ARCH D7.3

ARCH Disaster Risk Management Framework

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Executive Summary

This deliverable has been prepared for the European Commission-funded research project *ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards*. It is the key output of task 7.3 *"ARCH disaster risk management framework"* within work package 7 *"Framework & Integration"*. The aim of task 7.3 is twofold: (1) to develop a combined disaster risk management (DRM) / climate change adaptation (CCA) process specifically aimed at historic areas that helps heritage managers, public administrators, and other actors in the field of DRM and CCA to understand which steps are necessary to develop a combined DRM / CCA plan that helps to improve the resilience of historic areas; and (2) to provide a conceptual structure for the solutions developed by the different work packages of the project and indicate where these can support end-users in the combined DRM / CCA process. To achieve this, a review of existing DRM and CCA frameworks was conducted to identify best practices and gaps, with special focus on heritage management. In parallel, a co-creation process with project partners was established to receive early feedback and ensure practicality for end-users as well as compatibility with other project solutions. This report describes the result from these processes.

The ARCH DRM Framework takes the DRM cycle proposed by Jigyasu, King, and Wijesuriya in the UNESCO manual on managing disaster risk for world heritage [1] as basis and extends it with the climate change adaptation planning cycle of climate-ADAPT's Urban Adaptation Support Tool [2]. This combined planning cycle is then further extended with considerations from topic specific frameworks, like the Culture in city Reconstruction and recovery framework [3], the SMR European Resilience Management Guideline [4], and the RESIN Conceptual Framework [5]. The result is a DRM / CCA process consisting of ten cyclical steps spread across the three phases 'pre-disaster' (or 'normal operating' phase), 'during', and 'post-disaster'. If no disaster occurs, the steps of the normal operating phase are regularly repeated. In case of a disaster, this cyclic process is disrupted, and the emergency operating phase (i.e. the during and post-disaster phases) is initiated. These steps cover all necessary emergency response and post-disaster recovery actions and are dependent on the preparatory plans and actions resulting from the pre-disaster phase. Within the post-disaster phase an additional (potential) revision of the results from the pre-disaster phase is included to account for the need to adjust information and actions identified under normal conditions with the post-disaster situation. In addition, this revisiting of the original actions planned before the incident, makes it explicit that the post-disaster reconstruction phase can and should be used as an opportunity to reassess (climate change adaptation) measures in order to support Building Back Better [6].

As a result, the ARCH DRM Framework can be seen as a DRM cycle that includes two conditionally interlinked CCA cycles, one conducted and regularly repeated as part of the normal operating phase and one used to inform reconstruction and Building Back Better after the occurrence of an incident.

Lastly, this report describes how the different solutions developed by the project are linked to the different steps of the ARCH DRM Framework to provide the conceptual links between these solutions. The link with one of these solutions, the ARCH resilience assessment method that is aimed to support evaluation and monitoring of the implementation of the ARCH DRM Framework, is examined in more detail.

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List of Abbreviations

Abbreviation	Meaning
AR5	5th Assessment Report of the Intergovernmental Panel on Climate Change
BRIC	Baseline Resilience Indicators for Communities
CCA	Climate Change Adaptation
CEN	European Committee for Standardization
CH	Cultural Heritage
CI-RAT	Critical Infrastructure Resilience Assessment Tool
CRI	City Resilience Index
CURE	Culture in city Reconstruction and recovery framework
CWA	CEN Workshop Agreement
DoA	Description of Action
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support System
EEA	European Environment Agency
ERMG	SMR European Resilience Management Guideline
HArIS	Historic Area Information Management System
HM	Heritage Management
HSPN	Hybrid Social-Physical Networks
HYPERION	Development of a Decision Support System for Improved Resilience & Sustainable Reconstruction of historic areas to cope with Climate Change & Extreme Events based on Novel Sensors and Modelling Tools
IPCC	Intergovernmental Panel on Climate Change
IRP	International Recovery Platform
ISDR	International Strategy for Disaster Reduction
IUCN	International Union for Conservation of Nature
PARET	Post Assessment Resilience Enhancement Tool
RAD	Resilience Assessment Dashboard
ReMMAT	Resilience Management Matrix & Audit Toolkit
RMI	Resilience Measure Inventory

RMM	Resilience Maturity Model
RPVT	Resilience Pathway Visualisation Tool
SES	Social-Ecological System
SHELTER	Sustainable Historic Environments hoListic reconstruction through Technological Enhancement and community based Resilience
SJ	Social Justice
SMR	Smart Mature Resilience project
SotA	State-of-the-Art
THIS	Threats and Hazard Information Management System
(U)AST	(Urban) Adaptation Support Tool
UNDP	United Nations Development Programme
UNDRR	United Nations office for Disaster Risk Reduction
UNESCO	United Nations Educational, Scientific and Cultural Organization
WP	Work Package

1. Introduction

This deliverable has been prepared for the European Commission-funded research project *ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards.* ARCH will develop decision support tools and methods to improve the resilience of historic areas to climate change-related and other hazards. These tools and methods are developed together with the cities of Bratislava (Slovakia), Camerino (Italy), Hamburg (Germany), and València (Spain), in a co-creative approach, including local policy makers, practitioners, and community members. The resulting solutions will be combined into a collaborative disaster risk management platform for guided resilience management, and will include

- an information management system for relevant geo-referenced properties of historic areas;
- an information management system for geo-referenced data regarding hazards and risks relevant for historic areas;
- a Decision Support System (DSS) for risk and impact analysis of historic areas;
- an inventory of resilience building measures and appropriate financing sources;
- a visual planning tool for resilience pathways; and
- a resilience assessment method to identify resilience weak points and formulate resilience action plans.

1.1. Purpose of this report and relation to other ARCH deliverables

This report (D7.3) is the key output of task 7.3 *"ARCH disaster risk management framework"* within work package 7 (WP7) *"Framework & Integration"*. The objectives of WP7 are to develop a unified disaster risk management (DRM) framework for historic areas that combines DRM and climate change adaptation (CCA) to enable resilience management, develop an assessment approach to measure resilience (i.e. how well the combined DRM / CCA process is implemented), operationalise the DRM framework and resilience assessment approach in a data and information platform, and integrate into this platform the datasets, tools, and methodologies from WPs 4, 5, and 6 in order to support the resilience management and assessment process.

The aim of task 7.3 is twofold: (1) to develop a combined DRM / CCA process specifically aimed at historic areas that helps heritage managers, public administrators, and other actors in the field of DRM and CCA to understand which steps are necessary to develop a combined DRM / CCA plan that helps to improve the resilience of historic areas; and (2) to provide a conceptual structure for the solutions developed by the different work packages of the project and indicate where these can support end-users in the combined DRM / CCA process. To achieve these aims, the ARCH DRM Framework needs to bridge the gaps between disaster risk management, climate change adaptation, heritage management (HM), and social justice (SJ). Therefore, WP7 analysed different frameworks for DRM and CCA, but also resilience assessment and management. Based on the findings from this analysis an adapted DRM / CCA framework was developed and is described in this report. In addition, the ARCH DRM Framework is linked to the solutions provided by different work packages.

Subsequently, this document is aimed at three audiences:

1. Practitioners, decision-makers, and policy-makers from the fields of DRM, HM, and CCA that have an interest in knowing how the processes of disaster risk management and climate change adaptation for historic areas can be linked.
2. Researchers external to the ARCH project that conduct work at the cross-section of DRR, CCA, HM, and SJ.
3. ARCH project partners that develop, adapt, and employ methods / tools that support the resilience management process, specifically, those partners responsible for the following deliverables:

   D3.6 Evaluation report of the ARCH management platform

   D4.2 Historic Area Information Management System (HArIS)

   D4.3 Threats and Hazard Information Management 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

   D5.3 CIPCast DSS modification and integration

   D6.1 Inventory of resilience options

   D6.4 Resilience pathway visualisation tool

   D7.6 System design, realisation, and integration

   For these partners this document provides a frame of reference on how the different ARCH solutions fit together to support resilience management.

It is important to note that this deliverable is not intended to be a guideline on how to implement a combined DRM / CCA plan, but to describe the conceptual underpinnings of such a combined plan. Guidance for the implementation of the ARCH DRM Framework will be included in the disaster risk management platform (ARCH Hub) and the ARCH Resilience Assessment Dashboard (ARCH RAD) to be reported in D7.6.

1.2. Gender statement

The ARCH Disaster Risk Management framework has been developed taking into consideration the guidance on gender in research provided in the Project Handbook (D1.2) as well as State-of-the-Art (SotA) report number 5 of deliverable D7.1 on "*Gender aspects in conservation and regulation of historic areas, disaster risk management, emergency protocols, post-disaster response techniques, and techniques for building back better".*

Following these guidelines, the ARCH Disaster Risk Management framework has been designed with social justice as one of the main pillars besides heritage management, disaster risk management and climate change adaptation. Specifically,

- the resilience definition adopted by ARCH explicitly includes social justice as a key requirement for responding and adapting to disasters; and

- the combined DRM / CCA process has been designed to incorporate social justice in every step, whenever possible.

1.3. Structure of this report

The report is divided into six sections. Following this introduction, section 2 defines what ARCH understands under ‘historic areas’ and ‘resilience’ as well as locating these concepts in the larger contextual background of the project to establish the basis for the ARCH DRM Framework. Section 3 follows with a description of selected DRM and CCA frameworks, including a focus on historic areas and social justice. Section 4 describes the ARCH DRM Framework and how the different ARCH solutions are linked to it, before section 5 gives a more detailed introduction on how the ARCH DRM Framework will be linked to an assessment method that aims to help practitioners to evaluate how well they have implemented the ARCH DRM Framework. Finally, section 6 provides a short conclusion and an outlook on the next steps for WP7.

2. Historic areas and resilience in the context of ARCH

2.1. Historic areas as Social-Ecological Systems

The goal of ARCH is to support practitioners (e.g. heritage managers and municipal administrators) in improving the resilience of the historic areas they are responsible for, with a specific focus on climate change and natural hazards. In ARCH, these **historic areas** are understood as

> *"[a]ny 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."*[1] [7] (highlight added by the authors)

However, to identify sources of risks and suitable resilience building measures that go beyond the implementation of broad policies and procedures it is important to acknowledge that historic areas are (partially) made up of single **heritage assets**, i.e.

> *"[a]* ***building, monument, site, place, area or landscape*** *identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. Heritage asset includes designated heritage assets and assets identified by the local planning authority (including local listing)."* [8] (highlight added by the authors)

Likewise, it is important to understand that historic areas are not just the tangible buildings, structures, and landscapes they contain, but are linked to the broader concept of **cultural heritage**, to be understood as

> *"[…] an expression of the ways of living* ***developed by a community*** *and passed on from generation to generation,* ***including customs, practices, places, objects, artistic expression and values****."* [9] (highlights added by the authors)

As such, ARCH understands historic areas as **Social-Ecological Systems (SES)**, i.e.

> "[c]*omplex systems of people and nature, emphasising that humans must be seen as a part of, not apart from, nature."* [10]

[1] "The 'environment' shall be taken to mean the natural or man-made setting which influences the static or dynamic way these areas are perceived or which is directly linked to them in space or by social, economic or cultural ties.", see [1].

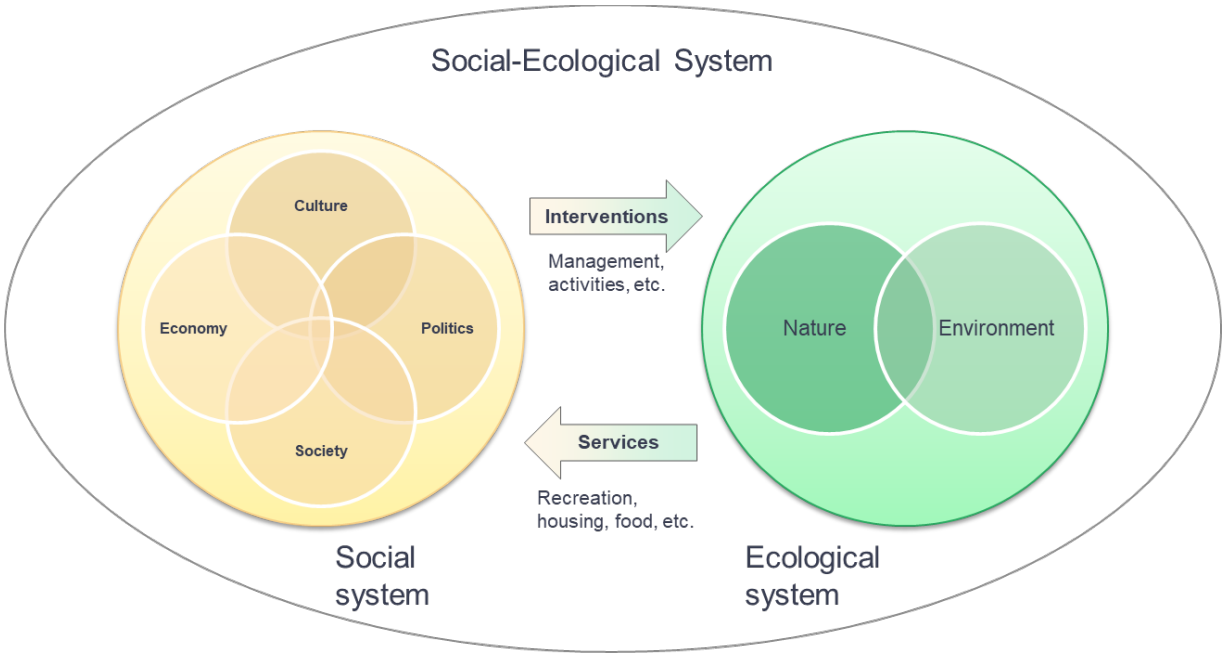

Figure 1: Elements of a Social-Ecological System, adapted from [11] and [12]

More specifically, ARCH understands historic areas as being composed of an **ecological sub-system** containing structural elements (nature and (built) environment) and a **social sub-system** containing social, cultural, economic, and political elements. These sub-systems are related to each other, with the ecological sub-system providing services for the social system, which in turn conducts interventions on the ecological system (see Figure 1).

