Shelter

Sustainable Historic Environments hoListic reconstruction through Technological Enhancement & community-based Resilience

D.4.1: Resilience ID incremental strategy

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Table of content

List of tables

List of figures

Glossary

Acronym	Full name
AMI	Areas of Mutual Interest
CCA	Climate Change Adaptation
CH	Cultural Heritage
CNH	Cultural and Natural Heritage
CNHM	Cultural and Natural Heritage Management
DDP	Data Driven Platform
DMF	Data Mapping Form
DRM	Disaster Risk Management
DSS	Decision Support System
EID	European Interoperable Database
EU	European Union
GIS	Geographic Information System
HA	Historic Area
HUL	Historic Urban Landscape
KPI	Key Performance Indicator
MMDM	Multiscale Multisource Data Model
OKF	Operational Knowledge Framework
OL	Open Lab
WP	Work Package

1 Executive summary

Adequate, georeferenced and easily accessible information is key for effective Disaster Risk Management and proper Cultural and Natural Heritage management. Information on risk assessment, prevention measures, preparedness systems and plans decrease the impacts that hazards may cause, and recovery planning increases the speed of recovery and the effectiveness of the response.

The scope of this deliverable is to describe a spatially explicit incremental documentation strategy, the "Resilience ID" (resilience identifier), which aims to store in the Multiscale Multisource Data Model, previously developed in SHELTER, all the relevant information needed for each phase of the Disaster Risk Management and to make it actionable when required. The Resilience ID has the objective of structuring the information following a multiscale approach, considering different scales and elements of Historic Areas and an incremental approach, which starts from prioritized elements and generates a roadmap for the dynamic completion of the information needed.

The Resilience ID is based on previous project results and builds on existing and identified information, providing the necessary context to activate different SHELTER tools, feeding the multiscale risk assessment, structuring its results as risk and vulnerability baseline of the selected target elements, storing the plans developed by the Decision Support System and interacting with the adaptation and maintenance scheduler to create spacially explicit programs. In summary, the Resilience ID, documents, structures and makes accessible the results generated by the application of the whole Operational Knowledge Framework of SHELTER.

All the required information has been identified and linked with Disaster Risk Management phases and elements of the Multiscale Multisource Data Model. This information includes the key information necessary for risk evaluation, indicators for the monitoring of the resilience and plans and programmed actions to improve the resilience. To ensure the replicability of the Resilience ID, several typologies of Historic Areas have been considered, taking into account their multiscalarity, by including different spatial scales such as buildings, districts, cities, regional and transnational historic areas. It has been considered also the variety of Cultural and Natural Heritage assets that they include and the multi-hazard scenarios that they face. The Resilience ID acknowledges the multidimensional character of the assessment, including cultural, environmental, economic, social, governance together with the physical resilience of the historic build environment.

SHELTER Open Labs have defined which elements of the Multiscale Multisource Data Model apply to their specific conditions, considering different details concerning the type of risk assessment required as well as on the available information and importance of the considered elements in the overall approach.

The flexibility provided by the Resilience ID allows for two data acquisition approaches, one based on a low data acquisition strategy based on already existing information for

data-rich environments and one based on a high data acquisition strategy, where data need to be specifically collected.

The Resilience ID represents a strategy aimed at increasing data availability in Historic Areas and which strongly supports the digitalization of Cultural and Natural Heritage. Within the SHELTER project, the models produced will be customized for each OL and all the information gathered will be visualised in the Resilience Dashboard.

2 Introduction

2.1 Aims and objectives

Adequate, georeferenced and easily accessible information is key for effective Disaster Risk Management (DRM) and proper Cultural and Natural Heritage Management (CNHM). Information on risk assessment, prevention measures, preparedness systems and plans and recovery planning decrease the impacts that hazards may cause and increase the speed of recovery and the effectiveness of the response. The **Resilience ID** (Resilience Identifier) is a multiscale and spatially explicit incremental documentation strategy intended to store in the Multiscale Multisource Data Model (MMDM) all this relevant information to make it actionable when required. Besides this, the Resilience ID structures and makes accessible the results generated by the application of the Operational Knowledge Framework (OKF) of SHELTER and could also support the monitoring of the resilience indicators. If any financing scheme is envisaged for the public and particulars owners, it could be linked to specific buildings and actions. The Resilience ID is implemented in an incremental and multiscale way:

- Multiscale approach: it includes information at the different scales of the model (mainly Historic Area (HA) and building, but could include also at object level)
- Incremental approach: the strategy starts from the prioritised elements (either for their community value or for the result of the risk assessment) and generates a roadmap for the dynamic completion of all the information needed for the HA.

Using the potentialities of the MMDM defined in the project[1], this task aims to propose a documentation procedure that:

- Structures all the information relevant to the Resilience of a HA
- Feeds the risk assessment methodology and consequently the Multi-hazard Risk Assessment module and Decision Support System (DSS) in the Data-Driven Platform (DDP)
- Makes quickly available information relevant to all Disaster Risk Management (DRM) phases
- Georeferences key indicators aiming to quantify resilience and to measure the success of adequate policies and strategies.

2.2 Relations to other activities in the project

The SHELTER project has been structured in 9 Work Packages (WPs) to ensure fertilisation among the different steps and partners. WP4 - "Collaborative planning low carbon systemic resilience" - is based on previous results, explained below, and it will develop actionable plans within the collaborative planning of the low carbon resilience in HA (see Figure 1):

[1] SHELTER deliverable "D1.4 Multiscale data model"

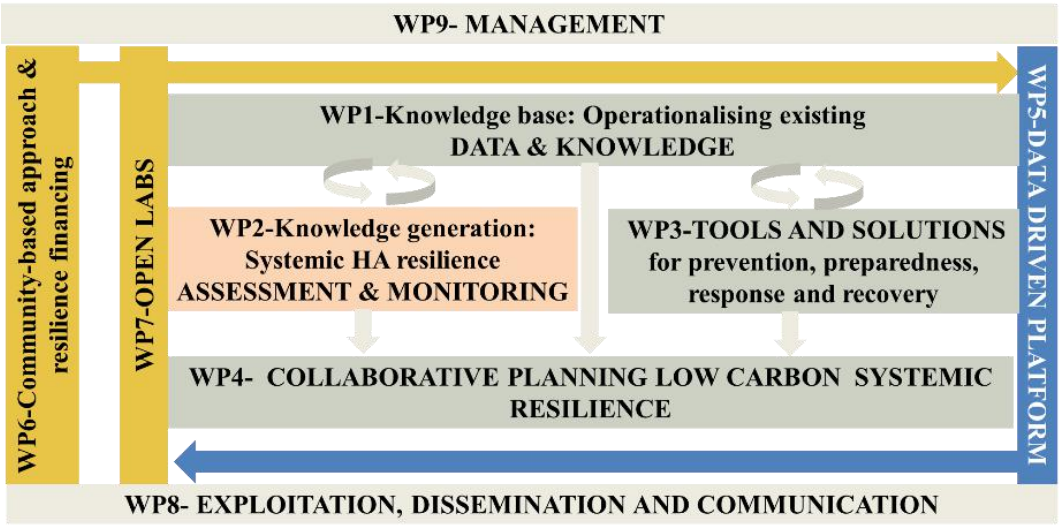

Figure 1 PERT chart of SHELTER

Within WP4, the aim of T4.1 – "Resilience ID incremental strategy"- is the definition of Resilience ID through the establishment of an incremental data collection. This task has a strong relationship with other WPs in SHELTER since it establishes the documentation strategy. The main relationships are the following:

WP1: Knowledge base: operationalising existing data and knowledge

- In T1.1 the identification, classification and evolution of useful data sources have been performed. The information collected in the Data Mapping Form (DMF) has been considered to define the Resilience ID
- In addition to that, when designing the data model, the concepts identified in the ontologies and the best practices collected in T1.2 – "Codification of existing knowledge" - have been also incorporated.
- In T1.4, the main requirements that the SHELTER data model should achieve have been identified and the MMDM has been created following international standards. This model set the basis for the definition of the Resilience ID.

