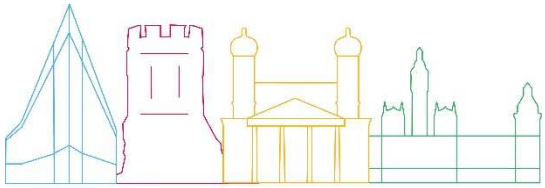
ARCH

D6.1 ARCH Resilience Measures Inventory

Concept and user guide



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List of Abbreviations

Abbreviation	Meaning
ARCH	Advancing Resilience of historic areas against Climate-related and other Hazards
BCA	Benefit-Cost Analysis
CCA	Climate Change Adaptation
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EU	European Union
ICCROM	The International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOMOS	International Council On Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
PNACC	Plan Nacional de Adaptación al Cambio Climático (Adaptation to Climate Change National Plan)
RAD	Resilience Assessment Dashboard
RD+I	Research Development and Innovation
RMI	Resilience Measure Inventory
SECAP	Sustainable Energy and Climate Action Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPA	Unión de Pequeños Agricultores y Ganaderos (Small Farmers and livestock breeders union)

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,* as a result from "*Task 6.1. Inventory of preparation prevention, emergency preparedness, response, and recovery options"* within work package 6 "*Resilience options & Pathway"*. This report, "D6.1 ARCH Resilience Measures Inventory: Concept and user guide" is a supporting document to the key output of the task, the ARCH Resilience Measures Inventory (RMI). It is a **practical deliverable** that is **conceived to describe the content and structure of the RMI to support its use and navigation**. The RMI is conceptualised to support municipalities and relevant stakeholders to identify suitable resilience measures for historic areas as a way to protect European cultural heritage and socio-ecological systems. The focus of the inventory is twofold: 1) built heritage as well as 2) cultural landscapes, with focus on agricultural heritage.

The RMI is an inventory of suitable resilience measures for Historic Areas, gathered from good practices, literature review and stakeholders' inputs which provides a general description as well as a general assessment of the implementation of these measures. It uses Microsoft's software Power BI, a tool for visualising data and analytics reporting tool format, which is easy to use and makes it possible to explore, identify, and assess features of the resilience measures such as visual, physical or spatial impacts of the solutions as well as their co-benefits. Eleven filter types have been included in order to help identify the most relevant measures for each case as more than 250 examples of resilience measure are presented in the RMI. These measures are classified according to their objectives in 71 subgroups which are gathered in 17 groups of resilience measures. RMI comprises not only structural or mechanical tools and measures to build resilience on historic areas, but also management, economic or social measures appliable for the sites aiming to be sustainably resilient to different hazards.

At the beginning of the report an overview is given in the context of the work package and project, followed by the description of the purpose and intended uses of the RMI Tool. The report further describes the methodology used for data gathering and the co-creation activities carried out in the process of the RMI development. The next subsections define the structure and content of the inventory and give some examples of possible use cases for the RMI.

1. Introduction

The Resilience Measures Inventory (RMI) and this report have been prepared for the European Commission-funded research project ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards. ARCH aims to enhance the resilience of areas of historic and cultural value to climate change-related and other hazards. Tools and methodologies are being developed with the pilot cities of Bratislava, Camerino, Hamburg, and Valencia, in a co-creative approach with local policy makers, practitioners, and community members. The results will be combined into a collaborative disaster risk management platform for local authorities and practitioners, the urban population, and international expert communities. A range of models and methods will be developed to support decision-making at appropriate stages of the resilience management cycle. The results of the co-creation processes with the pilot cities will be disseminated to a broader circle of other European municipalities and practitioners and through European standardization.

The RMI comprises a compilation of suitable resilience measures for historic areas, based on work conducted in previous tasks of the project (T3.3., T7.1., T7.2.) together with a desk-based research on existing guides, inventories, and toolkits of resilience measures in urban and historic areas facing risks and hazards. Therefore, the set of resilience measures presented in the inventory is based on previous already existing solutions, some theoretical and some already applied. The Inventory will also support T6.2 "*Assessment of long-term implementation options*" and T6.3 "*Inventory and categorization of funding opportunities*" as the performance of resilience measures and identification of funding opportunities and financing models are based on the solutions identified in T6.1.

The information gathered from the above-mentioned sources has been analysed, mined and joint in groups of measures corresponding to the objectives that ARCH is tackling. Following this data processing and aiming for further refinement, the RMI has been shared and co-worked with the ARCH partners for input, particularly with the pilot cities and their local stakeholders.

This document's objective is to describe the content, structure, and functionalities of the RMI, being the main outcome of Task 6.1., to support users in its navigation. Furthermore, this report presents the development of the inventory, as well as guidelines for navigating it.

1.1. Gender statement

The RMI 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 "Mainstreaming gender in building cultural heritage resilience".

Following these guidelines, the RMI has been built under the gender perspective to conduct a gender mainstreaming in the work carried out as follows:

- Ensuring gender balance when considering the researchers who carried out the development of the RMI in the framework of the task 6.1 and the reviewers.

- Providing equal opportunity to all members of the consortium and external participants when involved in the meetings and feedback workshops carried out in the framework of the task 6.1. for the development of the RMI.

1.2. **Structure of this report**

The report is divided into 5 parts. Following this introduction, section 2 describes the purpose and potential uses of the inventory and its scope. Section 3 presents the rationale of the development of the inventory; the development approach is described following the co-creation activities carried out together with ARCH partners. This allowed to collect their inputs regarding the list of measures and final user preferences. Section 4 focuses on the content of the inventory (namely the resilience measures and associated information), their categorization and the sequence of steps to be followed to access and navigate the tool to obtain a resilient measures portfolio. Section 5 provides step by step guidance for the three specific examples of potential use cases.

2. Objectives, content and potential uses of the Inventory

2.1. Objectives

One of the ARCH project objectives is to advance on tools and approaches to help city administrators, heritage managers, and related stakeholders to develop their resilience strategies considering both Disaster Risk Management (DRM) and Climate Change Adaptation (CCA) while ensuring that their decisions strengthen the resilience of their heritage and consequently the whole city/municipality. In line with this objective, the RMI has been developed.

The aim of the RMI is to help users to identify suitable measures for improving resilience and assess them according to different aspects, such as compatibility with the historic structure, implementation conditions, co-benefits, etc. Additionally, the selected measures aim at covering all the DRM phases, namely 'pre-disaster', 'during', 'post-disaster', as well as climate change adaptation, in compliance with the ARCH DRM Framework (D7.3). [1]

The proposed resilience measures have also been structured according to:

(i) their applicability to different scales of implementation (element, district, or territory) associated to the wider urban context, the main scope of the ARCH project,

(ii) their compliance with conservation principles, as reported in D7.1 [2], and

(iii) the most relevant hazards faced by the pilot cities of ARCH, according to the baseline reports (D3.3 [3]).

The RMI structure also integrates the resilience essentials (or resilience thematic areas) included in the ARCH Resilience Assessment Dashboard (RAD, WP7) to help identifying resilience measures once the resilience of a historic area has been assessed.

A web-based tool format, Microsoft Power BI, was selected to increase the user-friendliness of the RMI. Furthermore, considering the end-user requirements and needs collected and reported in D7.4 [4], resilience measures have been classified -according to their similarities in function and characteristics (see subsection 4.4.2)- in two hierarchical levels "group" and "subgroup" to facilitate exploring and selecting measures and to support decision making in the selection of suitable solutions. Filtering criteria are also included to help to better explore and select from the large number of resilience measures collected.

2.2. What does the inventory cover?

Based on the Grant Agreement and the initial conversations with the ARCH pilot cities, which later on have been confirmed in the baseline reports (D3.3), Tecnalia adopted a twofold focus on 1) historic buildings and structures, and 2) cultural heritage landscapes, *e.g.* the Globally

Important Agricultural Heritage System (GIAHS) such as of l'Horta de València[1]. RMI incudes *e.g.* NBS and urban measures, as these support the resilience of the socioecological system associated to the cultural heritage (see Figure 1 for the description of the socioecological systems).

Thus, the RMI includes:

- a wide range of resilience measures for historic areas, such as urban environments, heritage buildings & structures and agricultural heritage sites (considered within cultural landscape) as a way to protect European cultural heritage and socio-ecological systems.