Going further, historic areas do not exist on their own, but are embedded in the larger urban area, i.e. historic areas are not just social-ecological systems themselves but are also part of larger social-ecological systems (be this a city, a region, or a larger territorial entity). This links ARCH's understanding of historic areas to the Historic Urban Landscape approach of UNESCO (see [13]), where a **Historic Urban Landscape** is understood to be

> *"[…] 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."* (highlights added by the authors)

2.2. Resilience of historic areas

The term 'resilience' can mean many different things to many different actors depending on the context in which it is applied (see e.g. [14] and [15]). Broadly speaking, three different understandings of 'resilience' can be distinguished: engineering (or 'narrow') resilience,

ecological / ecosystem and social resilience, and social-ecological resilience (see e.g. [16], [17], [18]). **Engineering resilience** usually aims at stability and control, i.e. to withstand shocks and to return to a stable pre-disaster state as fast as possible ('bouncing back', see e.g. [19]). Subsequently, the concept of engineering resilience is static and does not take the need for flexibility and adaptation into account.

Ecological / ecosystem and social resilience (also known as 'multi-equilibria-resilience', see [17]) is similar to engineering resilience, but acknowledges that a disturbed system might not always return to the same stable pre-disaster state. Unlike engineering resilience multi-equilibria resilience aims at adapting the system to better cope with the disaster ('bouncing forward').

Social-ecological resilience in contrast takes a dynamic perspective where social and ecological systems are seen as linked and co-evolving ('evolutionary resilience', see [17]). This notion of resilience treats it as a process and acknowledges the need to account for uncertainty and include flexibility, learning and the advancement of capacities and abilities of a system to withstand future shocks. This is also the view taken by the Intergovernmental Panel on Climate Change (IPCC) in their 5th Assessment Report (AR5) [20], where resilience is defined as

> *"[t]he 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."*

However, as discussed in ARCH SotA report no. 5 (see [21]), the system focus of this definition fails to explicitly link resilience and justice, obscuring that impacts are experienced by people. ARCH SotA report no. 5 goes on to argue – based on definitions from the Climate Just glossary [22] – that **socially just resilience needs to acknowledge that communities can be heterogenous, exhibiting diverse needs, capacities, and levels of power.**

In addition, a 'resilience' definition for historic areas needs to acknowledge the specific characteristics of these areas and recognise the need to **balance socially just response and adaptation with a need to maintain the historic area's identity, integrity, and authenticity.**

ARCH therefore adopts the following definition of resilience of historic areas:

> ***"The sustained ability of a historic area as a social-ecological system (including its social, cultural, political, economic, natural and environmental dimensions) to cope with hazardous events by responding and adapting in socially just ways that maintain the historic area's functions and heritage significance (including identity, integrity and, authenticity)."***

This definition is intentionally kept short to be operational. Nonetheless it covers all relevant aspects that were discussed before. Specifically

- it acknowledges that **historic areas are social-ecological systems** containing more than the (built) environment;
- it acknowledges that **resilience needs to be sustained**, i.e. resilience is a continuous process that needs to be maintained;

- it acknowledges the **dynamic character of resilience**, taking hazardous events as potential to adapt, learn, and transform;
- it acknowledges that any **response and adaptation needs to be socially just**, i.e. it 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."* [21]; and
- it acknowledges that any response and adaptation to maintain a historic areas function needs also to be **balanced with the historic area's heritage significance**, thus bridging the gap between resilience and heritage management.

While social justice and heritage significance are overarching topics in the definition above, the SES perspective to historic areas allows to specifically distinguish between three main and six sub-dimensions of resilience, that partially correspond to the categorisation of adaptation options established by the IPCC in AR5 (see [23], p. 845):

- **Structural resilience**, which corresponds to the resilience of the ecological system and consists of
  - *resilience of (built) environment* and services;
  - *resilience of natural ecosystems*.
- **Community resilience**, which covers the socio-cultural part of the social system and consists of
  - *resilience of social systems*, meaning people and communities;
  - *resilience of cultural systems*, meaning resilience of cultural identify, local knowledge and intangible heritage.
- **Institutional resilience**, which covers the political and economic part of the social system and consists of
  - *resilience of government institutions*, policies, and processes;
  - *resilience of economic institutions* and processes.

These dimensions are strongly interconnected, following the SES perspective. For example, governance processes will always affect the people living and working in a historic area, thus the resilience of governance processes is interlinked with the resilience of social and cultural systems. Similarly, resilient natural ecosystems will support the resilience of the whole social system of a SES.

2.2.1. Disaster Risk Reduction, Climate Change Adaptation, Resilience, and Sustainability

Until now, this report has not explicitly mentioned the relationship between disaster risk reduction (DRR), climate change adaptation, resilience, and sustainability. However, these concepts have a strong interconnection (see e.g. [14] and [15]). Morchain and Robrecht in [24] describe this relationship very succinctly (see also Figure 2):

> *"[…] addressing disaster risk reduces vulnerability, as do sustainable measures to deliver climate change adaptation (and mitigation, at least in the long term). These two*

fields – disaster risk management and climate change adaptation – are becoming closer in their approaches and objectives, as disaster risk management moves from reaction to also including prevention as a major objective. These efforts enhance a community's or a city's resilience […], and they contribute to sustainability and to the long-term prevalence of communities, cities, humans and biodiversity only if they are shaped with sustainability criteria […]."

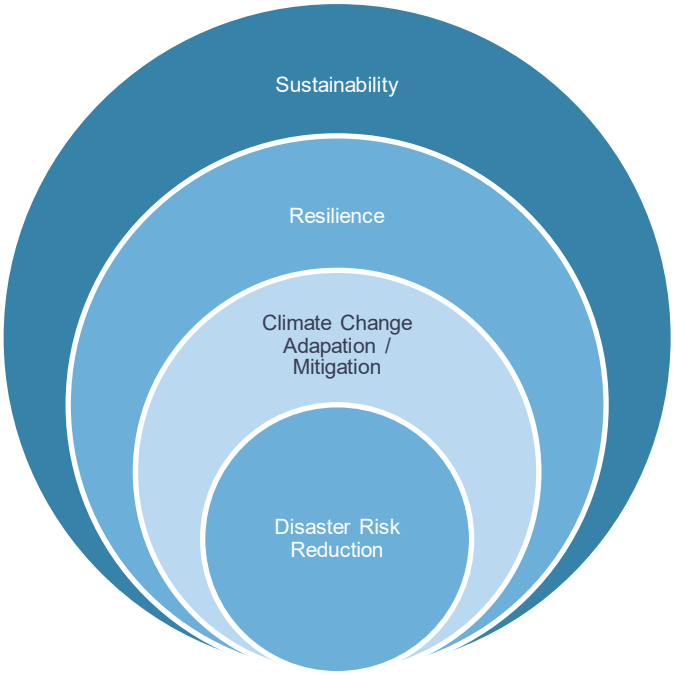

Figure 2: Relation of Disaster Risk Reduction, Climate Change Adaptation, Resilience, and Sustainability, after [18]

Therefore, to make a historic area resilient, both climate change adaptation as well as disaster risk reduction need to be considered jointly. Sudmeier-Rieux et al. in [25] illustrate the differences and commonalities between climate change adaptation and disaster risk reduction (see Figure 3).

Resilient historic areas therefore require practitioners and decision-makers to address both the long-term, slow on-set future risks posed by climate change as well as the short-term sudden on-set existing risks posed by other disasters. And in both cases, these must be addressed by reducing vulnerabilities and pursuing sustainable development[2] as well as poverty reduction using ecosystem-based, engineered, social, and institutional solutions. However, what is missing from this picture is that *"[c]ultural factors shape the [e]nabling conditions for adaptation and mitigation, including whether and how people respond to appeals for action."* [26] In the context of ARCH this is understood to not just covering culture and arts but also sites of cultural heritage significance for the local community that play an important role in fostering place-

[2] While 'sustainability' is the long-term goal, 'sustainable development' refers to the processes and pathways to achieve sustainability (cf. [35])

based identify and social cohesion. Therefore, any DRM framework for historic areas needs to also include these factors, as will be discussed in the following section.

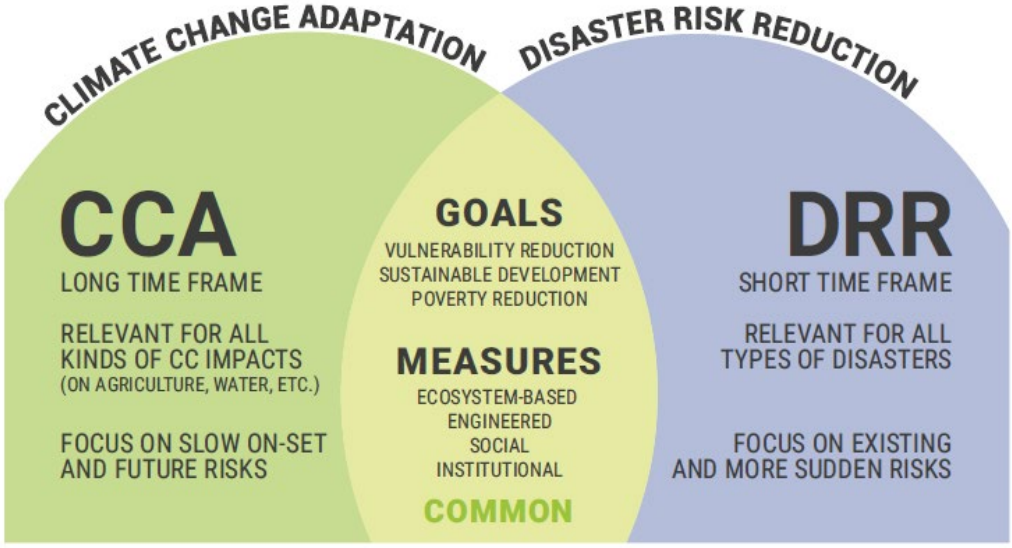

Figure 3: Commonalities and differences between Climate Change Adaptation and Disaster Risk Reduction. Source: [25]. Credit: W. Lange and S. Sandholz. Design: S. Plog

3. Existing frameworks for DRM and CCA

A variety of guidelines and frameworks for CCA and DRM are available in literature, mostly with particular focus on cities or urban areas. The following sections briefly describe those guidelines and frameworks most relevant for the ARCH DRM Framework. For each guideline and framework, the most important characteristics and 'lessons learned' for inclusion in the ARCH DRM Framework are described.

3.1. Climate change adaptation and resilience building frameworks

In 2013 the EU guidelines on developing adaptation strategies (see [27]) were issued. Based on these, the European Climate Adaptation Platform Climate-ADAPT[3] developed the **Adaptation Support Tool (AST)** and the **Urban Adaptation Support Tool (UAST)**. While the AST is *"a practical guidance tool for national level actors for all steps needed to develop, implement, monitor and evaluate a national adaptation strategy"* [28], the UAST is *"a practical guidance for urban areas, in recognition of their importance in the European economy"* [2]. Figure 4 shows the six-step climate change adaptation process of the UAST, which – like the AST – is based on the adaptation policy cycle and the iterative concept of the UKCIP Adaptation Wizard [29].