WP2: Knowledge generation: Systemic Historic Area (HA) resilience assessment and monitoring

- Resilience ID is the documentation strategy of the SHELTER OKF which structure was defined in T2.1
- The list of indicators identified in T2.2 – "HA Systemic resilience assessment and monitoring framework" - has been also considered for the Resilience ID, as it establishes the conceptual basis for the resilience quantification and improvement of HA.
- Also, data from T2.3 – "Anatomy of HA: collective characterisation of CH assets" - have been included in the Resilience ID, which relates the type of heritage included in the HA with the framework established for categorising CNH assets, namely the building, natural and urban macro-categories.

- The methodology for the risk assessment is being developed in parallel in T2.5. The information related to HAs, especially the data that characterised the exposure and vulnerability of CNH, will be structured in the Resilience ID.
- The Resilience Index and the definition of the Key Performance Indicators (KPIs) for resilience monitoring are being identified in T2.7, as a set of indicators. The indicators will aim to quantify the links between multiple dimensions of HA resilience, the connections between different spatial scales and the changes across temporal scales. These tools will be based on information from the data model and other external sources for the assessment of resilience through the methodology and indicators that will be defined in T2.7 – "Development the SHELTER cross-scale HA systemic resilience assessment methodology".

WP4: Collaborative planning for building low carbon systemic resilience

- Resilience ID provides a structure to the results from T4.2 (Definition of protocols, plans and guidelines for CCA/DRM and integration within planning policies) and T4.3 (Strategy for early recovery roadmaps).
- Resilience ID will be connected to the adaptation and maintenance scheduler developed in T4.3.

WP5: Data-Driven Platform

- The Resilience ID will be visualised in the Dashboard developed in T5.3
- The Resilience ID will also feed the methodology implemented in the Multi-risk assessment module and DSS developed in T5.4

WP6: Community-based approach and resilience financing

- T6.1 identified the GLOCAL user requirements for the SHELTER project. User requirements related to the data have been used to define the general requirements of the Resilience ID.

WP7: Open Labs

- The relation between T4.1 and the Open Labs (OLs) is crucial. The implementation strategy has been defined with the inputs of the OLs.

2.3 Report structure

The document is structured as follows:

- **Section 1** is the Executive Summary.
- **Section 2** establishes the purpose of the deliverable and the links with other WPs and tasks of the SHELTER project.
- **Section 3** establishes the background for the task
- **Section 4** defines the role and workflow of the resilience ID in SHELTER OKF
- **Section 5** describes the methodological framework
- **Section 6** describes the definition of the Resilience ID

- **Section 7** describes the definition of the Resilience ID in the OLs
- **Section 8** defines the incremental strategy and the workflow
- **Section 9** draws the conclusions and the future work

2.4 Contribution of partners

The following table (Table 1) details the contribution of each partner to the development of the task and the editing of the deliverable:

Partner	Contribution
TEC	Responsible for the coordination of the task and deliverable. Led the overall methodology and coordinated activities with OLs. Participated in the definition of the Baixa Limia-Serra Do Xurés OL strategy. The main editor of the deliverable.
UNIBO	Responsible for the coordination of the task within the WP. Defined requirements and information to be included concerning WP4. Participated in the definition of the Ravenna OL strategy. Reviewer of the deliverable.
UPV/EHU	Defined requirements and information to be included concerning the solutions provided in WP3.
UNIS	Defined requirements and information to be included concerning the financial field.
RED	Defined requirements and information to be included about dynamic data.
EGIS	Defined requirements and information to be included about the MMDM and participated in the definition of the OLs strategies. Reviewer of the deliverable.
UNESCO	Defined requirements from the OLs perspective. Participated in the definition of the Sava OL strategy.

Table 1: Contribution of partners

3 Background

In the recommendation on the Historic Urban Landscape (HUL) of 2011, UNESCO states that *"Knowledge and planning tools should help protect the integrity and authenticity of the attributes of urban heritage. They should also allow for the recognition of cultural significance and diversity and provide for the monitoring and management of change to improve the quality of life and of urban space. These tools would include documentation and mapping of cultural and natural characteristics. Heritage, social and environmental impact assessments should be used to support and facilitate decision-making processes within a framework of sustainable development" [1].*

The conservation and management of CH require "*understanding the object and gathering data about its physical condition prior to any action and intervention that might change the object*" [2]. But an advanced knowledge of the assets is essential also to reduce the errors and negative consequences in DRM [3]. ProteCHt2save project identified the "*optimization of preventive and post-disaster documentation and mapping risk*" as one of the management strategies that can be learned from the experience of real disasters. Consequently, the lack of verified and complete data hinders the proper assessment of the risk and prevents the implementation of suitable measures [4].

Resilience ID aims to structure, georeference and make available all the information that the SHELTER project, and the Open Labs (OLs), have identified as important for resilience enhancement and DRM in HAs. This information includes the key information necessary for risk evaluation, indicators for the monitoring of the resilience and plans and programmed actions to improve the resilience.

The specific information for each OL will be structured in a multiscale data model based on INSPIRE and CityGML standards that was developed in an early stage of the project[2]. Urban models are increasingly necessary tools for the planning and development of policies as they can support the design of policies to the implementation of specific strategies [5]. Standard data models together with ontologies, also addressed in SHELTER[3], are critical tools to make accessible the information explicitly and in a machine-understandable way supporting the advanced analysis [6]. The following sections describe some examples of the use of georeferenced information for vulnerability and risk mapping.

3.1 Noah's Ark (Global climate change impact on built heritage and cultural landscapes)

The EU FP6 Project Noah's Ark (2004–2007) developed a vulnerability atlas with maps using the global and regional Hadley climate models, with grid resolutions of 295 × 278 km and 50 × 50 km. The project also developed guidelines for cultural heritage protection towards climate change. A Web GIS risk mapping tool was used for the identification of

[2] SHELTER deliverable "D1.4 Multiscale data model"

[3] SHELTER deliverable "D 1.2 : Building of best/next practices observatory", section 4 "Towards a collective knowledge: the ontology"

risk-prone areas and vulnerable CH areas exposed to extreme events related to climate change (particularly heavy rains, flood, and fire due to drought periods).[7]

3.2 ResCult project

The objective of the ResCult project (Increasing Resilience of Cultural Heritage) was to improve the capability of Civil Protection to prevent or lessen disasters impacts on CH by defining a European Interoperable Database (EID). The EID provides a unique framework for multi-stakeholders partners (such as Civil Protection, national Ministries, the European Union and local authorities) and a supporting decision tool to understand the risk of damage to CH as well as its impact on local communities [3].

3.3 ProteCHt2save

The project ProteCHt2save produced an online tool that visualizes interactive high resolutions hazard maps of Central Europe. Specifically, they produced [4]:

- Maps with a spatial resolution of 25X25 km for historical observation for both climate extreme indices and variables (for 1987–2016)
- Maps with a spatial resolution of 12X12 km of future projections of heavy rain, flooding, drought and extreme heat
- Changes in temperature and precipitation and climate extreme indices are available for 2 future 30-year periods (2021–2050 & 2071–2100) for the reference historical one (1976–2005) and under Representative Concentration Pathway scenarios RCP4.5 (stabilization) and RCP8.5 (pessimistic).