- measures to be implemented in urban environments, that while not necessarily suitable for heritage areas, can nonetheless be considered for implementation in their vicinity *e.g.* to minimize impacts of extreme heat & heatwaves and flooding

- measures that address primarily flooding, extreme heat & heatwaves, drought & water scarcity, and earthquakes. It will also consider, to a lesser extent, landslides, and biological hazards.

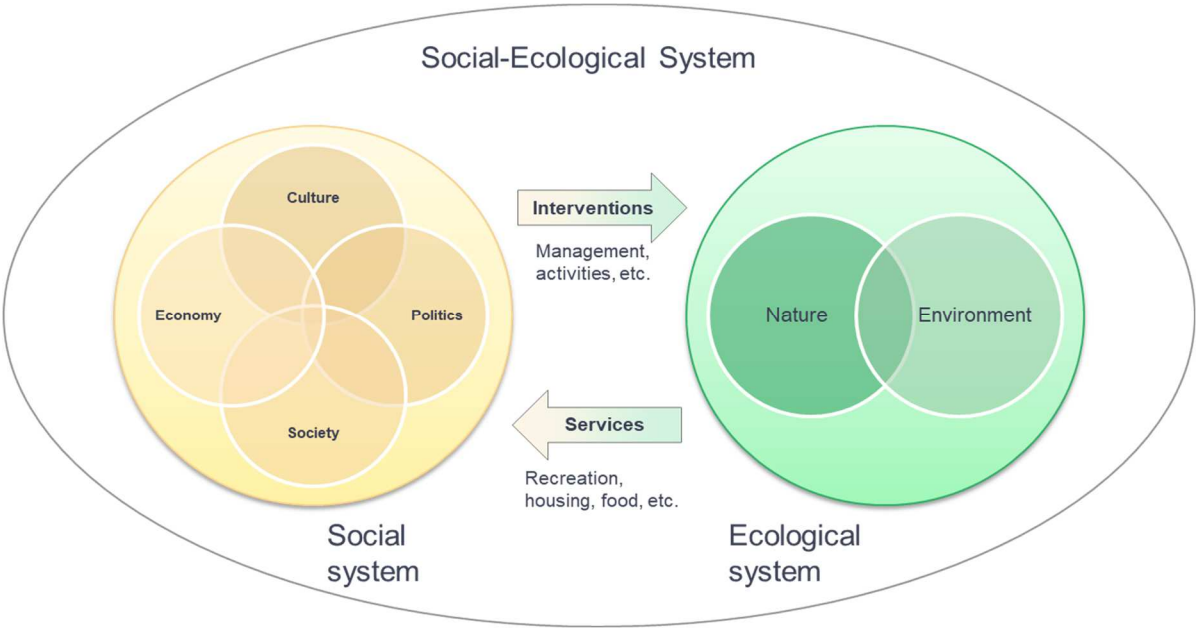


Figure 1. Representation of a socioecological system. Modified from Virapongse *et al.* [5]

- measures applicable to certain cultural heritage categories according to the needs and expectations defined in the project together with the pilot cities. Thus, the library is not an exhaustive list of measures.

[1] http://www.fao.org/giahs/giahsaroundtheworld/designated-sites/europe-and-central-asia/historical-waterscape-of-lhorta-de-valencia/en/

2.3. **Potential uses of the inventory**

The inventory allows practitioners:

- To browse and compare measures for inclusion in a climate adaptation plan, a heritage management plan, or other action plan or strategy,
- To develop a preliminary portfolio of feasible measures[2]. The RMI may be helpful in conjunction with vulnerability and risk analyses (WP5) as well as resilience assessments (WP7), with the former being suitable to identify the need for "hard" measures and assess their effectiveness, while the latter is suitable to include "soft" measures.

These measures may be used:

- To identify previously unknown measures
- To gather more information about known measures
- To support SECAP development in the framework of the EU Covenant of Mayors (aiding the selection of appropriate measures for inclusion in the SECAP)
- To serve as an input for the design of a resilience pathway (T6.3: the resilience pathway visualization tool).

[2] To fine-tune the portfolio and develop a corresponding action plan, the preliminary portfolio should be complemented with additional context-specific knowledge and information *e.g.* feasibility, acceptability, alignment with other policy etc. This information may be available in the ARCH Hub or tools, come from local stakeholder knowledge and/or other sources (*e.g.* other relevant EU Projects). This finetuning may be done by other means such as prioritization exercises (*e.g.* multicriteria analysis , benefit-cost analysis) *e.g.* supported by tools as the CLIMACT-Prio tool and the FEMA Benefit-Cost Analysis (BCA) Toolkit 6.0 for multicriteria decision analysis and benefit-cost analysis, respectively.

3. Methodology

3.1. Information sources

The inventory has been created based on existing classifications and resilience measures repositories and following the advances made in previous ARCH tasks, particularly the state-of-the art research developed in the WP7. The set of measures contained in the inventory is therefore classified according to the established literature, as well as recognized bodies responsible for safeguarding cultural heritage.

Following to previous ARCH tasks' recommendations ARCH RMI is based on the following guidelines and research publications both from theoretical base and from those based on real cases (thus already applied measures) used for the structuring of the information:

- Managing Disaster Risks for World Heritage. UNESCO (2010).[6]
- Guidance on Post Trauma Recovery and Reconstruction for World Heritage Cultural Properties document. ICOMOS (2017).[7]
- First Aid to Cultural Heritage in Times of Crisis. ICCROM (2018).[8]
- The Sendai Framework for Disaster Risk Reduction. UNITED NATIONS (2015 – 2030).[9]
- Adaptation Needs and Options from the Intergovernmental Panel on Climate Change (IPCC). UNITED NATIONS (2014). [10]

Other significant references that have been used, are the following:

- Climate Change Adaptation for Natural World Heritage Sites A Practical Guide. UNESCO (2014) [11]
- Promoting Disaster Resilient Cultural Heritage. WORLD BANK (2017) [12]
- Flooding and Historic Buildings. HISTORIC ENGLAND (2015) [13]
- Linee guida per la valutazione e la riduzione del rischio sismico del patrimonio culturale con riferimento alle Norme tecniche per le costruzioni di cui al decreto del Ministero delle Infrastrutture e dei trasporti del 14 gennaio 2008. ITALIAN GOVERNMENT(2008) [14]
- Marie Josefine Hintz *et al*. Facing the heat: A systematic literature review exploring the transferability of solutions to cope with urban heat waves (2017) [15]
- Resiliència climàtica en la gestió agrària. Guia pràctica de mesures per a l'adaptació al canvi climatic. GOB Menorca (2018) [16]
- Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. U.S. Department of Agriculture [17]

- Manual de adaptación frente al cambio climático: Cultivos herbáceos de secano, Cultivos leñosos, Cultivos herbáceos de regadío. UPA(2018) [18]
- PNACC- Impactos, vulnerabilidad y adaptación al cambio climático en el sector agrario. Spanish Ministry of Agriculture (2016) [19]
- Forest and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia. UNITED NATIONS (2013).[20]
- SUSDRAIN community for sustainable drainage [21]

Additionally, when relevant, measures obtained from the following research projects and initiatives have been integrated in the RMI:

- RESIN project's Adaptation Options Library for Climate Resilient Cities and Infrastructures.[22]
- SCAN4RECO project's tools for Cultural Heritage preventive conservation. [23]
- ProteCHt2save project's tools for Risk Assessment and sustainable protection of Cultural heritage in changing environment. [24]
- STORM project's resources for effective safeguarding of cultural heritage [25]

3.2. **Co-creation activities**

The RMI has undergone a co-creation design process in which inputs from ARCH research partners as well as city partners and their local stakeholders were received. The inventory also has accounted for other ARCH tasks *e.g.* the outputs from the different match-making events (WP 3) between ARCH city and research partners or standardization activities and tools such as the ARCH Resilience Assessment Dashboard (RAD). The co-creation activities have had different purposes and degrees of involvement. A summary of the co-creation activities and purposes can be seen in Figure 2.