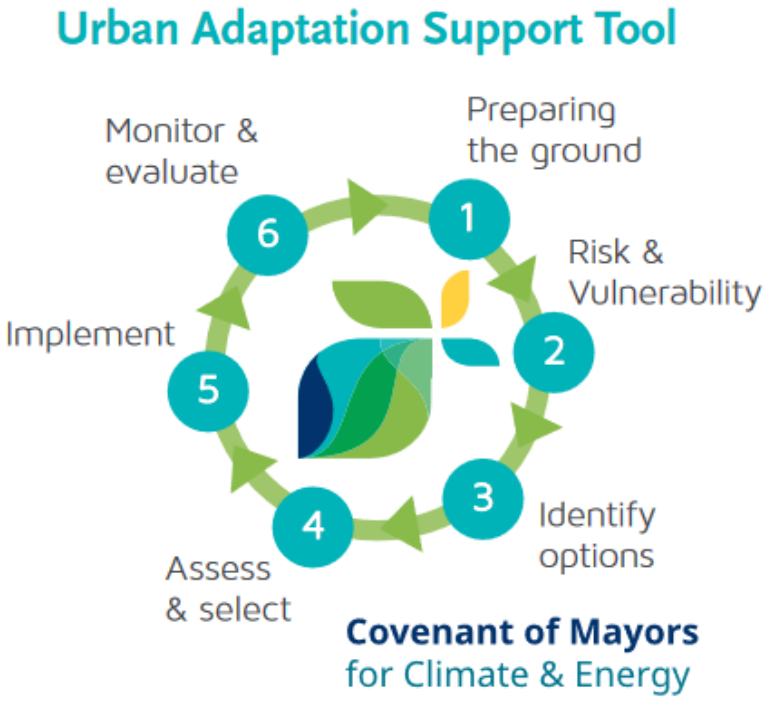

Figure 4 Urban Adaptation Support Tool, taken from [2]

[3] https://climate-adapt.eea.europa.eu/

The core idea of the (U)AST is that CCA is not a sequential, linear process and different end-users can be in different stages of the process. Therefore, the (U)AST models the CCA process as a cyclical process of sequential steps and provides guidance in an iterative process to ensure that decisions are based on up-to-date data and knowledge.

The UAST has become the de facto standard for CCA and is often basis for CCA and resilience frameworks. For example, in the **Transition Handbook of EU FP7 RAMSES**[4] (see [30]) the UAST is the basis to embed the key project results into a process management cycle. Specifically, RAMSES linked its own Urban Adaptation Support Tool with the six steps of the UAST as shown in Figure 5.

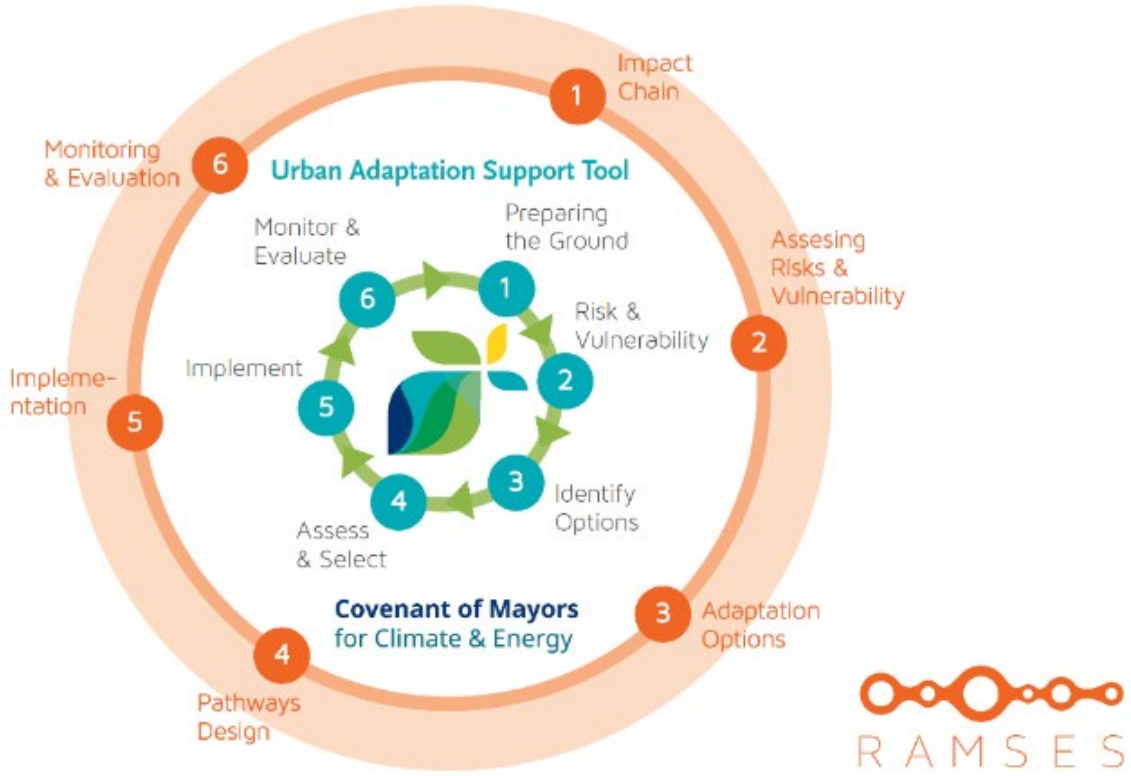

Figure 5: RAMSES Urban Support Tool vs Urban Adaptation Support Tool. Source: [30]

In addition to the UAST, RAMSES based its Urban Adaptation Support Tool on the Integrated Management System developed in the CHAMP project[5]. CHAMP's Integrated Management System consists of five steps repeated in annual cycles: (1) baseline review; (2) target setting; (3) political commitment; (4) implementation and monitoring; and (5) evaluation and reporting.

Take-aways for the ARCH DRM Framework: Both the (U)AST as well as the RAMSES Urban Adaptation Support Tool follow a cyclical planning process that should be repeated in regular intervals. The processes start with a preparation phase and flow naturally via a risk analysis, the identification, selection, and implementation of adaptation options, into a monitoring and

[4] https://www.ramses-cities.eu/home/
[5] https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3245

evaluation phase. Each phase of these processes is – whenever possible – linked with specific methods and tools that can support end-users in conducting the specific phase.

Similarly to RAMSES, the EU H2020 project Smart Mature Resilience[6] (SMR) developed the **SMR European Resilience Management Guideline** (ERMG, see [4]) to support city decision-makers in developing and implementing resilience measures. SMR's ERMG follows a similar process as the UAST, but divides this process in the following five-step process: (1) baseline review; (2) risk awareness; (3) resilience strategy; (4) implementation and monitoring; and (5) evaluation and reporting. As the RAMSES Urban Adaptation Support Tool and the UAST, this process should be regularly repeated and for each step specific supporting tools are offered to end-users.

Furthermore, SMR linked its iterative process to a maturity model to assess how far a city has matured its resilience after each iteration of the cycle. This **Resilience Maturity Model** (RMM, see [31]) distinguishes between five maturity stages and several relevant (sub-)dimensions in each stage such as governance, preparedness, infrastructure resources and cooperation. For each stage the RMM defines policies that should be enacted to mature to the next stage. As part of the SMR project three CEN Workshop Agreements (CWA) were developed: CWA 17300 City Resilience Development – Operational Guidance; CWA 17301 City Resilience Development – Maturity Model; and CWA 17302 City Resilience Development – Information Portal. In addition, SMR developed several supporting tools, including an online version of the RMM[7] that provides detailed information, case study descriptions, and suitable tools for each policy.

Take-aways for the ARCH DRM Framework: As the CCA planning cycle, the ERMG for resilience building follows a cyclical process that should be repeated in regular intervals. In addition, resilience is assessed along different dimensions and can be matured by enacting different policies linked to the different resilience dimensions and maturity stages. Lastly, the resilience building process needs to take account of the individual situation in a city and depends on already existing structures and processes.

The EU H2020 RESIN project extended the adaptation planning cycle to explicitly consider the urban system to reflect the processes by which climate risks are generated and responded to. The resulting **RESIN Conceptual Framework** is shown in Figure 6. Its right-hand loop depicts the adaptation planning system and covers parts of steps 2, 3, and 4 of the UAST. This part of the framework *"is focused around an adaptation planning system that encompasses stakeholder networks and governance frameworks."* [5] Its left-hand loop covers the urban system and covers parts of steps 5 and 6 of the UAST and *"reflects the process by which climate risks are generated and then respond[ed]s to with the aim of building the resilience of the system to future hazards and drivers"* [5]. Subsequently, the RESIN Conceptual Framework emphasizes the on-going and evolving transformation processes of adapting and becoming resilient and that adaptation and resilience are complementary processes that influence each other. As RAMSES and SMR, RESIN provides specific tools for each step of

[6] https://smr-project.eu/home/
[7] https://smr-project.eu/tools/maturity-model-guide/resilience-maturity-model/

the adaptation planning process. In addition, RESIN supports the whole adaptation planning process using a web-based Decision Support Tool, the RESIN e-guide[8].

Take-aways for the ARCH DRM Framework: Adaptation processes and processes for improving resilience are not static and cannot be broken down in a linear process with strictly separated steps. They are evolving transformation processes that might be modelled and captured in circular processes that include overlapping and interconnected procedures and steps.

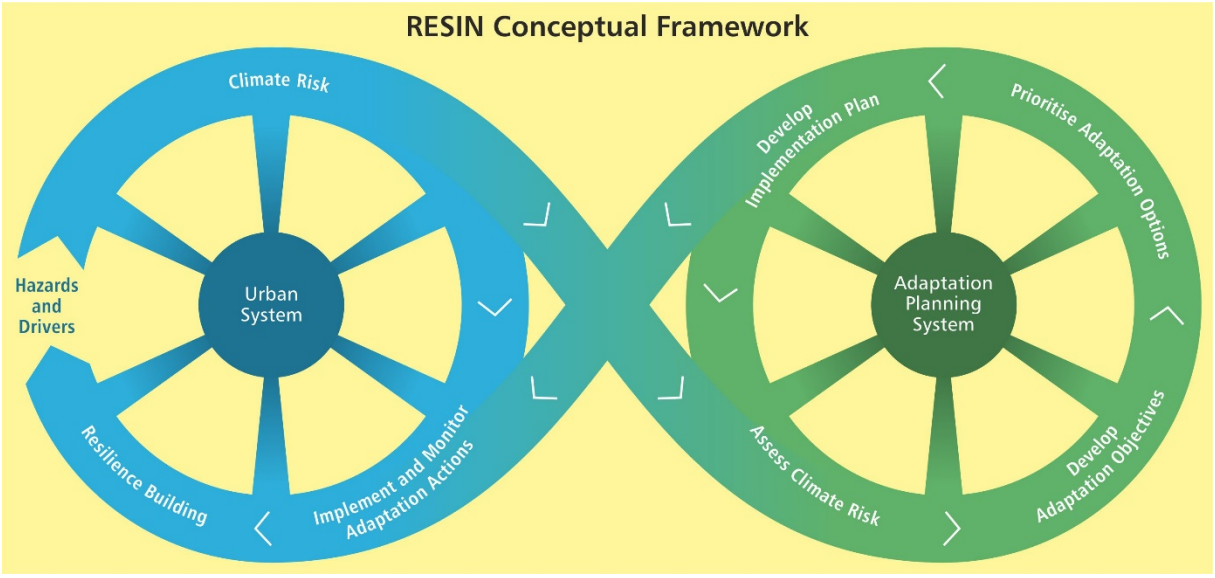

Figure 6 The RESIN Conceptual Framework. Source: [5]

3.2. Disaster risk management frameworks and guidelines

Since the 1970s the disaster risk management cycle has been the fundamental framework for managing disasters and their effects (see [32] for a discussion of the evolution and origin of the DRM cycle). Conceptual variations of the cycle differ mainly in the number of phases included. While some conceptualisations only differentiate between a pre-disaster and a post-disaster phase (see e.g. [33]), others further divide these two phases into prevention / mitigation and preparedness (covering the pre-disaster phase), as well as response and rehabilitation / reconstruction (covering the post-disaster phase) (see e.g. [34]). Other conceptualisations again differentiate between a pre-disaster phase, a during disaster phase, and a post-disaster phase, also indicating potential further subdivisions of the pre- and post-disaster phases (see e.g. [1]). ARCH adopts the conceptual view employed by Jigyasu, King, and Wijesuriya in the UNESCO handbook for managing disaster risk for world heritage (see [1]), where the DRM cycle is divided into the three overarching phases 'before disaster' (or pre-disaster), 'during disaster', and 'after disaster' (or post-disaster), which are further divided as shown in Figure 7.[9]

[8] http://e-guide.resin.itti.com.pl/

[9] The UNESCO handbook is discussed in more detailed in the next section, while the specific adaptation of the DRM cycle developed in ARCH is presented in section 4.