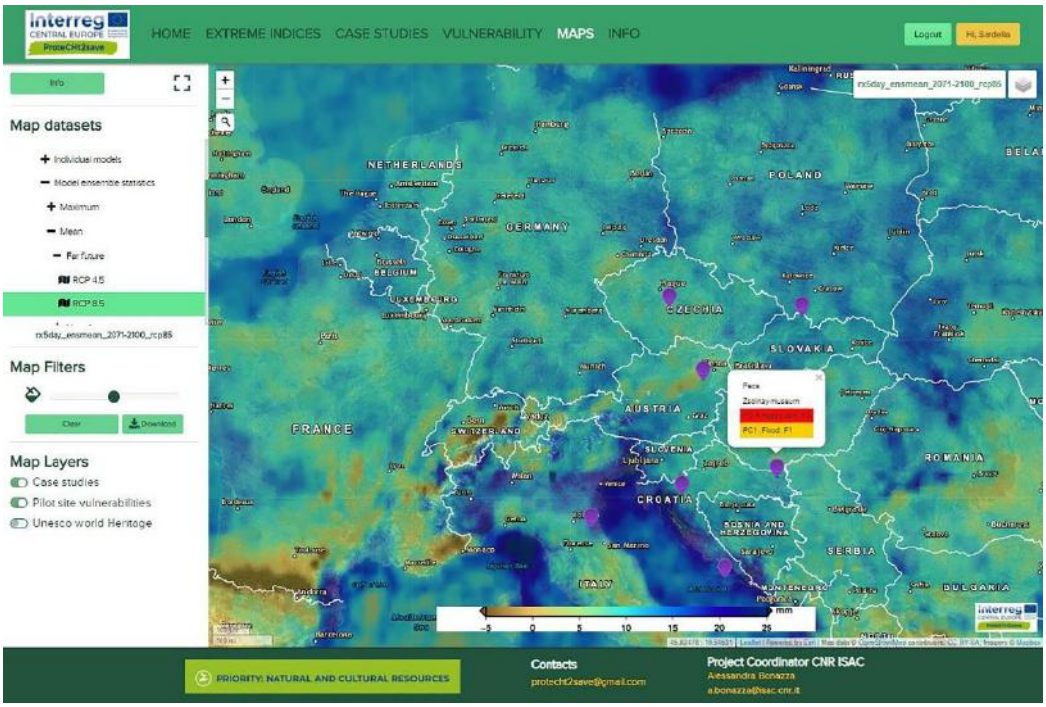

Figure 2: ProteCHt2save project

3.4 ADVICE

The ADVICE "Infrastructure and buildings adaptation to climate change" funded by the Basque Government, presents a methodology for assessing climate change-related risks in urban areas, focusing on extreme rainfall and flooding events. The project proposed a vulnerability evaluation integrating the architectural, socio-economic and cultural perspectives and a risk assessment based on indicators to support evidence in the decision-making process. The urban scale is addressed by the use of a sample building method, where data are extrapolated to obtain a risk index unique for each building, according to its vulnerability and exposure conditions. The MIVES method, based on a multiple criteria decision analysis, has been selected as appropriate for contributing to informed decision-making and a CityGML-based data model is used for the organisation and systematization of the information as well as for the graphical representation of results. The overall methodology has been applied and demonstrated in the city of Donostia-San Sebastián, a city located in northern Spain alongside a river estuary on the coastline [8].

Figure 3: Buildings vulnerability assessment in the city of San Sebastian

4 Role and workflow of the Resilience ID in SHELTER Operational Knowledge Framework (OKF)

Resilience ID aims to document and georeference all the relevant information for the resilience of the HA, within the SHELTER OKF it has a central role in structuring the results of the different tools making them available and actionable.

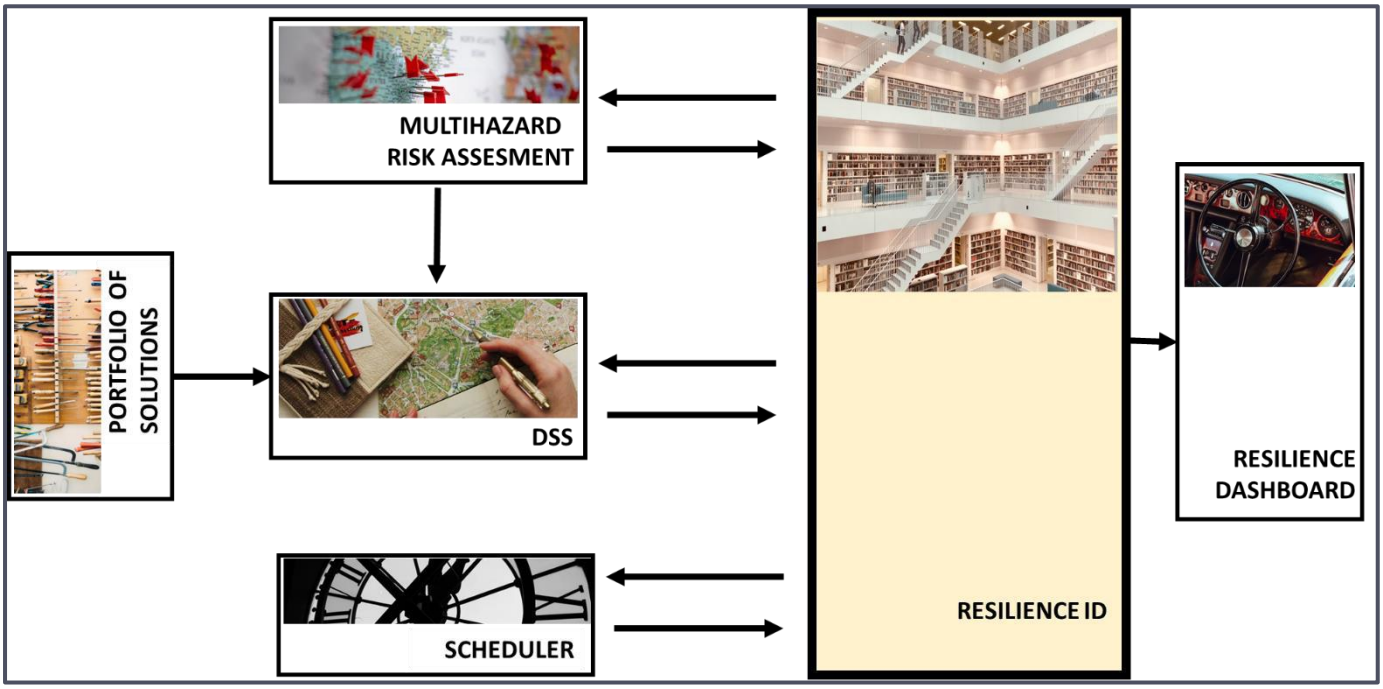

Figure 4: Role of the Resilience ID in SHELTER OKF

- The **multiscale risk assessment** will be fed by the information that is structured in the Resilience ID at different scales. The result of the assessment will establish the baseline regarding the risk and vulnerability of the selected target elements. This multiscale information will be associated with the elements of the Resilience ID to be available for the end-user.
- The **DSS** will use this baseline information to support the decision regarding which solutions from the **Portfolio of solutions** could increase the resilience and reduce the vulnerability of the given HA. The list of solutions (the planned ones along with the already existing ones) will be stored in the Resilience ID associated with the elements.
- This information will be used to create a roadmap with specific actions, timelines and financing requirements. The programmed actions will be managed by the **adaptation and maintenance scheduler.**

The specific workflow of the Resilience ID is described in Section 8.

5 Methodology

The methodology to build the Resilience ID followed these steps:

1. **Define existing information:** First existing and desired information was defined using the results of T1.1[4] (where all the information of the OLs was identified and mapped) and the expertise of the partners involved in the task.
2. **Define HA typologies:** The Resilience ID and its further application to the diverse variety of SHELTER OLs required for coordinated action between WP4 and WP7, especially for the implementation of the data models. Initially, three different parameters that influence multiscale resilience were identified: scale, hazard and type of Cultural and Natural Heritage (CNH).
3. **Link HA typologies with MMDM elements:** The SHELTER MMDM[5] aims to organize relevant information to represent the Resilience ID and facilitates access to the information through all the phases of DRM. The information of the multiscale model is organized around a geospatial data model with information at different scales (from the city to the region) and three-dimensional representation (3D). The SHELTER data model combines information provided by the OLs with information obtained from external sources. The MMDM allows the representation of a HistoricArea with the following entities: *HistoricArea, ProtectedSite, HazardArea, RiskZone, ObservedEvent, ExposedElement and CityObjects (Building, Vegetation, WaterBody, Transportation, CityFurniture*). Those entities will contain the required geometric and semantic data to store relevant cultural heritage and climate change information.

