latter one is the end product of data processing.	[55]
Reconstruction	The medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing, facilities and livelihoods required for the full functioning of a community or a society affected by a disaster, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk	[7]

Recovery	The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster affected communities, including efforts to reduce disaster risk factors.	[3]
	The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and “build back better”, to avoid or reduce future disaster risk.	[51]
Recovery Framework	Establishes a common platform for the whole community to build, sustain, and coordinate delivery of recovery capabilities. Describes principles, processes, and capabilities essential to more effectively manage and enable recovery following an incident of any size or scale. Defines how emergency managers, community development professionals, recovery practitioners, government agencies, private sector professionals, nongovernmental organization leaders, and the public, can collaborate and coordinate to more effectively utilize existing resources to promote resilience and support the recovery of those affected by an incident.	[41]
	A document that articulates a vision for recovery; defines a strategy; prioritizes actions; fine-tunes planning processes; and provides guidance on recovery financing, implementation, monitoring, and evaluation. An effective recovery framework is not a plan, but rather a strategy that complements the Post-Disaster Needs Assessment process by outlining long-term goals and communicating the shared principles according to which progress will be measured.	[42]
Rehabilitation	The restoration of basic services and facilities for the functioning of a community or a society affected by a disaster	[7]
Reliability	Property of consistent intended behaviour and results	[13]
Resilience	The capacity of a social ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation. Building resilience needs to account for: the degree to which the community comes into contact with a hazard capable of causing harm; the amount of inherent susceptibility to harm in that community; and the extent to which people in the community are able to make adjustments in order to avoid negative consequences, taking into account existing imbalances in power distribution in that community and ensuring that neither the impact of the hazard, nor the policies and actions themselves exacerbate existing or create new inequalities across different groups	[4], [72]
	The ability to function, survive, and thrive no matter what stresses happen and to skilfully prepare for, respond to, and manage a crisis. Finally, it should include the ability to return to normal operations as quickly as possible after a disruption.	[43]
	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	[3]
Retrofitting	Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.	[51]

Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard.	[4]
Risk Analysis	Risk analysis is the determination of the likelihood of an event (probability) and the consequences of its occurrence (impact) for the purpose of comparing possible risks and making risk management decisions.	[26]
Risk Assessment	Risk assessment is the combination of vulnerability analysis and risk analysis.	[26]
Risk Management	Risk management is the process whereby decisions are made and actions implemented to eliminate or reduce the effects of identified hazards.	[26]
Risk Reduction	Risk reduction is defined as long-term measures to reduce the scale and / or the duration of eventual society which is at risk; by reducing the vulnerability of its people, structures, services, and economic activities to the impact of known disaster hazards.	[26]
Safety	Safety is a situation without unacceptable risks.	[26]
Scenario	A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g. rate of technological change, prices) and relationships.	[10]
Sensitivity	The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct … or indirect.	[1]
Severity	Severity is the impact of the disruption or destruction of a particular infrastructure, with reference to (1) public effect (number of members of the population affected); (2) economic effect (significance of economic loss and/or degradation of products or services); (3) environmental effect; (4) political effects; (5) psychological effects; and (6) public health consequences.	[44]
Sex-disaggregated data	Data that is collected and tabulated separately for men and women. For example, primary school attendance rates for boys vs. girls	[61]
Significance	Articulation of heritage values	[65]
Social Infrastructure (Institutional)	The social infrastructure includes the humans, organizations and governments that make decisions and form our economy as well as our institutions and policies.	[45]
Social Infrastructure (Physical)	Schools, hospitals, shopping or cultural facilities	[1]
Socially just adaptation	A set of policies and actions responding to current climate variability and anticipating the future climate change and its impacts designed to ensure that neither the impact of climate change nor the policies and actions themselves exacerbate existing or create new inequalities across different groups in the urban society	[62]
Socioecological heritage	Historical and place-specific set of social–ecological interactions of human beings with one another and with their environment as well as the practices which yield diverse, autonomous and resilient social–ecological systems may be considered as our social–ecological heritage	[46]

	▪ A coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner; ▪ A system that is defined at several spatial, temporal, and organisational scales, which may be hierarchically linked; ▪ A set of critical resources (natural, socio-economic, and cultural) whose flow and use is regulated by a combination of ecological and social systems	[47]
Socio-natural Hazard	The phenomenon of increased occurrence of certain geophysical and hydrometeorological hazard events, such as landslides, flooding land subsidence and drought that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources.	[3]
Stakeholder	Person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity. **Note:** A decision maker can be a stakeholder.	[1]
Traffic Light Protocol (TLP)	A widely accepted information classification scheme used to exchange, share, and handle information by public and private parties.	[48]
Tangible heritage	Tangible heritage includes buildings and historic places, monuments, artefacts, etc., which are considered worthy of preservation for the future. These include objects significant to the archaeology, architecture, science or technology of a specific culture.	[22]
Transformative Adaptation	Adaptation that changes the fundamental attributes of a system in response to climate and its effects.	[4]
Uncertainty	A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable	[4]
Underwater Cultural heritage	All traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years, such as: sites, structures, buildings, artifacts and human remains, together with their archaeological and natural context; vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context; and objects of prehistoric character.	[6]
Urban (Urban Area)	Urban 'is a function of (1) sheer population size, (2) space (land area), (3) the ratio of population to space (density or concentration), and (4) economic and social organization.'	[49]
	The OECD EU classification identifies functional urban areas beyond city boundaries, to reflect the economic geography of where people live and work... Defining urban areas as functional economic units can better guide the way national and city governments plan infrastructure, transportation, housing and schools, space for culture and recreation.	[50]
Urban conservation	Urban conservation is not limited to the preservation of single buildings. It views architecture as but one element of the overall urban setting, making it a complex and multifaceted discipline. By definition, then, urban conservation lies at the very heart of urban planning.	[60]
Urban Critical Infrastructure	An asset, system or part thereof located in an urban area which is essential for the maintenance of vital societal functions, health, safety, security, economic or social wellbeing of people, and the disruption or destruction of which would have a significant impact in an urban area as a result of the failure to maintain those functions	[1]

Urban Critical Infrastructure System	Urban critical infrastructure from a systemic viewpoint. It is part of the urban system and simultaneously part of the national critical infrastructure system.	[9]
Urban heritage	three main categories: • Monumental heritage of exceptional cultural value; • Non-exceptional heritage elements but present in a coherent way with a relative abundance; • New urban elements to be considered (for instance): The urban built form; The open space (streets, public open spaces), Urban infrastructures (material networks and mechanism).	[67]
Urban System	System of urban areas (Urban settlements from a systemic viewpoint)	[9]
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. **Note:** Please see contextual vulnerability and outcome vulnerability	[4]
	Intrinsic properties of something resulting in susceptibility to a risk source that can lead to an event with a consequence	[2]
	Weakness of an asset or control that can be exploited by one or more threats	[13]
	The structural conditions, including physical, social, cultural, economic and political systems that render people and communities susceptible to the impacts of hazards, and which make it possible for a hazard to become a disaster	[63]
Vulnerability Index	A metric characterizing the vulnerability of a system. A climate vulnerability index is typically derived by combining, with or without weighting, several indicators assumed to represent vulnerability	[4]
Warning System	An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events.	[51]
Wicked Problem	A problem that is categorized by a great number of uncertainties. These include: on the stakeholders involved, the boundaries of the problem, long term organisational developments and responsibilities, amongst others.	[1]
World heritage	The cultural and natural heritage as defined in Articles 1 and 2 of the World Heritage Convention for whose protection it is the duty of the international community as a whole to co-operate,	[6]

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