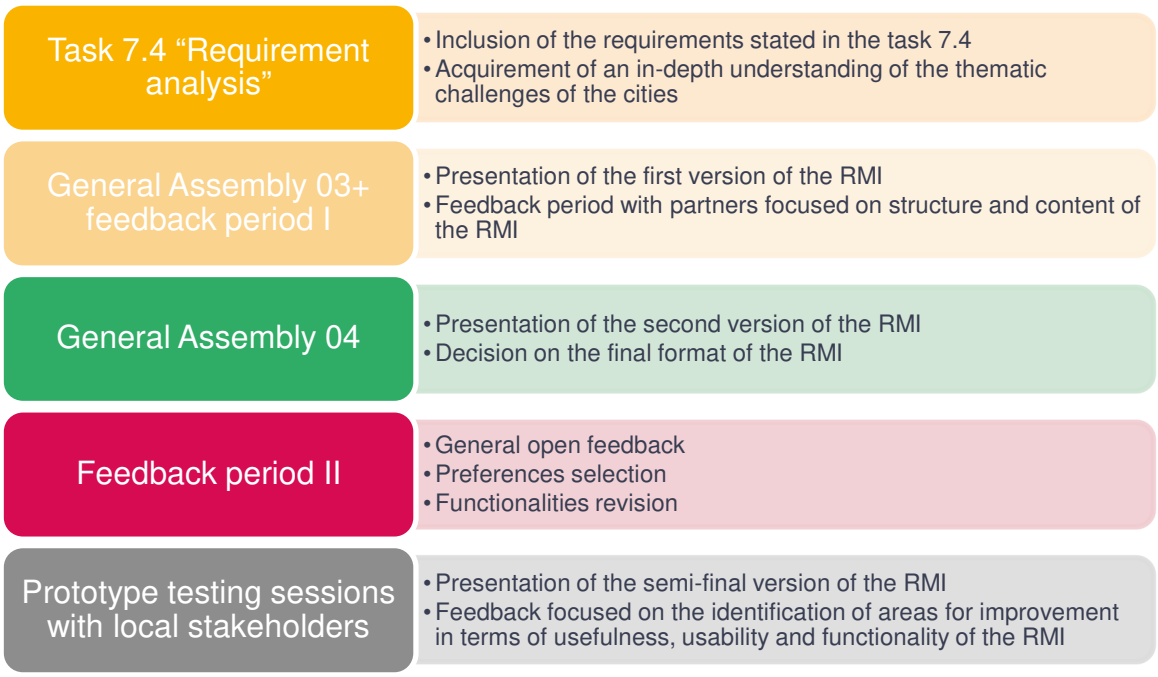


Figure 2. Co-creation activities for the development of RMI tool

4. How to navigate and use the Inventory

This section contains a short manual of the ARCH RMI tool. It describes the structure of the tool, the logical steps for using the RMI, and its content with the intention of helping end-users to navigate through the inventory and achieve its objectives.

4.1. Description of the tool format and technical requirements of use

The RMI tool is a web-based application built on Microsoft Power BI. Thus, there exist some technical requirements for the optimal performance of the tool that must be fulfilled by the users.

At the time of writing this document, according to Microsoft's information[3]:

"*Power BI is designed to work with any of the supported browsers listed below. However, performance varies depending on the browser you choose. If you use Internet Explorer in particular, you may experience poorer performance, therefore it is strongly recommended to use a more modern browser than Internet Explorer, such as Microsoft Edge. If performance is still not acceptable, try other supported modern browsers to see if they provide better results for the Power BI solution.*

Power BI supports these browsers on all platforms on which they are available:

- *"Microsoft Edge Chromium*
- *Internet Explorer 11. Some advanced features, such as lineage view, are not supported in Internet Explorer. See Data Lineage (preview release) for more information.*
- *As of August 17, 2021, Microsoft 365 applications and services, including Power BI, will no longer be supported in Internet Explorer 11 (IE 11). For more information, see this Microsoft 365 blog post.*
- *Latest version of Chrome for desktop*
- *Latest version of Safari Mac*
- *Latest version of Firefox for desktop. Firefox may change the fonts used in Power BI"*

4.2. The inventory structure & sequence

The welcome page to the RMI is the landing page and presents the essence of the inventory in one sentence (Figure 3).

[3] https://docs.microsoft.com/es-es/power-bi/fundamentals/power-bi-browsers

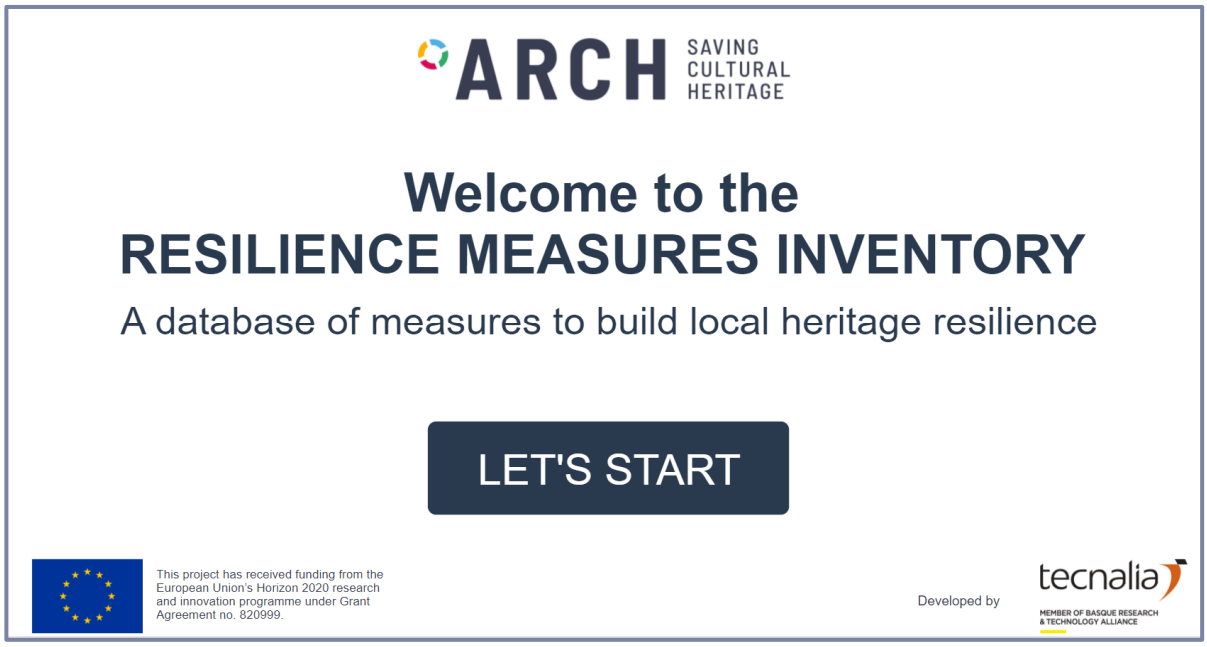


Figure 3. Landing page to the RMI

Click on the "Let's start" button to arrive to the main page (Figure 4).