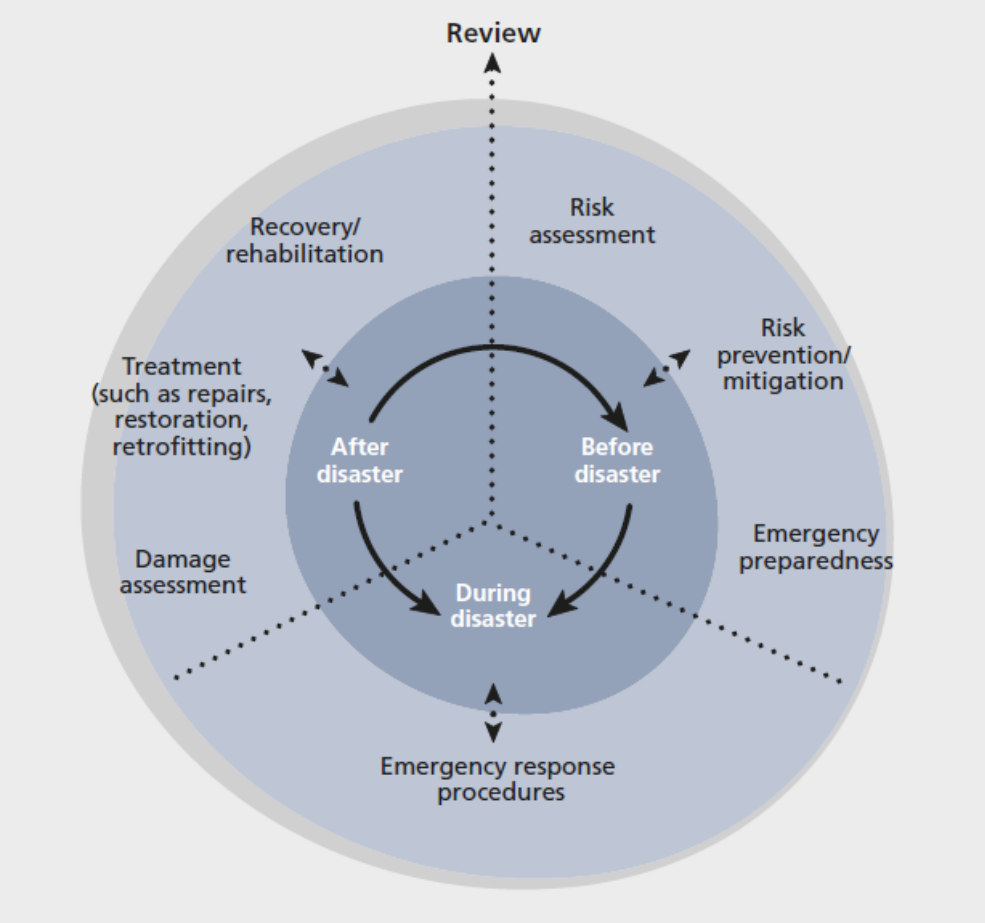

Figure 7: The Disaster Risk Management cycle as employed in [1]

To provide greater clarity about the components of disaster risk management and provide indicators to measure the progress towards resilience, the **Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities** (see [35]) was developed. It was adopted by 168 countries in 2005 and endorsed by the UN General Assembly. The successor to the Hyogo Framework is the **Sendai Framework for Disaster Risk Reduction (2015-2030)** (see [36]), which was adopted by the UN member states and endorsed by the UN General Assembly in 2015. As the internationally accepted framework for DRR, the Sendai Framework provides the frame for all DRM frameworks and guidelines. Specifically, the Sendai Framework sets out four priorities for action that should be addressed:

> Priority 1: Understanding Disaster Risk, which stresses, among others, the need "[t]o systematically evaluate, record, share and publicly account for disaster losses and understand the economic, social, health, education, environmental and **cultural heritage impacts** […]" [36] (highlights added by the authors) and the need *"[t]o ensure the use of traditional, indigenous and local knowledge and practices […] which should be tailored to localities and to the context […]"* [36].
>
> Priority 2: Strengthening disaster risk governance to manage disaster risk, which stresses, among others, that *"[c]lear vision, plans, competence, guidance and coordination within and across sectors, as well as participation of relevant stakeholders, are needed"* [36].

Priority 3: Investing in disaster risk reduction for resilience, which makes clear that *"[p]ublic 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".* It specifically stresses that it is necessary *"[t]o strengthen the design and implementation of inclusive policies […]"* [36] *and "[…] to* ***find durable solutions in the post-disaster phase and to empower and assist people disproportionately affected by disasters*** *[…]"* [36] (highlights added by the authors).

Priority 4: Enhancing disaster preparedness for effective response and to "Built Back Better" in recovery, rehabilitation and reconstruction, which includes as one central pillar that "[…] the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to "Build Back Better" […]" [36].

Take-aways for the ARCH DRM Framework: While the Sendai Framework in its entirety is the most important basis for all DRM / DRR frameworks, the points cited above stand out in particular for inclusion in the ARCH DRM Framework, i.e. impacts to and opportunities from cultural heritage should be included in DRM, DRM should follow a participatory approach that explicitly acknowledges the impacts to and needs of disproportionately affected people, and DRM should provide durable solutions that – in the post-disaster phase – should be taken as opportunities to build back better.

To accelerate the implementation of the Sendai Framework, the United Nations Office for Disaster Risk Reduction (UNDRR) developed the **Ten Essentials for Making Cities Resilient** (see [37] and Figure 8), which map against the priorities and indicators defined by the Sendai Framework and provide the steps a city needs to undertake in order to build and maintain resilience.

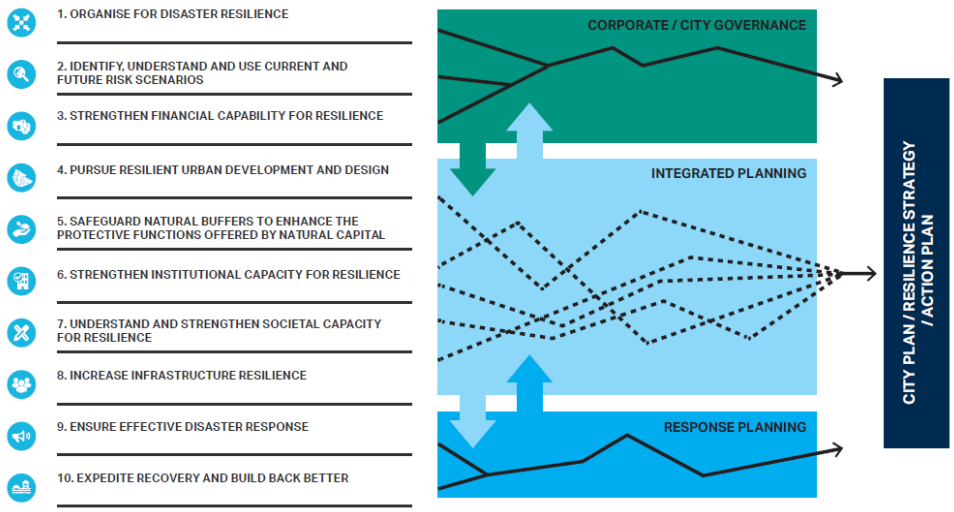

Figure 8: The Ten Essentials for Making Cities Resilient. Source: [40]

The Ten Essentials were the basis for development of the UNDRR Disaster Resilience Scorecard for Cities (see [38]), which is a tool to assess and monitor the progress of a city towards the implementation of the Sendai Framework.[10]

Take-aways for the ARCH DRM Framework: The DRM and resilience management process should be designed in a way that allows assessment and monitoring of its implementation progress. It should support breaking down this assessment and monitoring into manageable parts that should ideally be linked to the priorities of the Sendai Framework and other relevant frameworks.

A multitude of guidelines and handbooks have been written covering the implementation of the DRM cycle (see e.g. [1] and [39]), the implementation of specific parts of the DRM cycle (see [3], [40], [41], [42], [43], [44], [45], [46]) as well as how to address the links between DRM and CCA (see e.g. [25]). While an exhaustive discussion of these guidelines is out of scope for this report, the following guidelines should be mentioned as of particular importance for the topics of ARCH:

- The Guidance Notes on Recovery for climate change, environment, and gender by the International Recovery Platform (IRP), the International Strategy for Disaster Reduction (ISDR), and the UN's global development network (see [44], [45] and [46]),
- The Culture in city Reconstruction and recovery (CURE) framework developed by UNESCO and the World Bank Group (see [3]),
- The UNESCO handbook for managing disaster risk for world heritage (see [1]),
- The PDNA Guidelines Volume B: Culture developed by GFDRR and the World Bank Group (see [40]),
- The Risk Management Guidelines and Risk Assessment and Management Methodology of the H2020 STORM project[11] (see [43] and [42]),
- The methodologies for climate change impact evaluation and risk and vulnerability analysis of the H2020 HERACLES project[12] (see [41]).

A selection of these guidelines will be discussed in more detail in the following sections, while adoption and / or adaptation of specific methods for the support of single steps (e.g. conducting risk assessments for heritage), will be reported – as appropriate – in subsequent deliverables from the different ARCH WPs that focus on the individual tool and methods develop by ARCH. However, from the existence of the multitude of general and specific handbooks for DRM, another **take-away for the ARCH DRM Framework** can be derived: The framework should be designed open enough to allow integration of local processes and guidelines already in place, especially those covering specific topics for selected DRM phases.

[10] The Scorecard and other assessments are discussed in detail in section 4.
[11] https://www.storm-project.eu/
[12] http://www.heracles-project.eu/

3.3. Heritage and culture in CCA and DRM

Guidance and frameworks for including culture and heritage with climate change adaptation and disaster risk management were developed, for example, by Jigyasu, King, and Wijesuriya for UNESCO in [1], by ICOMOS' Climate Change and Cultural Heritage Working Group (CCHWG) in [26], by UNESCO and the World Bank Group in [3], and by the H2020 SHELTER project in [47].

The **UNESCO handbook on Managing Disaster Risk for World Heritage** by Jigyasu, King, and Wijesuriya provides a step-by-step guide for World Heritage managers and administrators to identify, assess, and reduce disaster risks. It aims at raising awareness of the risks faced by heritage sites associated with disasters, instead of the usual focus on pressure from development and the more visible wear and tear. At the same time, the handbook aims to raise awareness that heritage sites can positively contribute to reducing disaster risks, because (a) they provide ecosystem services to the communities and social-ecological systems they are a part of and (b) they possess characteristics due to centuries of accumulated knowledge that have proved to be resilient.

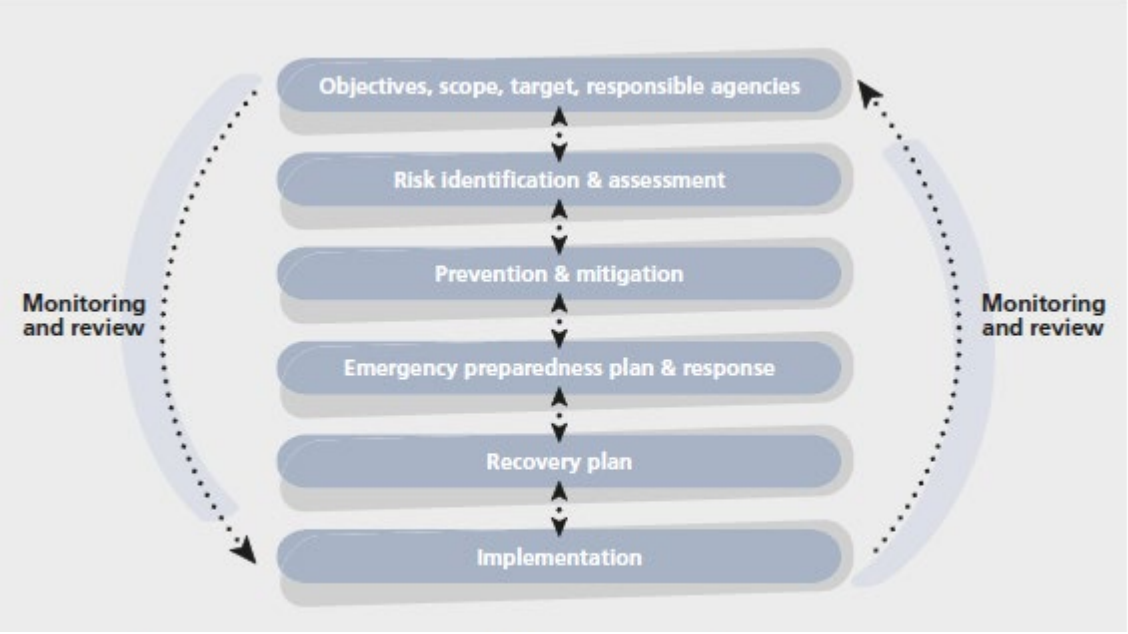

Figure 9: Main components of a DRM plan. Source: [36]

The handbook focuses on sudden-onset disasters rather than slow-onset processes like climate change and does not cover specific technical and operational aspects. It focuses on describing how to formulate a disaster risk management plan according to the DRM cycle depicted in Figure 7 by following the steps shown in Figure 9.

Importantly, the handbook links the DRM plan to the site management plan and to DRM systems for the surrounding area as well as describing how to include the specific needs and opportunities of heritage sites in each step.

Take-aways for the ARCH DRM Framework: Whenever possible, each step of a DRM plan should link to the specific needs and opportunities of historic areas, linking these to existing

plans, knowledge systems, and communities. At the same time the DRM framework should not just focus on sudden-onset disasters, but also slow-onset events.

The EU H2020 SHELTER project, funded under the same call as ARCH, developed the **SHELTER Operational knowledge framework** (see [47] and Figure 10). It adopts a similar 'infinity symbol' approach as EU H2020 RESIN, but instead of differentiating between the adaptation and urban system, SHELTER distinguishes between a climate change adaptation cycle in the (pre-disaster) prevention phase that migrates into a (post-disaster) reconstruction cycle and back to the adaptation cycle once the reconstruction phase is over. For each stage within and between these cycles, different data, assessments, tools, and policies will be developed to help practitioners in managing the resilience of their historic area.