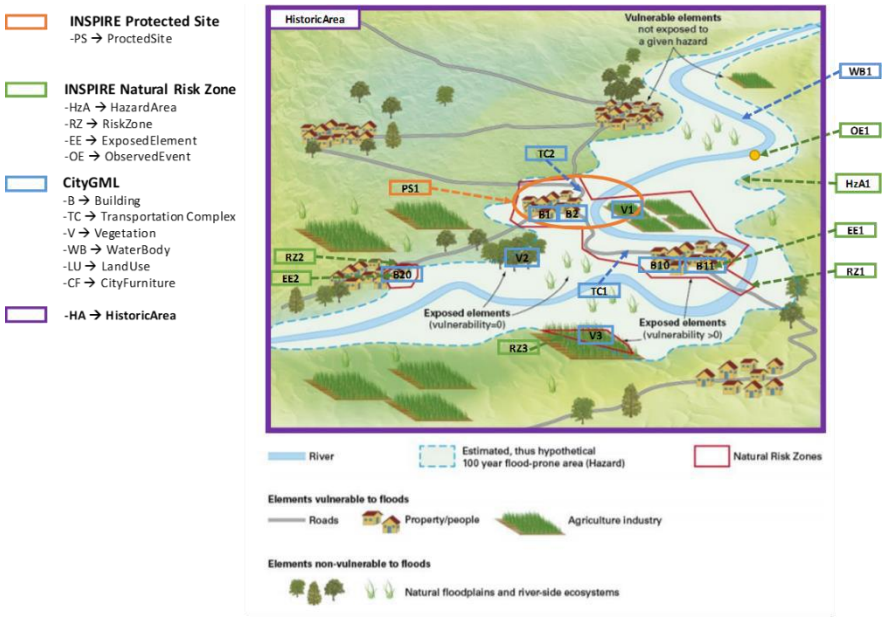

Figure 5: An example scenario where the main entities that will be included in the SHELTER MMDM are pointed out.

[4] SHELTER deliverable "D 1.1: Data sources and Knowledge"

[5] SHELTER deliverable "D1.4 Multiscale data model"

The following Table (Table 2) shows the definition of each element included in the SHELTER MMDM as well as the essential information needed for the Resilience ID. The elements marked as compulsory (x) are the ones establishing the minimum required information needed to build the Resilience ID, while other elements are included or excluded depending on the specific characteristics of the HA typology considered.

ELEMENT	COMPULSORY	DEFINITION
Historic Area - HA	X	Identifies the boundaries of the HA considered in the project and is defined by the OL
Hazard Area- HzA	X	Represents the area where a hazard can occur (current or expected in future) and is defined by the OL
Land Uses - LU	X	Uses as provided by Corine Land Cover 2018
Protected Site - PS	X	Area(s)/building(s) legally protected, as identified by OLs
Buildings - BU		May include, among others, buildings that are included in the HA but not formally protected, buildings with uses relevant for the risk assessment (critical facilities, fire stations, residential areas, etc.), museums and archives…
Transportation Complexes - TC		May include, among others, main communication roads, pedestrian areas, access for emergency vehicles, etc.
Vegetation -V		May include, among others, urban green areas, trees, native species, deadwood….
Water Bodies - WB		May include, among others, watercourses, lakes, sea, port infrastructure, storage equipment/infrastructure, monitoring and forecasting services, etc.
City Furniture - CF		May include, among others, shading devices, blue infrastructure, sculptures, Immersite
Exposed Elements - EE	X	Elements included in the historic area and in the hazard area
Risk Zones - RZ	X	Identifies vulnerable and exposed elements in the Hazard area, according to indicators and methodology established in T2.5
Observed Events - OE	X	Past events as reported in Task 1.2

Table 2: SHELTER MMDM elements, definition and minimum requirement information

4. **Implementation of the Resilience ID in the OLs:** through the interaction with the OLs it was defined which elements established in the SHELTER MMDM applied to the specificities of each OL.
5. **Definition of the workflow and the incremental strategy:** finally, the incremental strategy and the workflow that allows the development of the specific Resilience ID for each OL was defined

6 Definition of the Resilience ID

6.1 Requirement for the Resilience ID

In Task 6.1[6] ("GLOCAL user requirements"), the requirements for the SHELTER results were identified following a top-down and bottom-up strategy. Top-down requirements identified addressed the pre and post-disaster phases, while bottom-up requirements addressed, besides the already mentioned phases, also the disaster phase. The following tables (see Table 3 and Table 4) show and explain how the Resilience ID addresses a significant number of them:

TOP-DOWN REQUIREMENTS			
Topic	**Pre-disaster phase**	**Post-disaster phase**	**RESILIENCE ID Response**
Data	Georeferenced data	Platform of data consolidation (e.g. GIS)	MMDM is a georeferenced model
Data	Baseline data (including history of previous hazards)	Damage data standard (e.g. SAVA)	Previous hazards information is associated to the "Observed event" element
Data	Risk mapping (hazard, vulnerability)	Acquire data from other ministry (satellite image)	Risk assessment results will be included in the MMDM and calculated through the DSS
Analysis	Improving safety (protocols and tools)	Prioritization tool (Science, culture value)	Prioritization strategy and roadmap will be included in the MMDM as result of D4.2/DSS/ solution portfolio
Tool/ solution		Expert (contact info, training)	Information associated to the Historic Area element
Analysis	Monitor for evaluation improving and evacuation	Format of rapid assessment of damage and update damage information	Information will be associated to specific elements, risk zone or observed events
Analysis		Management Plan/ Action plan/implementation	Information associated to the Historic Area element
General	Emergency plan	Ameliorate governance system	Specific procedures for CH associated to protected sites or risk zone
General	Evacuation plan for movable heritage	Coordination (Civil protection & culture agency/ local government) just after incident (when, who, responsibility)	Specific procedures for CH associated to protected sites or risk zone

Table 3: Top-down requirements addressed by the Resilience ID

[6] SHELTER deliverable "D6.1 GLOCAL User requirement"

BOTTOM-UP REQUIREMENTS				
Topic	**Pre-disaster phase**	**Disaster phase**	**Post-disaster phase**	**RESILIENCE ID**
General	The SHELTER solution shall support the collection of data from a range of present information sources and the possibility of adding other information sources in the future.			Resilience ID is an incremental strategy and it conceived considering data increase
General	The SHELTER solution shall support the organisation of the information collected to enable an effective analysis			The MMDM is conceived to structure the information according to different elements
Analysis	Adjust specific parameters and scales for analysis			Resilience ID is conceived to give flexibility to users on the type and quantity of information and considers the diverse CH scales
Visualisation	Automatically visualisation of relevant content on digital mapping tool and content following a structured/ defined way			SHELTER MMDM is a digital map that allows visualising information
Visualisation	Specific content is visualised in combination with 3D models			SHELTER MMDM supports 3D content
Models	Implement state of the art index model with KPIs for resilience			Resilience KPIs are part of the Resilience ID related information
Visualisation	Geographic visualisation of risk and resilience measures over time			Resilience and risk are spatially represented in a defined area
Analysis	Resilience indicator assessment to map CH correctly due to vulnerability and resilience.			Resilience ID considers indicators for the calculation of risks and adaptative strategies for resilience improvement
Analysis			Financial calculation tool about losses. Need to identify financial solutions to protect CNH	Financial schemes and insurance tools, as result of T6.6 are included in the Resilience ID
Analysis	Risk monitoring system (including frequency, magnitude, probability, etc.).			Hazard characterisation is part of risk assessment, included as part of Resilience ID
Data	Database about CH in area of interest with several information about status.			MMDM represents different CH elements and store related information, including state of conservation