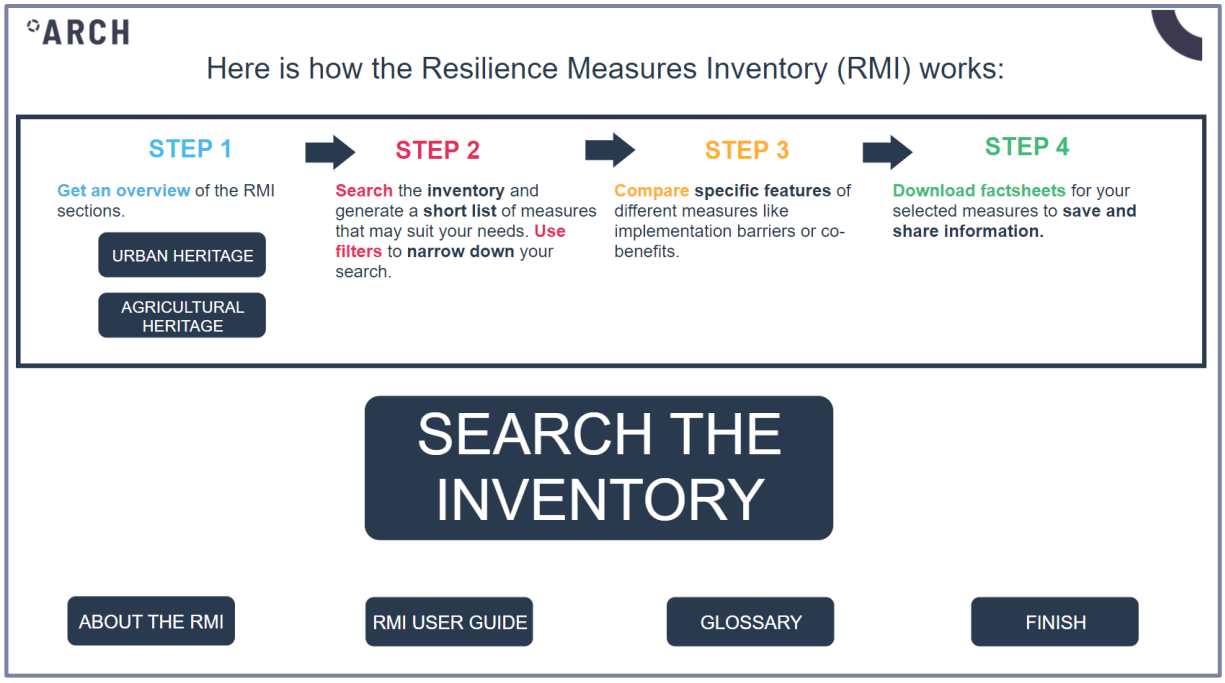


Figure 4. RMI main page

The overall RMI structure is described in Figure 5.

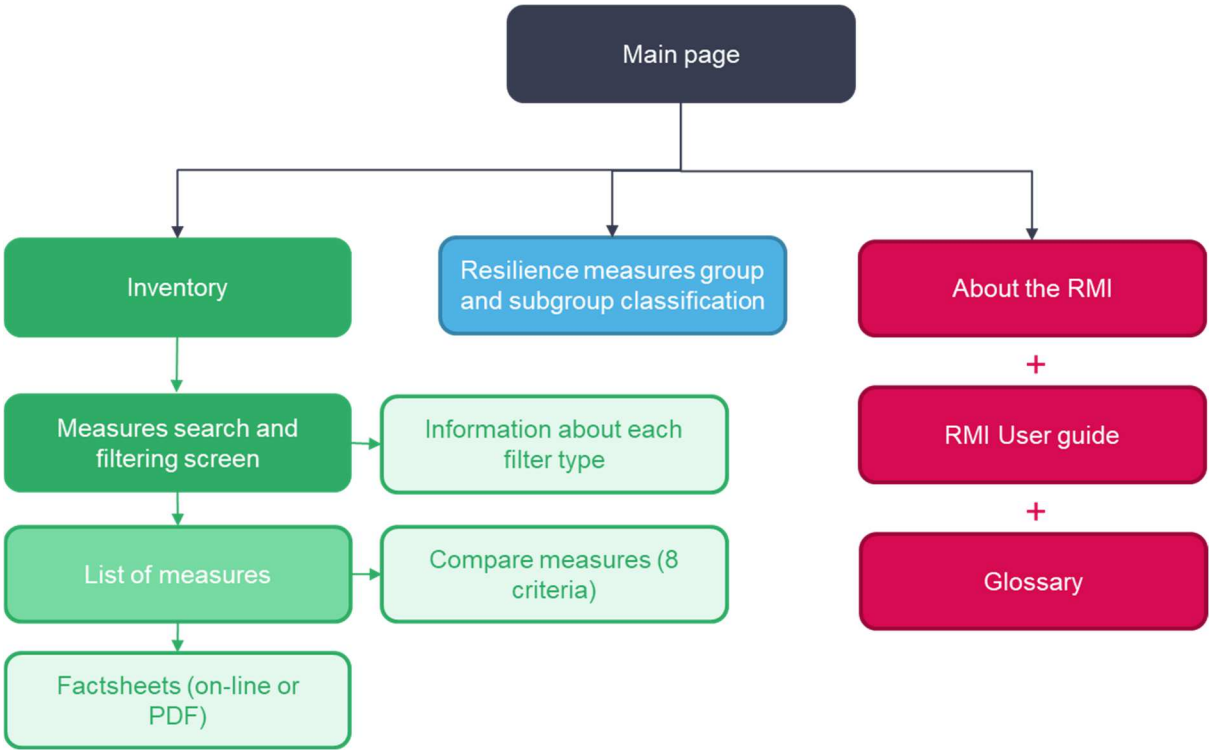


Figure 5. RMI content map of the main page

Use the different buttons to further explore the RMI as shown in Figure 6 to Figure 8.

Being a web-based tool the introductory information to the RMI is summarised under the "**About the RMI**" button (Figure 6). However, more comprehensive information about the purpose, scope and content of the RMI, as well as how it was developed, can be found in Sections 2.2 and 2.3 of this report, respectively.

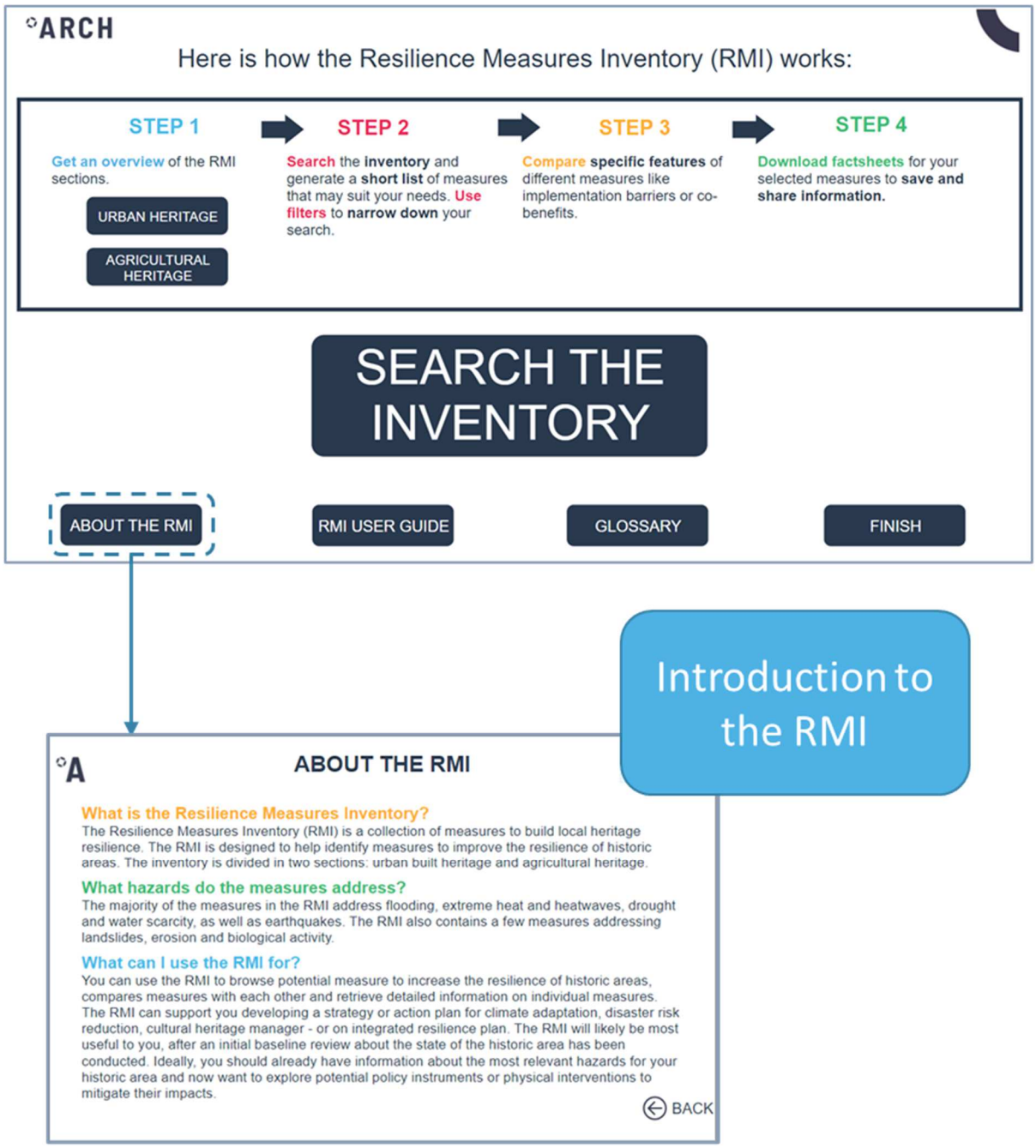


Figure 6. Short RMI introduction window with its aim, envisioned use, and scope

The RMI provides direct access to a shorter version of this document (D6.1) by clicking on "**RMI User Guide**" (Figure 7). This shorter version is intended to provide practical information on how to navigate through the RMI and use cases.