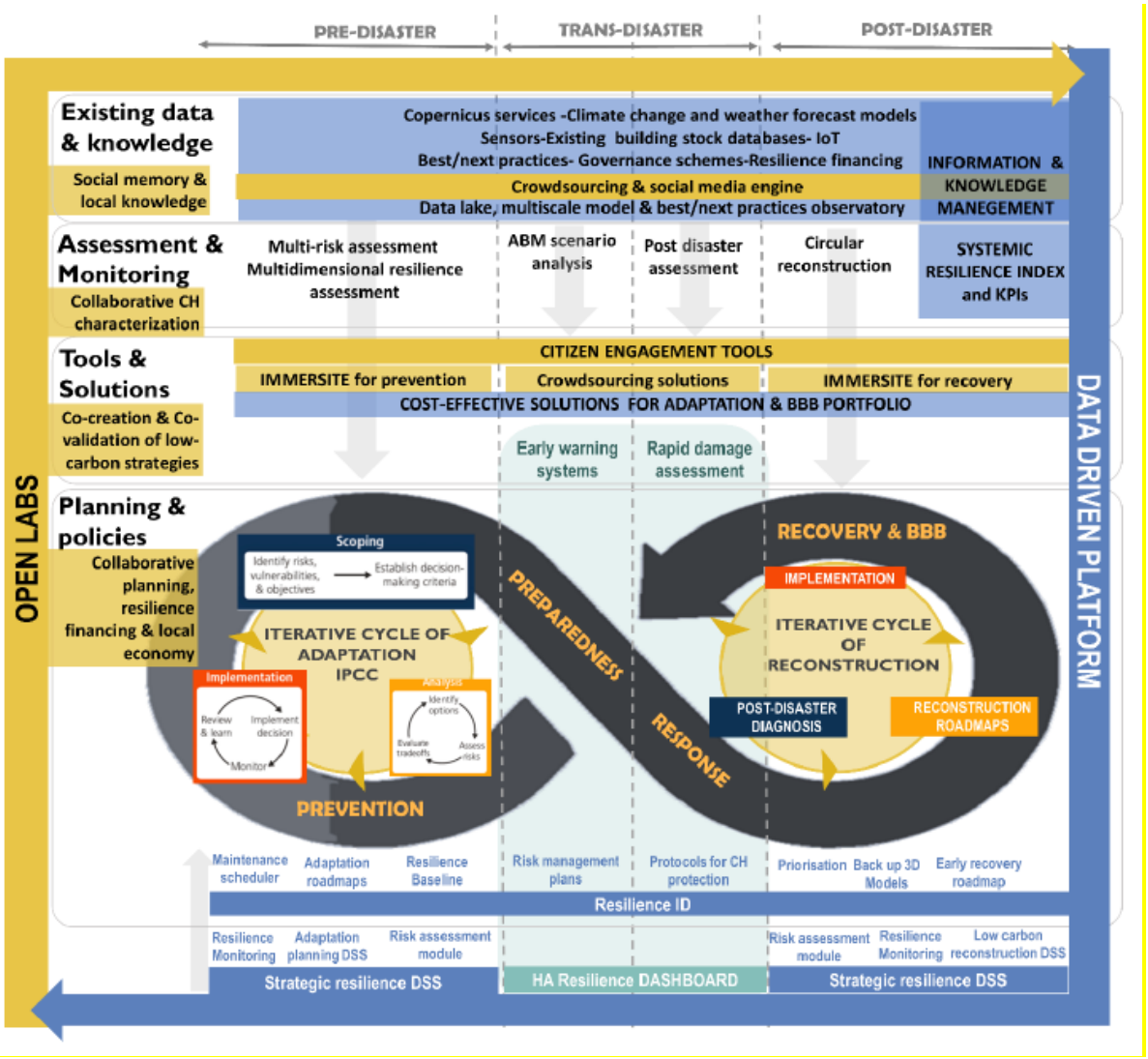

Figure 10: SHELTER Operational knowledge framework. Source: [47]

Take-aways for the ARCH DRM Framework: In the pre-disaster phase, climate change adaptation and disaster risk management have strong overlaps in processes and approaches (risk analysis, identification and selection of measures, implementation of measures, establishing monitoring and evaluation, etc.). In contrast, in the post-disaster phase SHELTER's Operational knowledge framework seems to focus more strongly on the DRM and

heritage management processes. As will be seen in section 4, ARCH follows a different approach in this regard, making the potential of the reconstruction and rehabilitation phase for CCA more explicit.

Figure 11: The CURE framework. Source: [24]

To address issues of culture and heritage in the recovery and reconstruction phase of disaster risk management, UNESCO and the World Bank Group developed the **Culture in city Reconstruction and recovery (CURE) framework**. Specifically, UNESCO and the World Bank Group adapt the People, Place, and Policy (3P) approach developed by UNESCO in [3] to a culture driven framework for city recovery and reconstruction (see Figure 11). The framework was already extensively discussed in ARCH SotA no. 3 (see [48]), so that only the three main principles of the framework are recapped (cf. [48]):

- **People-centred approaches to support 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 approaches to support 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:** Ensure that community needs, priorities, aspirations, and traditions are central to the reconstruction and recovery processes.

Operationally, the CURE framework is divided into four phases that cover the post-disaster phase of the DRM cycle and start with damage and needs assessments and end with the implementation of identified measures to recover and built back better.

Take-aways for the ARCH DRM Framework: The steps of the post-disaster phase of the DRM cycle should take specific notice on how needs of the heritage and cultural sector can be addressed and how the enabling factors that heritage and culture as well as local communities can bring to the post-disaster phase.

How culture and heritage can help to address climate change adaptation and which challenges remain to be addressed between climate change adaptation and heritage management is addressed by **ICOMOS' CCHWG The Future of our Pasts** (see [26]). They argue that culture and heritage are an asset for climate action, especially for communication and education. Furthermore, cultural heritage supports building social resilience (called 'community resilience' in section 2), because the participatory governance models, participatory knowledge-gathering initiatives, and the use of traditional knowledge systems in the heritage management field, can empower the community and societal responses to disasters.

However, there remain gaps that limit the connections between climate change adaptation and heritage management. These include questions of how to reconcile potentially necessary changes due to climate change with the needs of conservation, how to prepare for loss when adaptive capacity is exceeded, how to raise awareness and built capacity among communities, practitioners, and policy makers, how to record sites under imminent threat of destruction, and how to champion adaptive re-use to ensure that historic buildings can retain their fitness-for-purpose and use value.

Take-aways for the ARCH DRM Framework: A disaster risk management framework for historic areas that also takes climate change adaptation into account should not just leverage the ecosystem services and inherent resilience of historic areas for DRM, but should also leverage the communication and education potential of these areas with regards to climate change. In addition, the DRM framework should – whenever possible – advocate for participatory governance and knowledge-gathering processes as well as the use of traditional knowledge systems to increase the resilience of the social-ecological system. At the same time, such a DRM framework also needs to acknowledge that climate change might necessitate changes to historic areas – including management processes – that might run counter to usual practices, if these areas are to be kept for future generations.

3.4. Social Justice

The need for socially just heritage management and disaster risk management has been convincingly laid out in **ARCH State-of-the-Art report no. 5** (see [21]), with one of the major conclusions being that *"[…] 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, analysis of or detailed information about specific measures to be applied in heritage areas remains scarce."* Subsequently, ARCH SotA no. 5 identified the following specific obstacles that hinder socially just HM and DRM (cf. [21]):

Obstacles in data and information

- 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.
- 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 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 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.

Obstacles in processes, policies, and guidelines

- Lack of specific operational recommendations on applying gender mainstreaming measures in heritage / protected areas.
- 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.

Obstacles in associated assessments

- Lack of assessment of dependent-care infrastructure availability around cultural heritage assets.
- Lack of gender-impact assessments for projects on adaptive reuse of cultural heritage.
- Lack of awareness that impacts are gendered.

Guidelines and frameworks addressing the above obstacles are comparatively scarce. However, UNDRR, the United Nations Development Programme (UNDP), and the International Union for Conservation of Nature (IUCN) in 2009 published a handbook with policies and practical guidelines on how to make disaster risk reduction gender-sensitive (see [49]); the ISDR, UNDP, and the IRP in 2010 published a guidance note for the recovery process with specific focus on gender (see [46]), and UNDP and UN Women in 2018 published a facilitator and trainers guide for gender and disaster risk reduction (seer [50]). All have in common that they stress the need for disaggregated data, assessments and processes that are sensitive to the differentiated needs of and impacts to all social groups connected to an area struck by a disaster, and the need for heightened participation of marginalised and disproportionately affected people in planning, decision-making, and implementation.

Take-aways for the ARCH DRM Framework: A socially just DRM framework needs to explicitly consider inclusion of underrepresented and disproportionately affected population groups in planning processes, decision-making bodies, and implementation efforts (including reconstruction and Building Back Better). Any assessments (risk, damages and needs, etc.) as well as data sources need to disaggregate information on a level that allows to make the different affects disasters have on different population groups visible. Lastly, communication and participation processes need to explicitly target and involve underrepresented and disproportionately affected population groups.

4. The ARCH Disaster Risk Management Framework

Following the discussions in the previous chapter, it becomes apparent that in order to assess and manage resilience of historic areas it is necessary to define a unified disaster risk management and climate change adaptation process that considers the two overarching topics of heritage management and social resilience as well as the six different resilience dimensions: The ARCH DRM Framework.

Besides aligning long-term adaptation goals and short-term disaster risk actions (see Figure 3), the framework needs to take the special needs and opportunities of historic areas into account. In addition, the framework needs to go beyond the simple system definition of resilience and acknowledge the need for socially just resilience building.

To develop the ARCH Disaster Risk Management Framework, a literature review of established frameworks and guidelines for DRM and CCA was conducted (see previous section). The review showed that while DRM and CCA frameworks are in the process of convergence, there still exist some fragmentation, specifically with aligning the established management / planning cycles. In addition, the literature review showed that DRM and CCA frameworks often focus on urban areas in general and that there does not seem to exist a unified process to DRM and CCA specific to historic areas. Instead, DRM and CCA for historic areas are usually treated separately, with (technical) solutions covering single issues (e.g. environmental assessment or situational awareness platforms as developed by the H2020 projects STORM and HERACLES). Reinforcing this are several publications covering DRM or for historic areas and (world) cultural heritage (see e.g. [51], [52], [53], [3], [54], [40]), as well as recent initiatives (e.g. the Climate Heritage Network[13]) and guidelines (e.g. [26]) for CCA for cultural heritage. The goal of the ARCH DRM Framework is to close the existing gap and provide a unified process that allows practitioners and solution developers to position individual tools and methods in a combined DRM / CCA process.

4.1. How the ARCH DRM Framework was developed

The ARCH DRM Framework has been developed collaboratively based on input from ARCH partners. Specifically:

- A guided interview for requirements elicitation (covering all ARCH solutions) was conducted with city partners and their local research partners as part of the second General Assembly meeting in November 2019.
- As part of task 7.4, a number of requirements for all different solutions developed by ARCH have been gathered, these include requirements from standards, from previous research projects, and requirements elicited based on results from match-making meeting between city partners and technical partners of the project. During these match-making meetings the local ‘problems’ faced by the city partners were matched

[13] https://climateheritage.org/

with expertise of technical partners and specific solutions. The requirements collected from these processes are described in deliverable D7.4 [55].
- As part of the third General Assembly meeting in September 2020, a feedback session on the ARCH DRM Framework was conducted together with all ARCH partners.
- Multiple bi-lateral discussions and written feedback rounds were held during the process of developing the ARCH DRM Framework.

Based on the outcomes of these processes and the review of existing frameworks, guidelines, models, the final ARCH DRM Framework has been developed.

As ARCH follows an agile co-creation process, additional feedback for the ARCH DRM Framework might be received over the remained of the project. In case this feedback requires substantial adjustments to the framework, an updated version will be included as part of deliverable D7.6.

4.2. The general structure of the ARCH DRM Framework

The ARCH DRM framework, illustrated in Figure 12, is designed to combine disaster risk management and climate change adaptation for historic areas. It merges the DRM cycle with the climate change adaptation cycle with a focus on historic areas and integrates specific concepts for reconstruction and Building Back Better with a focus on historic area. The framework consists of ten cyclical steps spread across the three DRM phases ‘pre-disaster’, ‘during’, ‘post-disaster’. The steps can be understood as consecutive but not completely distinct working stages since they have strong interconnections and related actions. In addition, the framework acknowledges that the results of some steps might need to be revised in case of the occurrence of a disaster to facilitate the recovery process.