BOTTOM-UP REQUIREMENTS				
Topic	**Pre-disaster phase**	**Disaster phase**	**Post-disaster phase**	**RESILIENCE ID**
Analysis	Flood risk management plan for CH sites			MMDM will store information on available plans at HA scale
Data	Emergency, evacuation and communication plans available. The plans must be updated continuously so therefore a database with reminder would be good.			MMDM will store information on available plans at HA scale
Data	Location information about CH sites. The locations may be visualized in map.			The MMDM is a georeferenced model. Elements will be visualised in their locations
Analysis			Instrument/ database to receive total amount of damage after event.	Damages and losses are considered in resilience KPIs developed in T2.2
Analysis	Vulnerability assessment or analysis of CH in advance			Vulnerability is part of risk assessment, included as part of Resilience ID
Data	Flood data (return period, height, velocity, water quality).			Hazard characterisation is part of risk assessment, included as part of Resilience ID
Analysis			Information about status of measures taken before event starts available after event.	Available information on measures associated to each element of the MMDM
Equipment	Water pumps (specific for RAVENNA).			MMDM can store relevant information associated to equipment
Data	Database with value of CH not only money based. Value parameters to be defined			CH value will be included as part of the calculation of the risk assessment
Data	Database about the soil conditions (carbon, quality).			This parameter can be specifically included in the MMDM
Data	Database about the soil humidity			This parameter can be specifically included in the MMDM

Table 4: Bottom-up requirements addressed by the Resilience ID

6.2 Information and documentation for resilience

Information requirements have been initially identified considering the different phases of the DRM cycle. Information will consider results coming from other Tasks and WPs and will especially include: i) Resilience indicators and quantification; ii) Existing and planned solutions; iii) Planning, roadmaps and protocols; iv) Dynamic information and v) Financial information.

Table 5 shows the relation between the type of information and the DRM phase, as well as its applicability to the different scales (HA or building/element level):

PH-I-PREVENTION PHASE			
INFORMATION	**SOURCE**	**HA LEVEL**	**BUILDING/ ELEMENT LEVEL**
Resilience baseline	Dashboard	X	
Risk assessment	DSS	X	
Long term and short-term general HA adaptation roadmap	DSS/ solutions portfolio	X	
Adaptive governance scheme	D6.3	X	X
Specific long term and short-term adaptation plans	DSS/ solutions portfolio		X
Maintenance procedures and adaptation scheduler	Scheduler		X
Vulnerability assessment	DSS		X
PH-II- PREPAREDNESS PHASE			
INFORMATION	**SOURCE**	**HA LEVEL**	**BUILDING/ ELEMENT LEVEL**
Contingency plans	External	X	X
Early warning systems	D3.1	X	X
Risk management procedures	External	X	X
Training requirements	External	X	X
Adaptive governance scheme	D6.3	X	X
Consolidation and structural stabilization measures in emergency phases	D3.3	X	X
PH-III- RESPONSE PHASE			
INFORMATION	**SOURCE**	**HA LEVEL**	**BUILDING/ ELEMENT LEVEL**
Emergency procedures and protocols for short-term fast responses focused on CNH	D4.2	X	X
Consolidation and structural stabilization measures in emergency phases	D3.3	X	X
Adaptive governance scheme	D6.3	X	X
PH-IV- RECOVERY PHASE			
INFORMATION	**SOURCE**	**HA LEVEL**	**BUILDING/ ELEMENT LEVEL**
Risk-based optimal design guidelines and standards for reconstruction interventions	D4.2	X	X
Prioritization strategy and roadmap	D4.2/DSS/ solutions portfolio	X	

PH-IV- RECOVERY PHASE			
INFORMATION	**SOURCE**	**HA LEVEL**	**BUILDING/ ELEMENT LEVEL**
Pre-planned early recovery roadmaps for cultural heritage-conscious reconstruction under the principle of building back better and safer	D4.3	X	X
Back up 3D models with different level of details to preserve digital memory and support short- and long-term reconstruction strategies.	WP7- External		X
Adaptive governance scheme	D6.3	X	X

Table 5: Initial information and DRM phases

6.3 Structure of Resilience ID

Each element represented in the model will store the necessary resilience information that will be activated in the different phases of the DRM. Each OL will start to collect information on the prioritised elements and will generate a roadmap for the competition of the information of the whole HA. Available information, as well as information generated during the project, will be associated with one or different elements of the SHELTER MMDM, depending on the specificities of each OL, their governance structure and data collection procedures, such as sources and entities responsible for information gathering. Information and documentation related to demographic and socio-economic characteristics, planning, roadmaps and protocols, financial information as well as training and educational programmes are usually encountered at a larger scale, which can be the defined HA, while other information, such as existing solutions, specific adaptation plans, early warning systems or dynamic information related to sensors and monitoring tools can be associated to more specific elements, as a building or a protected site. Table 6 shows the information that has been identified as important to be included in the model and their relationship (highlighted in yellow colour) with one or several elements.

INFORMATION	HA	HzA	LU	PS	BU	TC	V	WB	CF	EE	RZ	OE
Social, demographic and economic characteristics												
Environmental characteristics												
Urban characteristics and morphology												
Buildings and infrastructures characteristics												
Transportation, connection and accessibility characteristics												
Natural resources												
Water storage infrastructure and systems												

INFORMATION	HA	HzA	LU	PS	BU	TC	V	WB	CF	EE	RZ	OE
Level of protection and protected elements				■								
Land cover classes			■									
Hazard characterisation based on intensity/ severity, duration, frequency, probability		■										
Planning (spatial, climate adaptation, DRM and CNH management)	■											
Adaptive governance schemes	■											
Adaptation roadmap	■											
Prioritization strategy and roadmap	■											
Specific long term and short-term adaptation plans	■			■	■	■	■	■	■		■	
Financial schemes and insurance tools	■											
Emergency procedures and protocols focused on CNH				■							■	
Emergency procedures on the evacuation of CH, stabilization measures and protocols				■							■	
Early warning systems	■	■		■	■	■	■	■			■	
Monitoring and forecasting tools	■			■	■	■	■	■			■	
Vulnerability assessment	■			■	■	■	■		■	■		
Maintenance procedures and adaptation scheduler	■			■	■	■	■	■	■			
Pre-planned early recovery roadmaps for cultural heritage-conscious reconstruction	■			■								
Risk assessment	■			■	■	■	■	■	■	■	■	
Rehabilitation and reconstruction planning	■											
Insurance/funds	■											
Shelter capacity/infrastructure	■										■	
Equipment	■										■	
Risk-based optimal design guidelines and standards for reconstruction interventions	■											
Back up 3D models to preserve digital memory and support reconstruction strategies	■			■								
Resilience index	■										■	
Awareness/information	■											
Training and education plans	■											
Contingency plans	■			■								
Scenarios resulting from ABM simulations	■											
Exposed individuals, activities, object/buildings/infrastructure and ecosystems									■	■		

INFORMATION	HA	HzA	LU	PS	BU	TC	V	WB	CF	EE	RZ	OE
Damage characterisation, casualties, economic losses												
Past event information												

Table 6: Information and documentation and their relation with SHELTER MMDM elements (HA - Historic Area; HZA – Hazard Area; LU – Land Uses; PS – Protected Site; BU - Building; TC – Transportation Complex; V - Vegetation; WB - Water Body; CF - City Furniture; EE - Exposed Element; RZ - Risk Zone; OE - Observed Event)

6.4 Phases of DRM

The Resilience ID aims at structuring all the information of a HA and make it quickly available during the DRM phases. The type of data stored will contribute to enhancing HA resilience in different steps by activating the necessary information when needed and according to the priorities of each phase. The identified resilience information will contribute to the following DRM phases:

INFORMATION	Prevention	Preparedness	Response	Recovery
Social, demographic and economic characteristics				
Environmental characteristics				
Urban characteristics and morphology				
Buildings and infrastructures characteristics				
Transportation, connection and accessibility characteristics				
Natural resources				
Water storage infrastructure and systems				
Level of protection and protected elements				
Land cover classes				
Hazard characterisation based on intensity/ severity, duration, frequency, probability				
Planning (spatial, climate adaptation, DRM and CNH management)				
Adaptive governance schemes				
Adaptation roadmap				
Prioritization strategy and roadmap				
Specific long term and short-term adaptation plans				
Financial schemes and insurance tools				
Emergency procedures and protocols focused on CNH				
Emergency procedures on evacuation of CH, stabilization measures and protocols				