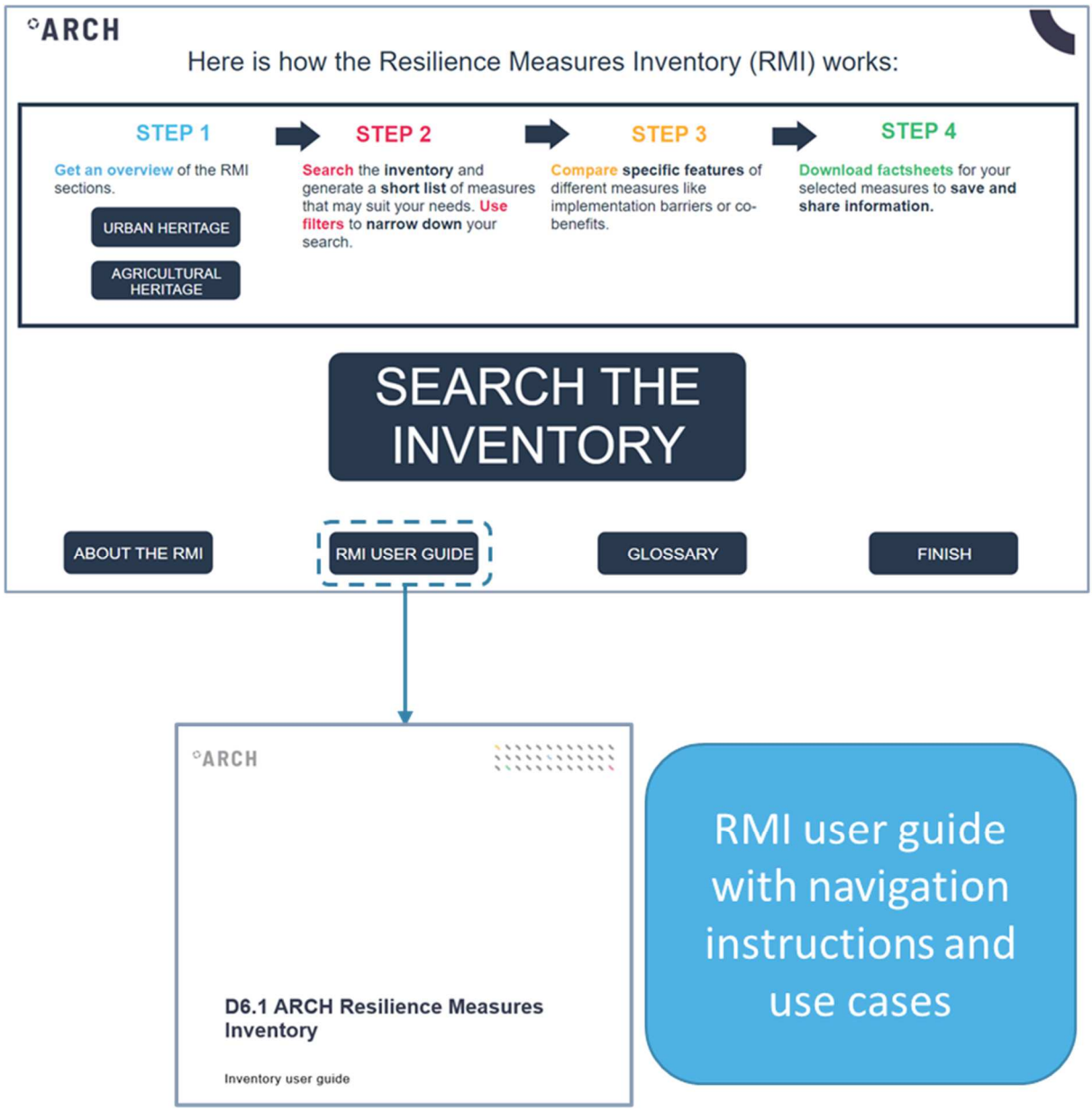


Figure 7. Access to the RMI user guide

As the RMI is intended for users with different backgrounds, mainly in the fields of cultural heritage management, adaptation to climate change and disaster risk management or reduction, a glossary is provided. The glossary based on the ARCH Glossary (annex from D7.1) can be consulted as seen in Figure 8 and includes the terms that are specific for these three themes.

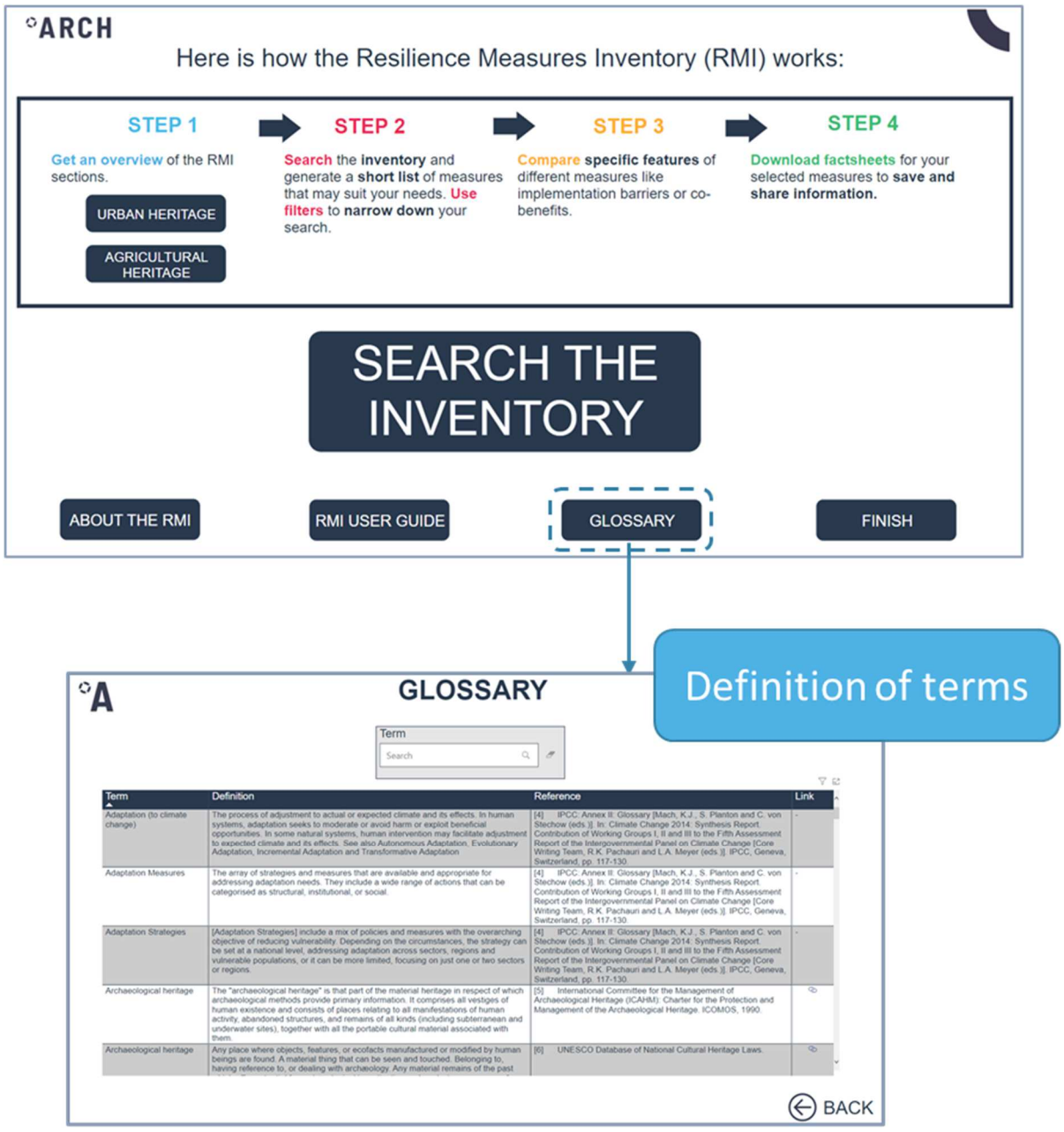


Figure 8. A brief ARCH glossary with terms regarding disaster risk management, adaptation to climate change and cultural heritage management

The main page also describes the recommended steps to create a portfolio of resilience measures, especially for first-time users. This sequence is envisioned to be applied when a search from general to more concrete information is desired. However, all steps are optional and once the user is proficient with the tool the navigation is meant to be free between the different windows of information. See subsections 4.2.1 to 4.2.4 for further information about the steps.