More specifically, the ARCH DRM Framework splits all steps between a ‘normal operating’ phase (the pre-disaster phase) and the ‘emergency operation’ phase (the during and post-disaster phases). In Figure 12 these two high-level phases are represented by the outermost light grey and dark grey rings. As long as no disaster occurs, the steps within the light grey ring are regularly repeated, jumping to step 1 from step 6 and skipping steps 7-10 (see Figure 13). Steps 1-6 are synonymous with the adaptation planning cycle of the UAST but extended with the necessities for disaster preparation. That is, the ARCH DRM Framework advocates to conduct vulnerability and risk assessments both for slow-onset climatic risks as well as sudden-onset risks from, e.g. natural disasters. Similarly, based on these analyses, not only climate change adaptation measures, but also risk prevention and mitigation measures, as well as emergency response measures should be identified, assessed, selected, and implemented. Step 6 constitutes the biggest difference between the usual DRM cycle and the ARCH DRM Framework: Instead of conducting a review between the post- and pre-disaster phase (see Figure 7), ARCH follows the CCA cycle and advocates to establish a monitoring, evaluation, and learning framework (see e.g. [56]) as the final step of the pre-disaster phase (with a revision of this framework and process as part of step 10 in case of a disaster). It is important to note that this monitoring, evaluation, and learning framework should not just cover monitoring of the implementation effort, but should also allow monitoring and evaluation of the combined DRM / CCA process, enabling a feedback loop of learning processes that allows to adjust goals and processes.

Figure 12 Illustration of the ARCH DRM framework

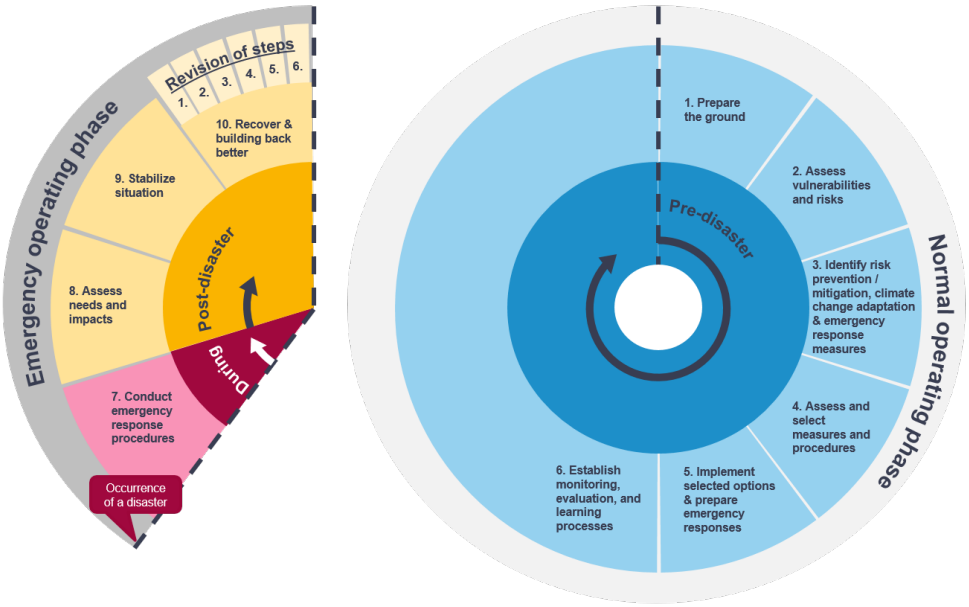

Figure 13: The two operating phases of the ARCH DRM framework pulled apart for better illustration

In case of the occurrence of a disaster, the normal operating phase is disrupted, and steps 7-10 (might) need to be performed. They cover all necessary emergency response and post-disaster recovery actions and are dependent on the preparatory plans and actions resulting from steps 1-6. Within the emergency operation phase an additional revision of the results from the normal operating phase is included (see step 10) to account for the need to adjust information and actions identified under normal conditions with the post-disaster situation. In addition, this revisiting of the original actions planned under steps 1-6, makes it explicit that the post-disaster reconstruction phase can and should be used as an opportunity to reassess (climate change adaptation) measures in order to support Building Back Better.

As a result, the ARCH DRM Framework can be seen as a DRM cycle that includes two conditionally interlinked CCA cycles (again, see Figure 13), one conducted and regularly repeated as part of the normal operating phase (steps 1-6) and one used to inform reconstruction and Building Back Better after the occurrence of a disaster (revision as part of step 10).

4.3. The ARCH DRM Framework in detail

The following sections describe the individual steps of the ARCH DRM Framework and describes some exemplary associated tasks in more detail. However, while the steps of the ARCH DRM Framework are presented in a sequential fashion and numbered, it is not expected that the process is necessarily started from the beginning. Usually, DRM and CCA processes within the historic area or the larger social-ecological system in which the historic area is embedded, will already be ongoing, so that certain steps might already have been (partially) conducted.

1. Prepare the ground

The first step of the ARCH DRM Framework is aimed at building a stable basis and structure for the subsequent steps by clarifying objectives, scope, and responsibilities, identifying relevant stakeholders to involve, and collecting initial information and data. For example, in this step

- initial data and key information about the historic area should be collected and screened to inform the decision on objectives and scope of the management process. This information can include, for example, location and size of the historic area, ownership structure for buildings within the area, structural information on buildings, but also information on social, cultural and natural aspects related to the area, like relevant community groups, associated local traditions, location and size of relevant ecosystems, etc.;
- initial data about relevant climate change-related and natural hazards should be collected and screened to support limiting the scope of the management process to the most relevant hazards. This might include gathering historical data about past impacts, but might also entail pre-identifying potentially relevant climate change scenarios;
- relevant data and information about the available funding and personnel resources need to be collected to be able to effectively define the scope and objectives of the process;

- the responsibilities for the resilience management process (i.e. the combined DRM / CCA process) should be clarified. This includes, for example, the main responsible person or team for the overall process, but also existing departments and public / private organisations connected to DRM, CCA, and HM, local communities and other stakeholders to involve, especially those representing minorities or disproportionately affected population groups. This might also include local businesses, academic institutions, cultural associations, and organisations from different governance levels that might support the process with knowledge and expertise;
- the objectives and scope of the resilience management process need to be defined. These depend on the time and resources available to the team involved in the management process and should be informed based on the preliminary information collected and screened. This should also include clearly defined boundaries of the process, i.e. which actions will be part of the current cycle and which actions will not be part of the current cycle (but potentially a future one);
- the communication and engagement processes should be defined. These include the potential use of participative approaches and engagement of local communities, but also decisions about how to communicate during the management process with affected stakeholders. The definition of the communication and engagement process should take special note on the possibilities heritage, historic areas, and cultural can provide for these activities due to their high value for the local communities; and
- a resilience baseline should be established by evaluating the initial situation of the historic area with regard to the implementation of a combined DRM / CCA plan.

2. Assess vulnerabilities and risks

The second step of the ARCH DRM Framework is concerned with identifying and assessing vulnerabilities and risks to identify those areas of the historic area that need increased attention and in order to identify suitable measures to address these vulnerabilities and risks. For example, in this step

- the main hazards to be analysed are selected, based on the preliminary information gathered in step 1;
- the main exposed elements to consider for the vulnerability and risk assessment are selected. These include those elements that are connected to the historic area as a SES (e.g. heritage assets, population, (intangible) cultural assets, as well as environmental and economic assets, and more);
- the scenarios for which to conduct a risk assessment are selected, these include climate change scenarios but also urban development scenarios and other projections with relevance to vulnerability and risk factors;
- the potential impacts are identified by evaluating historic and current information. This should include impacts to the different elements of the SES and support disaggregating information in such a way that effects on different populations groups can be assessed. These impacts should also cover (intangible) heritage values that can, for example, be (partially) captured via surveying the local population about the values they attach to the historic area;
- the sensitivities and capacities influencing the vulnerabilities of the different exposed elements to different hazards need to be identified;

- the risk for different exposed elements when impacted by different hazards should be assessed; and
- the results should be visualised and communicated to all affected stakeholders.

3. Identify risk prevention / mitigation, climate change adaptation & emergency response options

Based on the vulnerability and risk assessment results from the previous step and the baseline resilience review from step 1, the aim of step 3 is to identify suitable measures and strategies to lower the risk and increase the resilience of the historic area. For example, in this step

- climate change adaptation, disaster risk mitigation and prevention, as well as emergency response and recovery measures potentially suitable to address the risks and hazards identified in step 2 should be identified. These should – if possible – specifically take note of local practices and traditional knowledge available in the historic area;
- policies and processed to address resilience weak points, i.e. gaps in the combined DRM / CCA plan, should be identified. As in the previous point, this action should take note of local, traditional practices, and knowledge systems, but also the opportunities offered by historic areas due to the accumulated knowledge they represent;
- additional information for potentially suitable measures should be collected to inform the selection process. These can include information from existing guidance material and other relevant example projects, consultations with experts, but also information from historical knowledge and local communities. Lastly, relevant standards and policies with relation to different measures should be identified;
- the identified measures should be described in an understandable and systematic way to facilitate assessment and selection in the next step.

4. Assess and select measures and procedures

In this step a prioritisation of the identified risk prevention / mitigation, climate change adaptation & emergency response options is conducted by determining their performance with regard to enhancing resilience and safeguarding the historic area in a socially just way. For example, in this step

- all potentially suitable measures should be assessed for their effectiveness, cost-benefit, potential co-benefits, effect on the historic area (including cultural heritage significance), compatibility with heritage management practices, compliance with regulations, effects on the local communities and their vulnerabilities; and
- a set of the assessed measures should be selected for implementation, based on target resilience / risk level to achieve, available time and resources for implementation, and associated effects on the social-ecological system that is the historic area. The selection process should – if possible – include local communities and other stakeholders affected by the measures.

5. Implement selected measures & prepare emergency responses

In this step the selected measures and procedures from step 4 are implemented, which should be guided by a dedicated resilience action plan for the historic area that is based on the outcomes of steps 1-4. This also includes setting up (and exercising) relevant emergency response procedures, as well as preparing potential recovery and reconstruction measures. The implementation of the resilience measures should not only be aimed at physical measures, but also target mainstreaming resilience thinking into different governance processes and policies. For example, in this step

- a resilience action plan should be developed based on the identified outcomes from step 1-4. This plan should match selected resilience measures with specific risks and / or resilience weak points and include responsible persons for the implementation of each measure as well as an indicative schedule for implementation;
- the selected resilience measures and processes should be communicated to the community and stakeholders affected by them. If possible, community groups, businesses, and other relevant stakeholders should be involved in the implementation of measures;
- emergency response measures should be set up, including regular drills with relevant governance and other organizations as well as communities and businesses.

6. Establish monitoring, evaluation, and learning procedures

To ensure the effectiveness of the DRM / CCA process, monitoring, evaluation, and learning processes need to be established. These procedures should not only target implementation monitoring but monitoring and evaluation of the complete DRM / CCA process to establish a continuous learning loop for improving the process. For example, in this step

- monitoring of risks and impacts from climate change-related and natural hazards should be established. This includes monitoring the indicators used for the risk assessment, including non-climatic trends in population and urban development;
- outcome-oriented indicators for monitoring the implementation process of resilience measures should be established;
- process-oriented indicators for monitoring the progress of the DRM / CCA process should be established to facilitate learning processes. These might include developing a theory of change[14] to establish specific DRM / CCA objectives, linked to certain measures, and additional assumptions in order to end up with a coherent formulation against which an evaluation can take place. This also allows to establish a continuous learning process, because it enables measuring if the objectives and assumptions formulated at the beginning of such a process were reached and if not, why not.
- a detailed resilience assessment should be conducted in order to assess how well the DRM / CCA process has been implemented;
- a continuous communicating mechanism should be established to continuously inform all relevant actors, including decision-makers, but also local communities

[14] https://www.theoryofchange.org/what-is-theory-of-change/

and other actors connected to DRM, CCA, and HM. This communication mechanism should try to take advantage of the potential historic areas as well as culture and arts have in activating people to act on natural disasters and climate change.

As mentioned earlier, steps 1-6 should be repeated and updated on a regular basis to ensure that up-to-date information and data is fed into the process and plans, and procedures are updated to reflect changing needs. Without a regular process, no long-term resilience can be achieved.

In case a disaster occurs, the regular process of steps 1-6 is interrupted, and steps 7-8 might become active.

7. Conduct emergency response procedures

Directly after or during the occurrence of a disaster (usually within the first 72 hours) the emergency response procedures need to be performed to safeguard humans and relevant heritage assets. For examples, in this step

- emergency response plans are executed;
- humans, infrastructures, buildings, and ecosystems need to be secured;
- theft of collapsed or damaged fragments needs to be prevented; and
- (essential) services need to be kept running.

8. Assess needs and impacts

After the initial phase of the disaster is over and emergency procedures have been conducted, damages, impacts, and needs have to be assessed. The results from the damage and needs assessment should ideally inform a subsequent update of the risk assessment before the reconstruction phase in order to inform decision making and support Building Back Better. For example, in this step

- differentiated assessments need to be conducted, including damages to tangible and intangible cultural heritage, as well as historical housing stock, damages to and needs of creative and cultural industries, needs of the population, with specific focus on minorities and population groups disproportionately affected by disasters. This also includes damage and needs assessments with specific focus on climate change adaptation and environmental issues in order to avoid that stabilizing and reconstruction measures at a later point worsen the environmental situation;
- relevant data and information (e.g. from rapid risk assessments) need to be systematically collected to inform the following steps.