INFORMATION	Prevention	Preparedness	Response	Recovery
Early warning systems				
Monitoring and forecasting tools				
Vulnerability assessment				
Maintenance procedures and adaptation scheduler				
Pre-planned early recovery roadmaps for cultural heritage-conscious reconstruction				
Risk assessment				
Rehabilitation and reconstruction planning				
Insurance/funds				
Shelter capacity/infrastructure				
Equipment				
Risk-based optimal design guidelines and standards for reconstruction interventions				
Back up 3D models to preserve digital memory and support reconstruction strategies				
Resilience index				
Awareness/information				
Training and education plans				
Contingency plans				
Scenarios resulting from ABM simulations				
Exposed individuals, activities, object/buildings/infrastructure and ecosystems				
Damage characterisation, casualties, economic losses				
Past event information				

Table 7: Information and documentation and their relation with DRM phases. The DRM phases highlighted in yellow colour represent the ones associated to the identified information

7 Implementation of the resilience ID in the Open Labs

SHELTER aims to develop an OKF that could be replicated in a big number of HA. To facilitate this replication, different HA typologies have been considered taking into account four factors: scale, type of CNH, addressed hazards and focus of the assessment.

As a first step, the overall methodology and the first proposal of information structure were shared during a monthly OL meeting. Secondly, to validate and tailor the strategy for the implementation of the Resilience ID in the OLs, bilateral meetings were organised with each OL. The objective of this dialogue was to define which elements established in the SHELTER MMDM applied to the specificities of each OL.

7.1 Scale

SHELTER aims at building a **multiscale resilience** and provides an articulated scenario based on its OLs, which include different spatial scales such as buildings, districts, cities, regional and transnational historic areas, considering built and unbuilt areas in urban, natural and mixed sites. The SHELTER conceptual framework (see D2.1[7]) grouped and categorised buildings and archaeological sites as object/building scale and neighbourhoods/districts, cities and regions as urban/territorial scale, as different methods for resilience assessment may be applied. The quantity and type of information needed to perform the resilience assessment vary according to the number of elements and extension of the area considered, as well as on data already available or collected. The incremental documentation strategy approach allows therefore to establish a risk assessment and resilience potential method according to specificities and characteristics of the site.

7.2 Type of Cultural and Natural Heritage

To address the **variety and diversity of heritage** features and scales which represent the OLs, Task 2.3 developed a methodology for the anatomy of Historic Areas aimed at characterizing the CNH assets in a Risk-Informed Thinking perspective and providing a practical approach to the management of HA in a DRM perspective (see D2.3[8]). In order to manage the HA complexity together with its specificities and scale, the methodology proposes a characterization built on macro-categories, as the highest level of anatomy, which are identified as Building, Urban and Natural. The Building macro-category refers to any kind of monument or historic building, located in both urban and rural areas, including complex buildings such as monasteries, industrial heritage, infrastructure, etc. and movable and intangible heritage. The Urban macro-category refers to a human settlement of different sizes and it refers both to historical cities as a whole and urban areas. It addresses the complex relationship among heritage assets, urban development and urban heritage resilience. Finally, the Natural macro-category refers to natural heritage assets of different sizes and types comprising human settlements, building sites

[7] SHELTER deliverable “”D2.1 HA Resilience structure”

[8] SHELTER deliverable “D2.3 Anatomy of HA”

and shelters where the natural landscape component is a relevant priority for the characterization of the site

7.3 Hazards

SHELTER OLs are exposed to different hazards and, in some cases, present **multi-hazard** scenarios. Hazards are usually characterised by their spatial nature and time dimension, thus can be generally mapped in a specific location and can be expressed in the probability of occurrence or return periods. Task 2.4 elaborated a proposal for clustering hazards in line with their main determinants (Table 8), the ones addressed by the project and OLs are reported below:

Hazard group	Main biophysical/weather/climate determinants	Hazard main type
Geophysical Originating from mass movement of solid earth.	Mass movement	Subsidence
		Earthquake
Meteorological Short-term or small-scale weather conditions (e.g., minutes to days).	Precipitation	Rainstorm
	Wind	Severe wind/storm
	Temperature trends and patterns	Heat wave
Climatological Long-term or large-scale atmospheric processes (e.g., intra seasonal to multi-decadal).	Wildfire	Forest fire and land fire
Hydrological Mass movement of water influenced by meteorology	Flood	Surface flood/runoff
		River flood
		Coastal flood
	Wave action	Storm surge

Table 8: Clustering of hazards according to the main biophysical drivers/determinant, based on SHELTER D2.4[9]

7.4 Focus of the assessment

SHELTER is built on a CNH centred vision and aims at providing a **multidimensional resilience** that considers cultural, environmental, economic, social, governance together with the physical resilience of the historic build environment. Nevertheless, the factors previously described influence the type of resilience assessment required by each OL, which may present different levels of maturity in each domain. The spatial scale, location and type of heritage highly determine the focus of the assessment, which can be twofold: more focused on cultural heritage elements or focused on an integrated approach that considers the HA as a whole. The first one can be related to cultural heritage with a high protection level that may require efforts in producing specific and accurate information with a high level of detail, or to heritage elements disperse in wide territories which may require more efforts in data collection but minor level of detail. The

[9] SHELTER deliverable "D2.4 Characterisation of hazards, climate change events and impacts"

second approach can be related to aspects such as the context and location of CNH which should be taken into account while fixing the scope of the assessment: heritage located in urban areas or historic areas with a mixture of protected and not formally protected elements may require for a more general approach, considering aspects related to other functions and characteristics, such as demographic and socio-economic characteristics, including tourism and visitors.

7.5 HA typologies in SHELTER

SHELTER OLs have been selected considering their CHN values and diversity, their exposure to diverse hazards, their scale and typology and their geographical representability and climate conditions.

The Resilience ID and its further application to the diverse variety of SHELTER OLs required for coordinated action between WP4 and WP7, especially the implementation of the data models. The objective of this dialogue was:

- to define which elements established in the SHELTER MMDM applied to the specificities of each OL, which were compulsory for all OLs
- to identify the associated geometric extension of these elements.
- to identify the target elements of the assessment: first if natural elements will be taken into account or only cultural elements and secondly if within urban areas only historic buildings will be considered or all the buildings within the selected area.

In Figure 6 dark yellow cells show the main scale, hazards, heritage type and assessment focus for each OL, while light yellow cells secondary or complementary categories:

			Area of Santa Croce. Ravenna	Seferihisar	Dordrecht	Baixa Limia-Serra Do Xurés	Sava River Basin
Scale	Building-District						
	District-city						
	Region-Transnational						
Hazards	Geophysical	Earthquakes					
		Subsidence					
	Meteorological	Storms					
		Heat waves					
	Hydrological	Floods					
	Climatological	Wildfire					
Type of heritage	Category	Building					
		Urban					
		Natural					
Experience and data	Level of experience in DRM instruments		High	Medium	High	Medium-high	High
	Level of information		Medium	Low-medium	High	Medium-high	Medium-high
Focus of the assessment	Only heritage elements						
	Historic area as a whole						

Figure 6: Scale, hazards, type of heritage, experiences and focus of the assessment for each OL

7.6 MMDM elements for each OL

To identify which elements of the SHELTER MMDM should be included in each OL according to their specific characteristics, and the level of detail of the information that will be gathered according to their priorities, bilateral meetings were organised. The selection of the elements was initially focused on the geometric area that the model will cover, as well as on the elements that will need to be visualised and spatially

represented, while semantic information will be included considering different details in relation to the type of risk assessment required by each OLs as well as on the available information and importance of the considered elements in the overall approach. Table 9, Table 10, Table 11, Table 12 and Table 13 summarise the type of information and the level of detail that will be included in the SHELTER model for each OL.