4.2.1. Step 1: Overview of the two sections of inventory

As explained before, the RMI is divided into two sections: one focused on urban, heritage buildings & structures and the other one focused on agricultural heritage.

The 261 measures present in the RMI are categorized by similarities in the intended outcomes[4] and nature[5] according to hierarchical classes (group & subgroups). Thus, Step 1, aims at a general **exploration of the hierarchical classification of the measures** (group & subgroups) by type of inventory. This classification may help for a quicker identification of resilience measures according to needs and/or function, especially for new users.

To access this categorization click on the section of the inventory of interest (Dark blue boxes: "**Urban Heritage**" or "**Agricultural Heritage**") as seen in Figure 9. However, the descriptions of each group and subgroup are be found after clicking "**Search the inventory**" under the "**Definition of your search**" window (see subsection 4.2.2 for further information).

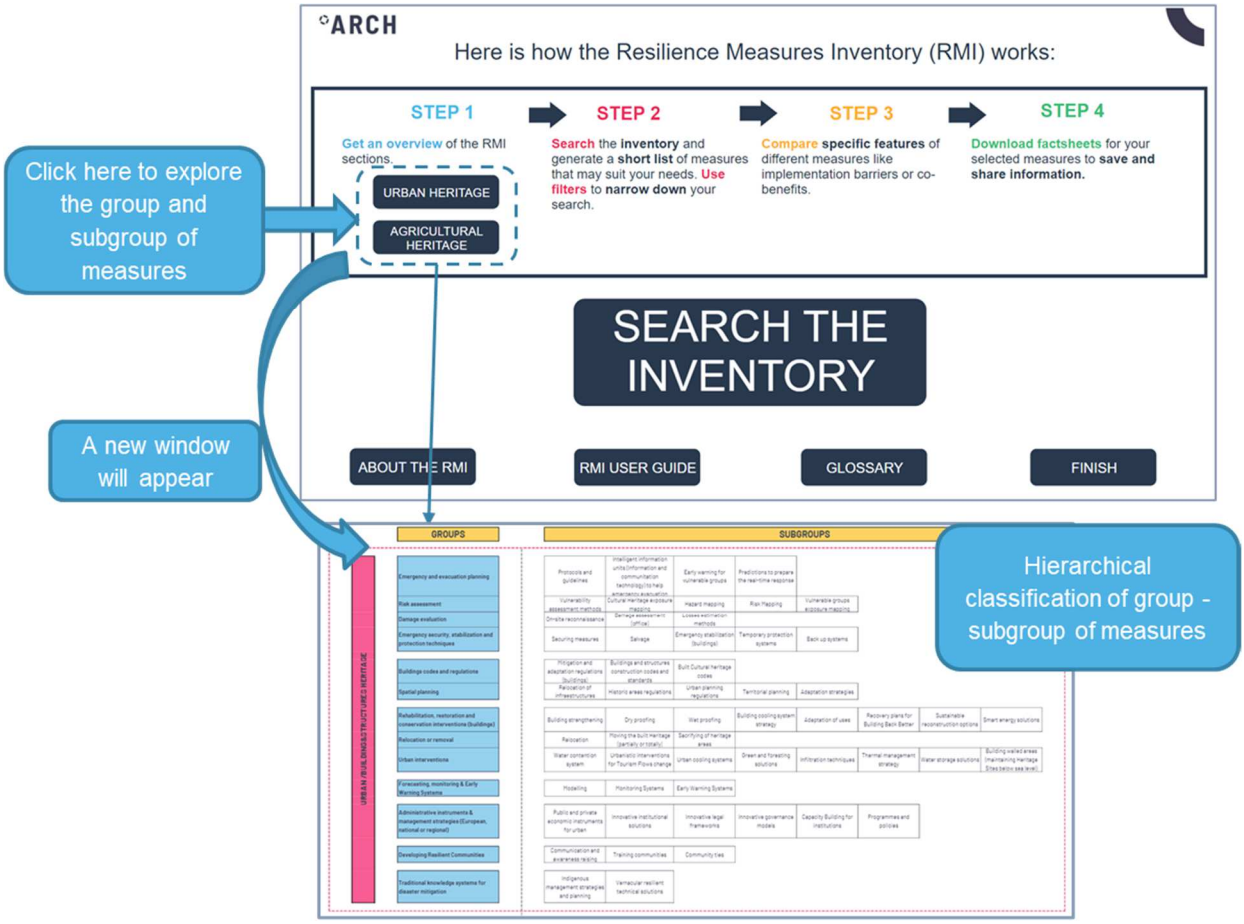


Figure 9. How to explore the higher hierarchical classification of resilience measures

There are different buttons to open the overview of the group and subgroup classification in the web browser (*e.g.* Google Chrome, Microsoft Edge *etc.*), download it as a PDF file or print it (Figure 10a). This allows to enlarge the font size and/or to aid in the measures search without the need to go back to the main page. This new window has also a zoom and search function in the bottom of the window (Figure 10b).

[4] Outcomes are can be defined as the results or impacts that the group or subgroup of measures achieve by their implementation

[5] Nature is referred to the type of measures according to the IPCC's classification. See subsection 4.4.6.

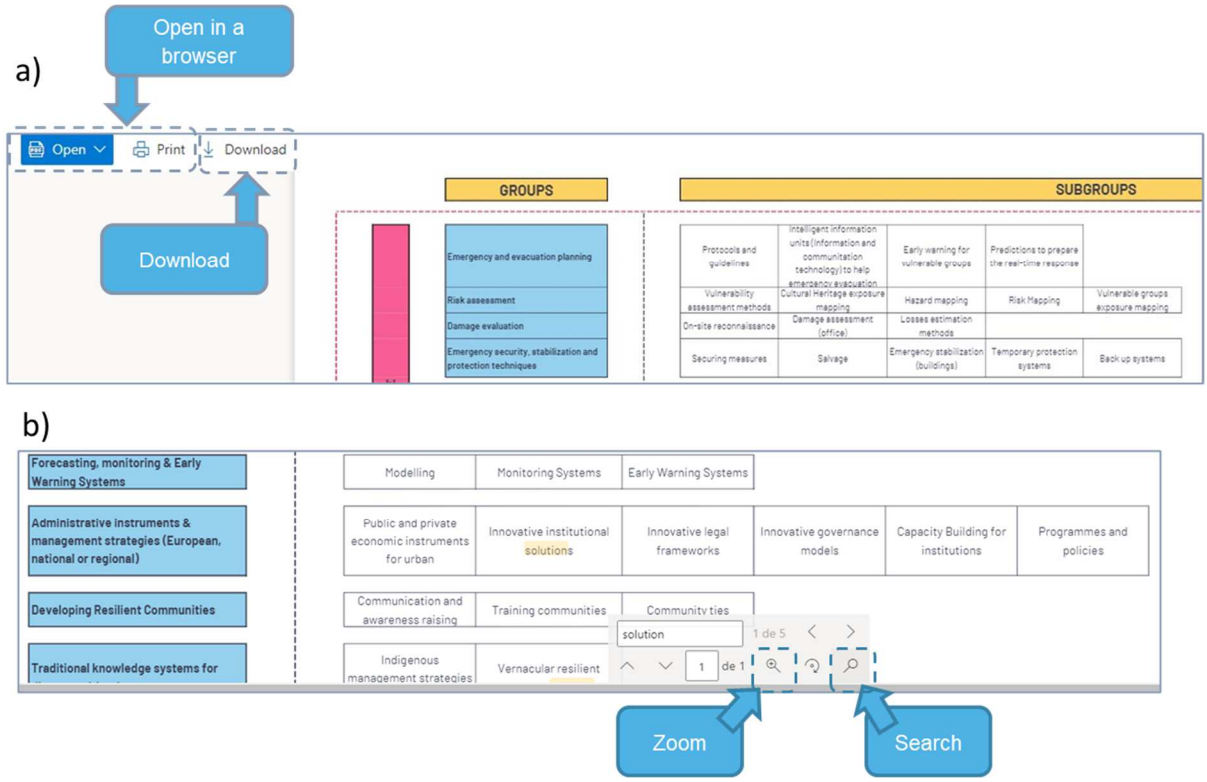


Figure 10.Available functions within the group and subgroup classification window. a) Download or open in in an explorer window functions, b) zoom and search functions