9. Stabilise situation

In this step (urgent) stabilising measures (e.g. retrieve and safely storing movable heritage assets like paintings, etc.) are performed to enable the following recovery and Building Back Better procedures. These measures should be based on the damage and needs assessment conducted in the previous step and ideally be – at least partially – pre-selected in steps 3 and 4. It is important to assess which effects the stabilising measures might have, specifically on

vulnerable population groups. Ideally, the local community will be involved in this step in order to raise the acceptance of the measures and compliance with local traditions.

10. Recover and building back better

In the final step, recovery and rehabilitation measures need to be implemented, including revisiting steps 1-6 to update the results of these steps based on the new situation in the historic area. This is also a good opportunity to include climate change adaptation actions in the rebuilding effort in order to build back better. However, all these measures need to take the needs of the local communities and – potentially – also the heritage management needs into account to ensure that the historic area is rebuild in alignment with local customs (see ARCH SotA no. 3 for more details on Building Back Better [48]). For example, in this step

- recovery and Building Back Better measures need to be selected and implemented. Ideally some measures have been pre-selected in steps 3-4. The final selection should be based on an updated risk assessment (informed by the damage and needs assessment) and an updated identification and assessment process;
- financing measures need to be identified in order to fund the recovery and rebuild process;
- institutional arrangements might need to be updated, including international NGOs supporting the rebuilding effort. In case external agencies are involved in the rebuilding effort it is paramount to include the local community in this process and ensure that their wishes and needs drive the rebuilding process. Otherwise, the risk is high that the historic area might be rebuild in a way that is non-compliant with local customs;
- constant communication with local communities and between all actors involved in the rebuilding effort needs to be ensured;
- the results of steps 1-6 might need to be updated, specifically
    - **step 10.1:** Identifying and evaluating if any information and characteristics of the historic area and associated people and assets changed;
    - **step 10.2:** Updating risk and vulnerability assessments based on damage and needs assessment;
    - **step 10.3:** Updating risk prevention / mitigation, climate change adaptation & emergency response options;
    - **step 10.4:** If needed, reassessing and revising measures and procedures;
    - **step 10.5:** If needed, implementing (newly) selected measures & preparing updated emergency responses;
    - **step 10.6:** Revising and updating monitoring, evaluation, and learning procedures, including monitoring and evaluation of rebuilding and rehabilitation processes and measures. This steps includes evaluating the actions taking during the whole emergency operating phase.

After conclusion of step 10 – and if no additional disaster strikes – the resilience management process should resume its normal operating phase, i.e. start a new cycle at step 1 at a regular time interval to maintain and improve the resilience and adapt to newly occurring external events and / or changing circumstances.

As already mentioned in section 3, for nearly all steps of the ARCH DRM Framework specific guidelines already exists that can (and should) be consulted to get a deeper understanding of and find best practices for these steps. In addition, several locally specific arrangements and responsibilities on different governance levels will exist that need to be taken into account when planning and conducting the different steps.

4.4. How the ARCH DRM framework steps are linked to other concepts

From the established concepts for CCA and DRM discussed in section 3, the DRM cycle as proposed by Jigyasu, King, and Wijesuriy in [1] and the cyclical climate change adaptation planning process of Climate-ADAPT's UAST [2] were identified as most relevant for the purpose of the ARCH DRM Framework and therefore used as a basis for a combined DRM / CCA process. In addition, the CURE framework [3] was used as a basis for the post-disaster phase. Table 1 provides an overview of how the steps of the DRM cycle and the UAST are linked to the steps of the ARCH DRM Framework (columns 1, 2, and 4) and how selected other frameworks (SMR ERMG [4], RESIN Conceptual Framework [5], CURE [3]) are related to these steps (column 3). Especially the comparison between the UAST, and the frameworks proposed by RESIN and SMR shows a distinct difference in structure and organisation, making it harder for practitioners to transition from one framework to another. The ARCH DRM Framework addresses this gap by following the UAST more closely and aligning it with the DRM cycle.

DRM cycle	UAST	RESIN/SMR/CURE	ARCH DRM Framework
Before disaster - Risk assessment	Preparing the ground for adaptation	**RESIN** Conceptual Framework – Assess Climate Risk **SMR** ERMG – Baseline Review (Steps 1-8)	1. Prepare the ground
	Assessing climate change risks and vulnerabilities	**RESIN** Conceptual Framework – Assess Climate Risk **SMR** ERMG – Baseline Review (Steps 9 & 10) **SMR** ERMG – Risk Awareness (Steps 1-4)	2. Assess vulnerabilities and risks
Before disaster – Risk prevention / mitigation	Identifying adaptation options	**RESIN** Conceptual Framework – Develop Adaptation Objectives **SMR** ERMG – Risk Awareness (Step 5) **SMR** ERMG – Resilience Strategy (Steps 1 & 2)	3. Identify risk prevention / mitigation, climate change adaptation & emergency response measures
	Assessing adaptation options	**RESIN** Conceptual Framework – Prioritise Adaptation Options **SMR** ERMG – Risk Awareness (Step 5) **SMR** ERMG – Resilience Strategy (Steps 1 & 2)	4. Assess and select measures and procedures
	Implementing adaptation	**RESIN** Conceptual Framework – Develop Implementation Plan & Implement and Monitor Adaptation Actions **SMR** ERMG – Resilience Strategy (Steps 3-7) **SMR** ERMG – Implementation & Monitoring (Steps 1-4)	5. Implement selected measures & prepare emergency responses
Before disaster – emergency preparedness			
Review	Monitoring and Evaluating Adaptation	**RESIN** Conceptual Framework – Implement and Monitor Adaptation Actions **SMR** ERMG – Implementation & Monitoring (Step 5) **SMR** ERMG – Evaluation & Reporting (Steps 1-5)	6. Establish monitoring, evaluation, and learning processes
During disaster – Emergency response procedures			7. Conduct emergency response procedures
After disaster – damage assessment		**CURE** Phase 1 - Damage and Needs assessment **CURE** Phase 1 – Scoping	8. Assessing impacts
After disaster – Treatment (such as repairs, restoration, retrofitting)			9. Stabilize situation
After disaster – Recovery/rehabilitation		**CURE** Phase 2 – Setting Policy and Strategy **CURE** Phase 3 – Financing **CURE** Phase 4 – Implementation	10. Recover and building back better and revision of steps 1.-6.

Table 1: The ARCH DRM Framework steps matched to steps of the DRM cycle, the UAST cycle and other frameworks

4.5. The ARCH tools within the ARCH DRM Framework

ARCH will develop several solutions to support resilience building and management (see ARCH Deliverable D7.4 for an initial overview [55]). Subsequently, these solutions can be directly linked to the steps of the ARCH DRM Framework and are very well suited to be applied during the steps. Figure 14 illustrates which work package and which solutions from this work package can be linked to the different steps of the ARCH DRM Framework. Here, the WPs and related solutions are indicated as blue shaded arcs along the steps. Specifically:

- The **Historic Area Information Management System HArIS** and the **Threats and Hazard Information Management System THIS**, developed in WP4, provide information about the historic area and related hazards to enable the identification of relevant information, support risk assessments, and monitor the condition of heritage assets.
- The **ARCH Decision support system ARCH DSS**, developed in WP5 and based on HArIS and THIS, enables vulnerability and risk assessments, and subsequently allows to support the identification and assessment of resilience measures and strategies. In addition, it allows to monitor these aspects.
- The **Resilience Measures Inventory RMI**, developed in WP6, provides a selection of resilience building measures linked to suitable funding approaches. The inventory includes measures covering most DRM phases as well as climate change adaptation measures. The measures in the inventory are assessed according to different aspects (e.g. effectiveness, co-benefits, compliance with standards, invasiveness, etc.). Accordingly, the RMI supports end-users in identifying, assessing, and selecting suitable resilience measures.
- The **Resilience Pathway Visualisation Tool RPVT**, also developed in WP6, allows to visually construct implementation paths for resilience measures, i.e. which resilience measures have to be implemented in which sequence to raise the resilience to a certain level until a certain time. It also allows to assess alternative resilience pathways. Subsequently, the RPVT also supports end-users in selecting and assessing resilience measures.
- The **ARCH Hub**, developed in WP7, is the web-based integrated disaster risk management platform that will link all ARCH tools and enable end-users to collaboratively assess the resilience of their historic areas and share best practices with each other. It will also include further guidance for the different steps of the ARCH DRM Framework. With the ability to share best practices, the ARCH Hub can support end-users in identifying and assessing resilience measures.
- The **ARCH Resilience Assessment Dashboard RAD**, also developed in WP7, is a web-based tool for semi-quantitative, multi-stakeholder resilience assessment, i.e. it enables end-users to assess how well the combined DRM / CCA process established by the ARCH DRM Framework is implemented and supports monitoring the implementation process. Subsequently, it can support the identification of the baseline resilience and can be used to monitor the DRM / CCA process. In addition, the Resilience Assessment Dashboard will allows end-users to link specific resilience measure to identified resilience weak spots and include information about persons or institutions responsible for their implementation as well as tentative timelines for the

implementation process. As such, the RAD can also support the formulation of resilience action plans.

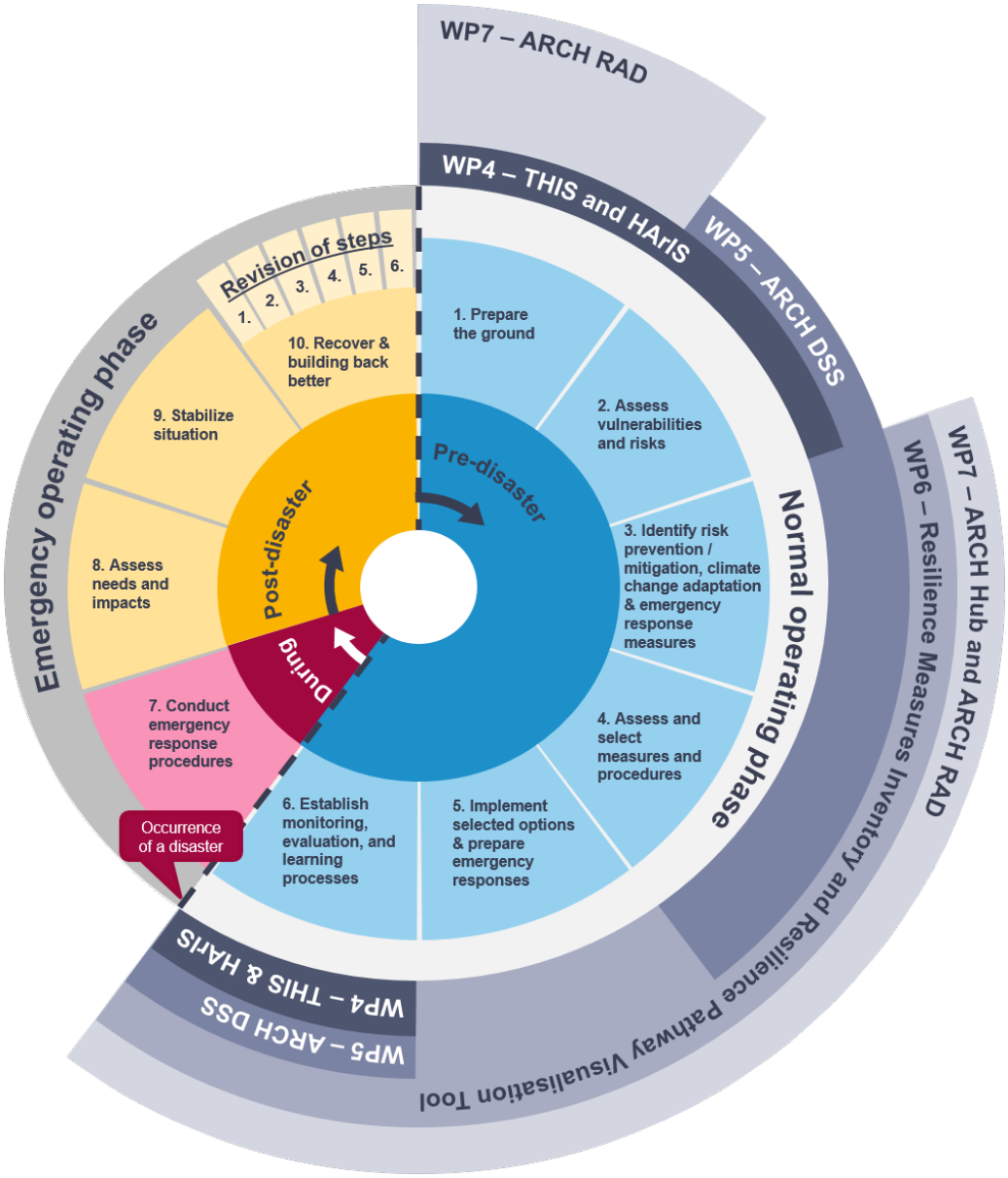

Figure 14: The ARCH DRM Framework steps linked to the ARCH work packages and tools

While the main focus of the solutions provided by ARCH is to provide better information and decision support in the pre-disaster phase, several of the solutions might also be able to support the emergency operating phase, e.g. depending on the (external) real-time information that is linked with the ARCH DSS, it can also be a useful supporting tool for first responders and crisis managers during the emergency phase. Similarly, if information from the damage and needs assessment is directly fed into the information management system HArIS, it can support the information exchange between different actors involved in the post-disaster phase by providing a common knowledge base. The Resilience Pathway Visualisation Tool could potentially also be used to guide the DRM / CCA process when treating the occurrence of a disaster as a tipping points in a pathway that requires switching to a different set of (emergency

and reconstruction) measures. Implicitly – through the revision of steps 1-6 during step 10 – all tools are also able to support the recovery phase.