RAVENNA		
ELEMENT	**TYPE OF INFORMATION**	**LEVEL OF DETAIL**
Historic Area - HA	This is the monumental area of S. Vitale and its surrounding buffer zone in which the complex of Santa Croce is included	High
Hazard Area- HzA	Maps of the 3 hazards (earthquake, subsidence and floods) and associated parameters on intensity, probability, frequency	High
Land Uses - LU	Corine Land Cover 2018	Low
Protected Site - PS	Buffer zone, San Vitale, Mausoleo di Galla Placidia, Santa Croce	High
Buildings - BU	All other buildings included in the HA (archives, Guardia di Finanza, residential buildings, museum). Information associated to visitors, residents, use…	Medium
Transportation Complexes - TC	Pedestrian streets, parking area.	Low
Vegetation -V	Green areas. Include results of T2.6 simulation	Low
Exposed Elements - EE	Elements included in the historic area and in hazard area	High
Risk Zones - RZ	Identifies vulnerable and exposed elements in the Hazard area	High
Observed Events - OE	Past events as reported in Task 1.2	High

Table 9: MMDM elements for the Ravenna OL

SEFERIHISAR		
ELEMENT	**TYPE OF INFORMATION**	**LEVEL OF DETAIL**
Historic Area - HA	The inner area of the Citadel	Medium-high
Hazard Area- HzA	Maps of the 2 hazards (earthquake and heatwaves) and associated parameters on intensity, probability, frequency	High for earthquake and medium for heatwaves
Land Uses - LU	Corine Land Cover 2018	Low
Protected Site - PS	The whole area is a protected site. Monuments included in the area and the walls	High
Buildings - BU	All other buildings included in the HA, mainly residential	Medium- low
Transportation Complexes - TC	Pedestrian/limited vehicles streets	Low
Vegetation -V	Green areas. Include results of T2.6 simulation	Low
Water Bodies - WB	Sea	Low
Exposed Elements - EE	Elements included in the historic area and in hazard area	High
Risk Zones - RZ	Identifies vulnerable and exposed elements in the Hazard area	High
Observed Events - OE	Past events as reported in Task 1.2	High

Table 10: MMDM elements for the Seferihisar OL

DORDRECHT		
ELEMENT	**TYPE OF INFORMATION**	**LEVEL OF DETAIL**
Historic Area - HA	Part of the historic city centre	Medium-high
Hazard Area- HzA	Maps of the 2 hazards (floods and heatwaves) and associated parameters on intensity, probability, frequency	High for floods, medium for heatwaves
Land Uses - LU	Corine Land Cover 2018	Low
Protected Site - PS	Municipal and National database on protected elements	High
Buildings - BU	All other buildings included in the HA, mainly residential	Low
Vegetation -V	Green areas	Medium
Water Bodies - WB	No need to associate information, just location	Very low
City Furniture - CF	Immersite	High
Exposed Elements - EE	Elements included in the historic area and in hazard area	High
Risk Zones - RZ	Identifies vulnerable and exposed elements in the Hazard area	High
Observed Events - OE	Past events as reported in Task 1.2	High

Table 11: MMDM elements for the Dordrecht OL

BAIXA LIMIA-SERRA DO XURÉS		
ELEMENT	**TYPE OF INFORMATION**	**LEVEL OF DETAIL**
Historic Area - HA	The boundaries of the area covers the whole extension of the natural park	Medium
Hazard Area- HzA	Map of the hazard (wildfire) and associated parameters on intensity, probability, frequency as well as other relevant parameters (wind, precipitation and temperature) and soil type	High
Land Uses - LU	Corine Land Cover 2018, SIOSE	Low
Protected Site - PS	Archaeological sites, natural areas (NATURA2000, EMERALD sites, RAMSAR, or other local protection figures), high value agricultural areas, biodiversity, historic assets	Medium-high
Buildings - BU	Other buildings which are important for the risk assessment and management (fire stations, visitors centres…) as well as historic settlements and houses	Low
Vegetation -V	Non- protected natural green areas, biodiversity, dead wood, type of vegetation, inventory of local species	High
Transportation Complexes - TC	Main roads and connections	Low
Water Bodies - WB	Rivers, lakes, wetlands	Low
Exposed Elements - EE	Elements included in the historic area and in hazard area	High
Risk Zones - RZ	Identifies vulnerable and exposed elements in the Hazard area	High
Observed Events - OE	Past events as reported in Task 1.2	High

Table 12: MMDM elements for the Baixa Limia-Serra Do Xurés OL

SAVA RIVER BASIN		
ELEMENT	**TYPE OF INFORMATION**	**LEVEL OF DETAIL**
Historic Area - HA	The boundaries cover all Areas with mutual interest (AMI)	Medium-low
Hazard Area- HzA	Map of the hazard (flood) and associated parameters on intensity, probability, frequency according to 2 scenarios (low and medium probability)	High
Land Uses - LU	Corine Land Cover 2018	Low
Protected Site - PS	Buildings and polygons, including natural sites	High
Buildings - BU	Mainly critical facilities and residential areas	Medium-low
Transportation Complexes - TC	Main roads and connections	Low
Water Bodies - WB	All information already available	High
Exposed Elements - EE	Elements included in the historic area and in hazard area	High
Risk Zones - RZ	Identifies vulnerable and exposed elements in the Hazard area	High
Observed Events - OE	Past events as reported in Task 1.2	High

Table 13: MMDM elements for the Sava River Basin OL

8 Definition of the incremental strategy and workflow

The information requirements for DRM, CNH and CCA are expanding with the new technologies and methodologies, therefore an incremental approach is necessary to ensure to have operative results as soon as possible. This incremental strategy to build the Resilience ID has to be iterative to address the DRM phases. During the pre-disaster phase, the Resilience ID has to be built, used and updated to be prepared for trans-disaster and post-disaster phases (see Figure 7).