4.2.2. Step 2: Search the inventory and arrive at a short list of measures

From the main page, the user can also access the inventory as seen in Figure 11.

Figure 11. How to access to the RMI and the resilience measures search window with multiple filters

The big dark blue button ('**Search the inventory**) brings the user to the inventory itself.

This new window (Figure 11) offers several filters to identify suitable resilience measures. It also provides info boxes ⓘ where descriptions of the filters and supporting information is available.

To make searching the over 250 measures included in the inventory less time-consuming, three categories of filter have been created to narrow down your search for suitable resilience measures as follows:

“**Basic Information**” filters allow to limit the search to those measures of interest, according to the measure categorization found in Step 1. These filters also allow to search for measures suitable to address gaps in the resilience assessments done via ARCH Resilience Assessment Dashboard (RAD), after its completion.

“**Specific Information**” filters provide parameters to fine-tune the search.

“**Search measures**” field allows to filter measures using a specific term.

To select the appropriate choice for each filter, click on the arrow icon “v” as seen in Figure 12. Note that the order in which filters are selected is important, because selecting one filter field automatically restricts the choices available for the next filter. For example, if only one category is selected under “Group of measure” (*e.g.* “Developing Resilient Communities”) then only the subgroups related to this category will appear under “Subgroup of measure”. In the same manner, if “soil erosion” is first selected under “Type of hazard” and then the user revisits “Type of inventory” the only option that will appear within this filter is “Agricultural Heritage”. The “Search Measures” feature also works as a filter and it will only show those measures that include the search words in their title. If no filters are used, all the measures will appear in the following window when clicking on “Check compatible measures”. It has to be highlighted that the more filters are used the more restrictive the search will be. However, an iterative search can be made until the final selection of measures is achieved.

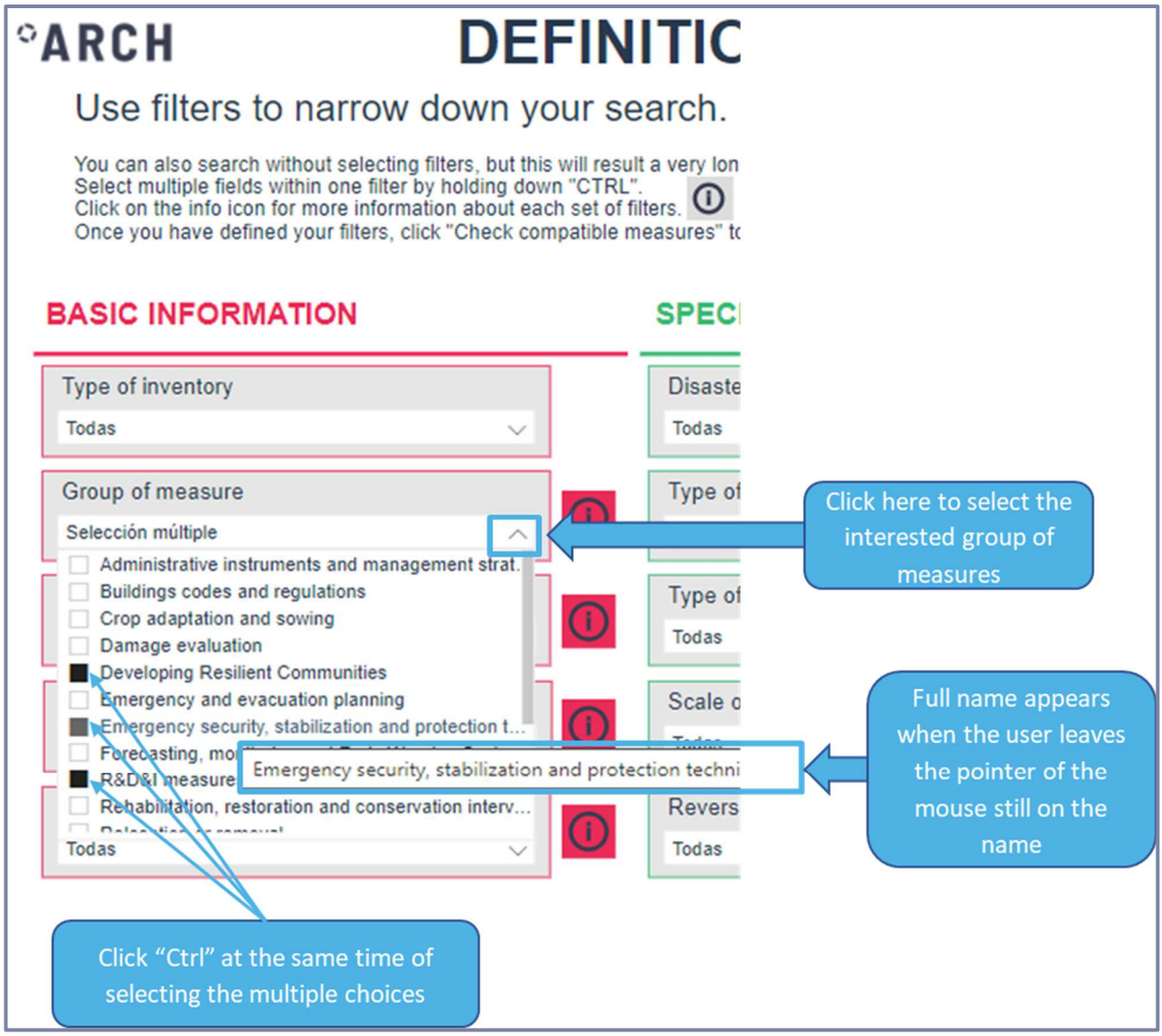


Figure 12. Instructions on how to select the desired filters

To select more than one choice at once, simply hold down Ctrl[6] while selecting the choices with the mouse (left button) as explained in Figure 13.

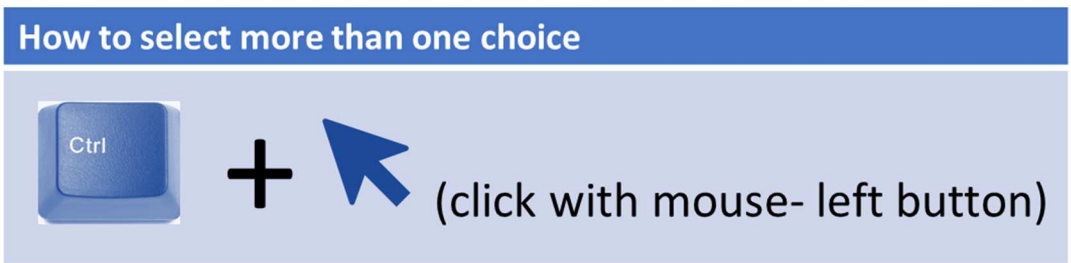


Figure 13. How to select multiple choices

[6] Note: German keyboards may label "Ctrl" key as "Strg".

To help in understanding the filters and their use, click on the available info boxes as seen in Figure 13. By clicking on each of them a new window will appear with extra information about the different choices.