In addition to the specific solutions offered by the project, ARCH work package 3 (not pictured in Figure 14), that is facilitating all co-creation processes and local activities in the ARCH pilot city cases, can be seen as overarchingly relevant for steps 1-6, since it establishes local stakeholder groups and facilitates communication and monitoring of local activities.

5. The ARCH Resilience Assessment

While all ARCH solutions have links to specific phases of the ARCH DRM Framework, the ARCH resilience assessment has an additional link: While it should be used to establish a resilience baseline (see step 1 of the ARCH DRM Framework) and for the monitoring of the DRM / CCA process (see step 6), it's objective is to enable practitioners to assess how well they have implemented the ARCH DRM Framework, monitor their progression in this implementation and define – if necessary – actions, time plans and responsibilities to increase the progress (see step 5). Therefore, the following sections give some more detailed insights into the ARCH resilience assessments, its concepts, and the broad ideas behind it. A full description, including the final implementation in the web-based ARCH Resilience Assessment Dashboard, will be reported in D7.6. To position the ARCH resilience assessment in the broader tool and method landscape, an overview of already existing assessments is provided in the following section.

5.1. Overview of existing resilience assessments

Several resilience assessment methods, tools, and frameworks exist, both developed as part of larger research projects as well as designed by individual researchers. Some of the products most relevant to the development of the ARCH resilience assessment are listed, including references, in Table 2.

The 100 Resilient Cities project has developed a number of Excel-based tools grouped around its City Resilience Index (CRI), including CRI Rapid Resilience Review, a modular tool producing graphs and tables relating to a city's assets and risks, CRI Resilience Actions Inventory, a tool to capture information about existing resilience building actions in a city, and the CRI Stakeholder Perceptions Review, a tool to capture information about the resilience 'perception' of relevant stakeholders.

UNDRR has published the Disaster Resilience Scorecard for Cities and the Disaster Resilience Scorecard for Buildings, both modular Excel-based tools to assess resilience of cities and individual (commercial) buildings, respectively. The tools produce graphics and tables relating to a city's or building's resilience according to the Ten Essentials for Making Cities Resilient. They also allow to formulate actions to maximise the resilience.

The RESILENS[15] project has developed a number of web-based tools as part of ReMMAT Resilience Management Matrix & Audit Toolkit, including CI System Definition Tool, a guided set of questions to elicit the necessary information for the definition of a Critical Infrastructure system under investigation, CI-RAT Critical Infrastructure Resilience Assessment Tool / Resilience Management Matrix Tool, a modular questionnaire to measure the resilience of critical infrastructure components, completed by the PARET Post Assessment Resilience Enhancement Tool, a guideline on how to use and interpret the score obtained from CI-RAT and to support the development of strategies / actions to enhance resilience.

[15] http://resilens.eu/

The SMR project started out with the development of its Resilience Maturity Model, a 5-stage (maturity/process) model for city resilience describing what objectives to target, what stakeholders to involve, what policies to enact, and what indicators to use for measuring progress. They followed up with the Risk Systemicity Questionnaire, a dynamic questionnaire that analyses the risk triggers and the ramifications of those risks, and the City Resilience Dynamics Model, a simulation game and training tool that helps cities explore different strategies regarding the implementation of resilience policies, simulate the results of each strategy, and learn about the resilience building process that the cities need to follow to improve their resilience level in the most efficient way. Their set of contributions is completed with the Resilience Building Policies collection that presents case studies as a reference for cities for further information.

Some other methods and tools include the Baseline Resilience Indicators for Communities (BRIC), an empirically-based resilience metric for community-level disaster resilience, the emBRACE Resilience Framework, a conceptual framework developed to characterise community resilience, aimed at facilitating a common understanding and coherent discussion with stakeholders, DRLRL, a new conceptual model of disaster resilience claiming to clarify many of the discrepancies found in existing literature, as well as the Hybrid Social-Physical Networks (HSPN) Resilience Framework, a resilience assessment method combining physical urban networks ("topological networks") and social networks between actors ("typological networks").

Only a few of these methods, tools, and frameworks explicitly consider climate change adaptation (SMR Risk Systemicity Questionnaire, DRLRL).

While a few methods still address researchers (BRIC, DRLRL, HSPN Resilience Framework), most have taken the leap to support practitioners, i.e. local stakeholders (the 100 Resilient Cities tools, the UNDRR Scorecards, SMR Risk Systemicity Questionnaire and City Resilience Dynamics Model, and BRIC), critical infrastructure providers and managers (the RESILENS tools) and/or local policy makers and urban planners (the 100 Resilient Cities toolset, the SMR tools, emBRACE), directly.

While some of the frameworks scope on critical infrastructure components (the RESILENS tools and framework) or even individual buildings (UNDRR Disaster Resilience Scorecard for Buildings), others focus on (social) communities (emBRACE), cities (UNDRR Disaster Resilience Scorecard for Cities the 100 Resilient Cities tools, the SMR tools, HSPN Resilience Framework), or whole counties (BRIC). DRLRL claims to cover multiple spatial scales, with feedbacks across scale.

To summarise: Several resilience assessment frameworks, models, and tools exist. Many of them consider risks originating from climate change in general, but none consider heritage management. With some outliers, most frameworks focus on assessing whole cities or urban districts. Most of these address local stakeholders and / or policy makers.

Generally, developers of disaster risk management frameworks seem to be ready to make the step from developing by-researcher-for-researcher tools to providing practitioners, be it providers and operators of critical infrastructure components, local policy makers or urban planners, with tools to increase the quality of their decision-making.

While a multitude of methods, tools, and frameworks for disaster risk management is available, literature review demonstrates that there still is a scarcity regarding a heritage-oriented, (semi)-quantitative resilience assessment approaches that cover all phases of DRM and address practitioners in European cities and historic areas. The work in progress ARCH RAD, is specifically designed to fill that gap by allowing practitioners to assess the implementation progress of the ARCH DRM Framework.

Name	Project / Developer	Source
CRI Rapid Resilience Review	100 Resilient Cities	*
CRI Resilience Actions Inventory	100 Resilient Cities	*
CRI Stakeholder Perceptions Review	100 Resilient Cities	*
Disaster Resilience Scorecard for Cities	UNDRR	[38]
Disaster Resilience Scorecard for Buildings	UNDRR	[57]
Resilience Maturity Model	Smart Mature Resilience	[31]
Risk Systemicity Questionnaire	Smart Mature Resilience	[58]
Resilience Building Policies	Smart Mature Resilience	[59]
City Resilience Dynamics Model	Smart Mature Resilience	[60]
ReMMAT Resilience Management Matrix & Audit Toolkit	RESILENS	[61]
CI System Definition Tool	RESILENS	[61]
CI-RAT Critical Infrastructure Resilience Assessment Tool / Resilience Management Matrix Tool	RESILENS	[62]
PARET Post Assessment Resilience Enhancement Tool / Resilience Management Audit Tool	RESILENS	[61]
emBRACE Resilience Framework	S. Kruse, et al.	[63]
BRIC - Baseline Resilience Indicators for Communities	S. L. Cutter, et al.	[64]
‘‘Loss–Response’’ of Location (DRLRL)	H. Zhou, et al.	[65]
HSPN Resilience Framework	A. Bozza, D. Asprone, G. Manfredi	[66]

Table 2 Overview of existing resilience assessments methods. Legend: *Website not accessible anymore

5.2. Concepts of the ARCH resilience assessment

Based on the discussions and explanations in the previous sections and chapters, the key concepts of the ARCH resilience assessment will be described in the following. These key concepts were already discussed in some detail in deliverable D7.4 [55] and are recapped here with additional context.

Historic areas, as social-ecological systems, include a multitude of different actors with different backgrounds, needs, and expectations. Likewise, disaster risk management plans and climate change adaptation plans are usually cross-cutting initiatives within a city or government that concern a multitude of actors from different departments and need to take the local communities into account. Therefore, the ARCH resilience assessment needs to **support a multi-stakeholder assessment process** that can support collaboration and information exchange. The highly localised nature of SES as well as DRM and CCA plans, make it also necessary that the ARCH resilience assessment can **incorporate local specificities by adapting to local conditions.**

In addition, if resilience is seen as a dynamic process within a changing system that accounts for learning and adaptation, the ARCH resilience assessment needs to be able to **support this learning process and enable documentation of assumptions.**

Furthermore, DRM / CCA processes involved more than structural measures for risk mitigation and prevention. Key elements of these processes are institutional and social aspects that cannot be quantified using mathematical functions. A resilience assessment that wants to capture these 'weak' factors of DRM / CCA processes, needs to employ either a qualitative or semi-quantitative approach. The ARCH resilience assessment will employ a **semi-quantitative approach** because it facilitates the multi-stakeholder approach best, allows to assess resilience characteristics and is suitable to incorporate expert opinion approaches.

Lastly, the implementation of DRM / CCA plans is a highly complex process that touches upon a variety of different topics (from risk assessment, to stakeholder engagement, to cost-benefit analysis, etc.). This process becomes even more complicated when including historic areas and cultural heritage. The ARCH resilience assessment therefore needs **guidance and supporting tools** to make the assessment as easy as possible for the people conducting it.

As a result of a resilience assessment, the most pressing **weak points should be identifiable,** and the result should support the identification and **formulation of resilience actions plans**.

Due to all these reasons, the UNDRR scorecards for cities [37] and buildings [57] have been identified as most suitable blueprints for a resilience assessment for historic areas. In addition, they allow linking the assessment to the Ten Essential for Making Cities Resilience, the priorities of the Sendai Framework, the Sustainable Development Goals, and the Paris Agreement. In addition, the concept of the scorecards is very well suited for application in a complex social-ecological system setting, because the assessment can be conducted in different steps, does not have to be conducted completely (thus allowing to adjust the assessment based on needs and resource availability), and can also be conducted in a 'preliminary' format with fewer questions.

The scorecards consist of varying numbers of scoring questions related to the Ten Essentials [37], that were originally formulated in the Sendai Framework [36]. For each essential a score is calculated that is then summed up to a total resilience score for the city or building, respectively.

For the ARCH resilience assessment, the 10 essentials are being adapted for historic areas and the scoring questions are formulated to suit the needs of heritage managers, urban planners and other actors involved within historic areas. An early prototype of the assessment,

covering adapted Essentials 1 and 2, was trialled at the third General Assembly meeting of the project in September 2020 and received positive feedback.

In contrast to the UNDRR Scorecards, the questions of the ARCH resilience assessment are not only mapped to the Ten Essentials, but also to the resilience dimensions described in section 2, the DRM phases, as well as the overarching topics of heritage management and social justice. Later on, this will enable the end-user to achieve a resilience score that can be broken down into the different categories and highlight resilience weak spots within these categories. Furthermore, the categorisation of the questions enables the linkage to other ARCH tools and information that are also partially classified in a similar way.

Like the UNDRR Scorecards, the ARCH resilience assessment will offer two different ways to conduct the assessment: A preliminary assessment and a detailed assessment. The first one can be conducted in a shorter period of time and give an initial idea of the resilience status of the historic area, the latter will be an extended version of the assessment, that is more comprehensive, enables a deeper analysis of the resilience of the historic area and in conclusion also requires more time and more expert knowledge to complete.

6. Conclusions and plan ahead

This document described the ARCH DRM Framework, a combined DRM / CCA cycle that takes considerations from heritage management and social justice into account. The framework is based on the DRM cycle proposed in [1] and combines this with climate-ADAPT's UAST [2] and the CURE framework [3]. Subsequently, the ARCH DRM Framework provides practitioners with an overview of which steps need to be undertaken to design a combined DRM / CCA plan. In addition, the ARCH DRM Framework provides the ARCH project partners with a conceptual frame into which the different solutions developed within the project can be positioned.

One specific ARCH solution with a closer link to the ARCH DRM Framework, the resilience assessment, was described in some more detail. The complete, detailed description of the assessment and its operationalisation will be described in the forthcoming deliverable D7.6. Currently, the resilience assessment prototype is being further developed to be ready for trialling by the ARCH pilot cities in the next months.

Based on the work presented in this report the ARCH Hub, the collaborative, web-based disaster risk management platform that will incorporate relevant ARCH solutions will be developed, also to be reported in D7.6. Part of the ARCH Hub will be the ARCH Resilience Assessment Dashboard, the operationalisation of the resilience assessment.

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