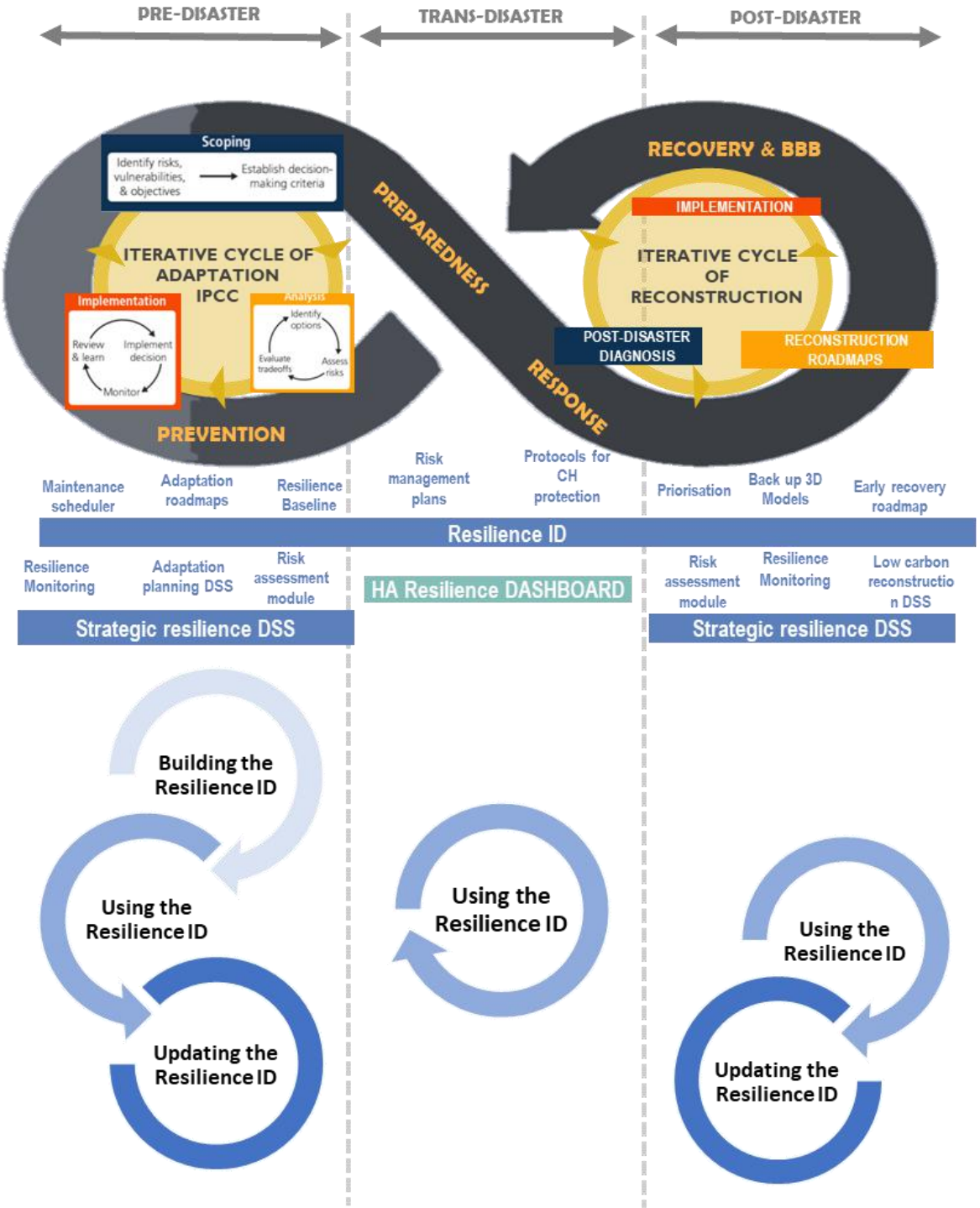

Figure 7: Resilience ID in DRM

The implementation of the Resilience ID will follow three stages that are different for each DRM phase. The three stages are the following:

1- **Building the Resilience ID**, where the MMDM is built and the key semantic information (information necessary to calculate the key indicators) is introduced.

2-**Using the Resilience ID,** where SHELTER tools are used to generate adaptation, prevention and recovery long and short roadmaps within the SHELTER OKF

3- **Updating the Resilience ID,** where more information is added, the model is adapted to new scenarios, the roadmaps are updated, and the indicators are monitored.

The first stage is developed once only in the adaptation phase, but the other two are iterative during the other phases as can be seen in Figure 7

STEP			CODE		DESCRIPTION	SHELTER TOOL
PREDISASTER PHASE	1- Building the Resilience ID	Identifying the scope of the model	IB1	Type of CNH	Identify the type of HA that will be addressed	MMDM
			IB2	Geographical	Define the geographical area of the HA	MMDM
			IB3	Target elements	Identify all the elements that will be prioritised as targets (only CNH elements or	MMDM
		Building the MDMM	IB4	Geometric information	The 3D model is built	MMDM
			IB5	Semantic information	Key semantic information: information necessary for the SHELTER tools and indicators	MMDM
	2-Using the Resilience ID	Assessing the risk and vulnerability	IU1	Baseline risk of the target elements	Using the Multi-risk assessment tool the baseline risk of the target element will be quantified for the current scenario	Multi-risk assessment tool
			IU2	Creating scenarios	Using the Multi-risk assessment tool the risk of the targets element will be quantified for future scenarios using Climate change projections	Multi-risk assessment tool
		Building adaptation/prevention strategies	IU3	Selecting strategies	Using the DSS and the results from steps U-1 and U-2 the most suitable strategies will be selected and associated with each element in the MMDM	DSS
		Programming long term and short term adaptation/prevention strategies	IU4	Programming strategies	The selected strategies (U-3) will be associated with a timeline through the maintenance/adaptation scheduler	Maintenance / adaptation scheduler
			IU5	Financing information	The financing and business model of the programmed	

STEP			CODE		DESCRIPTION	SHELTER TOOL
					actions will be linked to their elements	
		Monitoring Resilience KPI	IU7	Resilience baseline	The baseline of the prioritised indicators will be linked with an element	Dashboard
		Making available the information	IU8	At building level/element	Emergency procedures and protocols for short-term fast responses focused on CNH	
			IU9		Early warning systems	
			IU10		Risk management procedures	
			IU11		Training requirements	
			IU12		Consolidation and structural stabilization measures in emergency phases	DSS
			IU13		Back up 3D models with different level of details to preserve digital memory and support short- and long-term reconstruction strategies	
			IU14	At HA level	Adaptive governance scheme	
			IU15		Contingency plans	
			IU16		Pre-planned early recovery roadmaps for cultural heritage-conscious reconstruction under the principle of building back better and safer	
			IU17		Risk-based optimal design guidelines and standards for reconstruction interventions	
	3- Updating the Resilience ID	Broadening the scope	IUP1	New target elements	The model can be updated including other elements that were not considered	MMDM
			IUP2	Bigger area	The model can be updated including a bigger area	MMDM
			IUP3	New hazards	New hazards can be included in the assessment	MMDM
		Re-assessing the risk and vulnerability	IUP4	Baseline risk of the target elements	A new baseline will be calculated based on the new information	Multi-risk assessment tool
		Updating the road map	IUP5	Selection strategies	New strategies can be selected using the new information or changing priorities/preferences/contextual conditions	DSS
			IUP6	Financing	The financing and business plans can be updated	MMDM
			IUP7	Re-programming	Reprogramming the actions	Scheduler
		Including more information	IUP8	New plans and 3D model	New plans and 3D models can be incorporated to the model	MMDM
		Monitoring Resilience KPI	IUP9	Updating KPI	The KPIs will be updated regularly	

STEP			CODE		DESCRIPTION	SHELTER TOOL
PREDISASTER PHASE	**2-Using the Resilience ID**	Making available key information	IIU1	At building level/element	Emergency procedures and protocols for short-term fast responses focused on CNH	
			IIU2		Early warning systems	
			IIU3		Risk management procedures	
			IIU4		Training requirements	
			IIU5		Consolidation and structural stabilization measures in emergency phases	
			IIU6	At HA level	Adaptive governance scheme	
			IIU7		Contingency plans	
POST DISASTER PHASE	**3- Updating the Resilience ID**	Calculating damage	IIIUP 1	Calculating damage	The Resilience ID can be used to calculate the occurred damaged	
		Updating the model	IIIUP 2	Updating the model	The model has to be updated to the new circumstances	MMDM
	2-Using the Resilience ID	Planning post disaster phase	IIIU1	Accessing to reconstructio n guidelines	Risk-based optimal design guidelines and standards for reconstruction interventions	
			IIIU2	Roadmap	Prioritization strategy and roadmap	DSS
			IIIU3	Accessing to Pre-planned early recovery roadmaps	Pre-planned early recovery roadmaps for cultural heritage-conscious reconstruction under the principle of building back better and safer	
			IIIU4	Updating governance scheme	Updating adaptive governance scheme	

Table 14: Resilience ID incremental strategy

All the information gathered in the Resilience ID will be visualised in the Resilience Dashboard that is being developed in T5.3 (“Resilience Dashboard”).

9 Conclusions and outlook

Within SHELTER project Resilience ID aims to establish a documentation strategy that will allow structuring and georeferencing key information for the planning of CCA, DRM and Resilience enhancement. In this report, a general framework has been established that has been adapted to SHELTER OLs depending on their scale, CNH type, challenges, interests and data availability. Two different approaches to data acquisition have been followed:

- Low data acquisition strategy where existing data only have been used (for data-rich environments)
- High data acquisition strategy where data is been recollected

The flexibility of the approach will allow high replicability in different HAs. The next steps will be to customise the model for each OL in WP7, including the results coming from other tasks.

The Resilience ID is an effort in the direction of digitalisation of the CNH and construction sector. It will support data transparency and increase the data availability of historic environments that will be beneficial for Resilience in HAs but also open other possibilities in other sectors (tourism, data applications, local start-ups…).

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