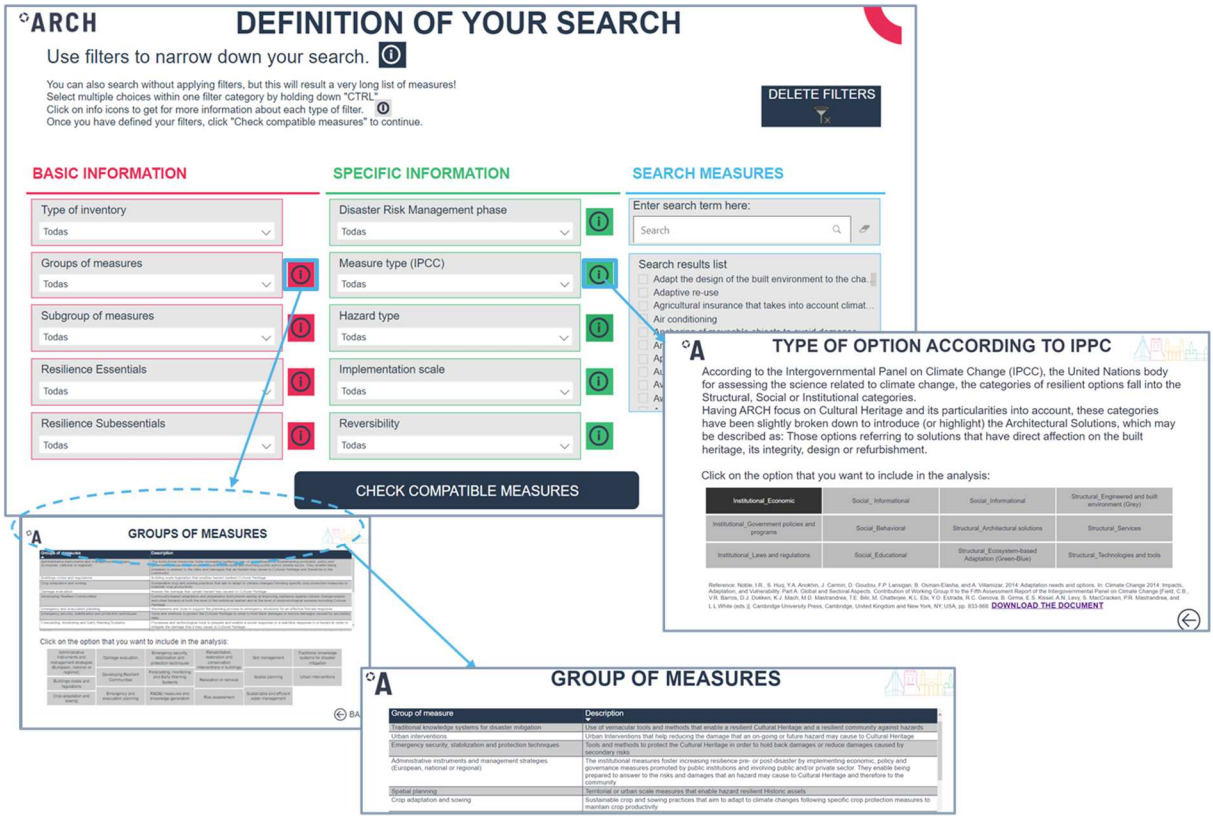


Figure 14. Two examples of information given in the info-boxes.: i) description of each resilience group of measures to clarify any doubts and ii) definition of a filter and its filter options

To select the filter options per measure follow instructions as shown in Figure 12 or within the info boxes windows as explained in Figure 15. After selecting the desired options within one filter, click the back button and the selection will be registered in the "Definition of your search" window. The selection of choices are not meant to take place on the table, but on the boxes in the bottom of the window as seen in Figure 15.

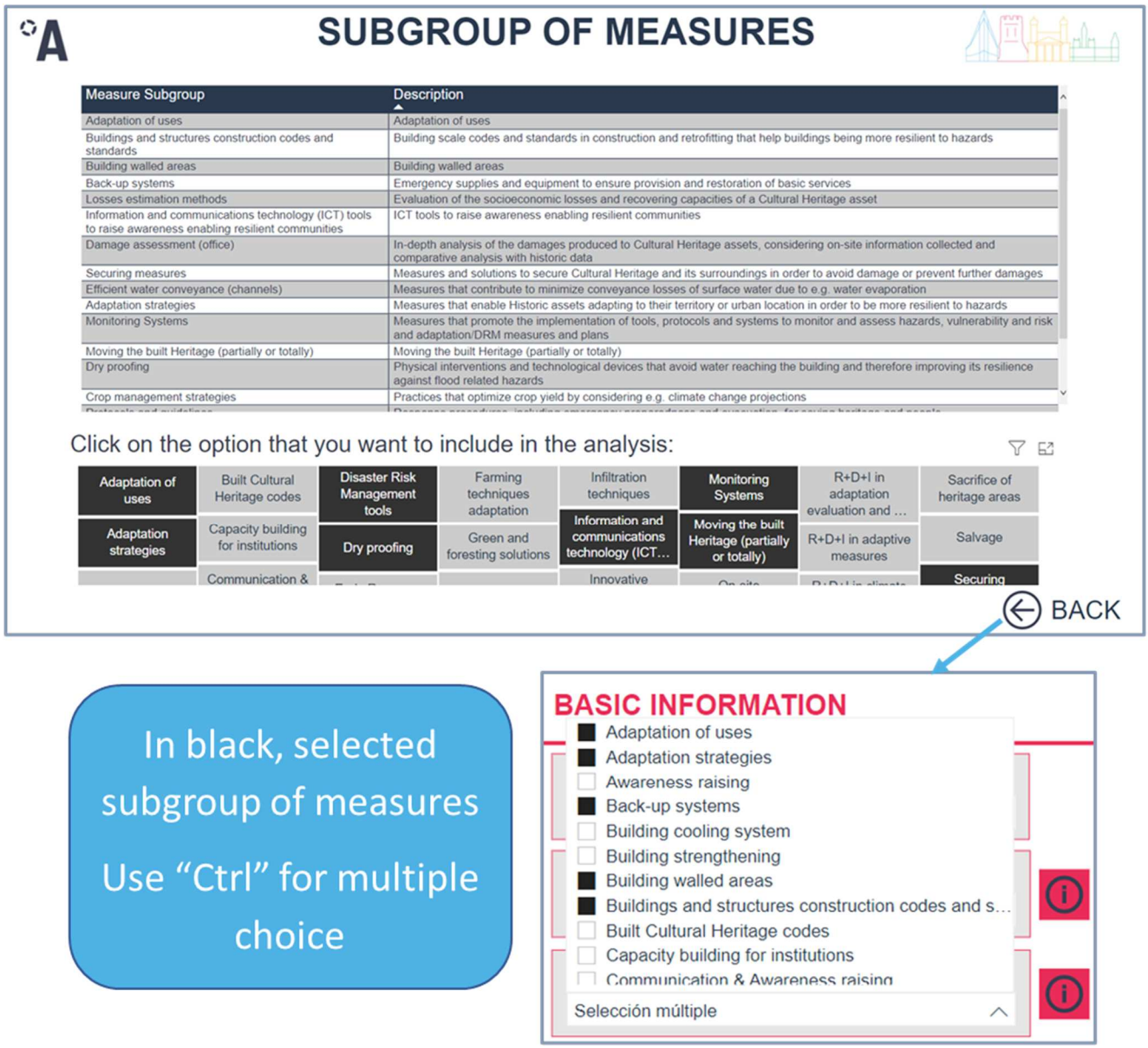


Figure 15. How to select filter options within the info boxes: when clicking on the back button the selection will be registered in the filter field from the "Definition of your search" window

In case there is a need to amend the selection of the filters, there are two ways to erase the filter selection (Table 1):

Table 1. Erase function buttons and information

Button type	Button image	What is its function?
Delete filter button		Erase all the filter selections
Eraser		Erase this specific filter field information (Image of "Search a measure" as example)

Once the filters have been selected click on the "**Check compatible measures**" button from Figure 11 to study which resilience measures meet the search needs or requirements.

A new window will appear with the full list of compatible measures. The table also includes information about the subgroup and group of measures they belong to. In the top right-hand corner, a counter is available where it shows how many results the search returned (Figure 16).

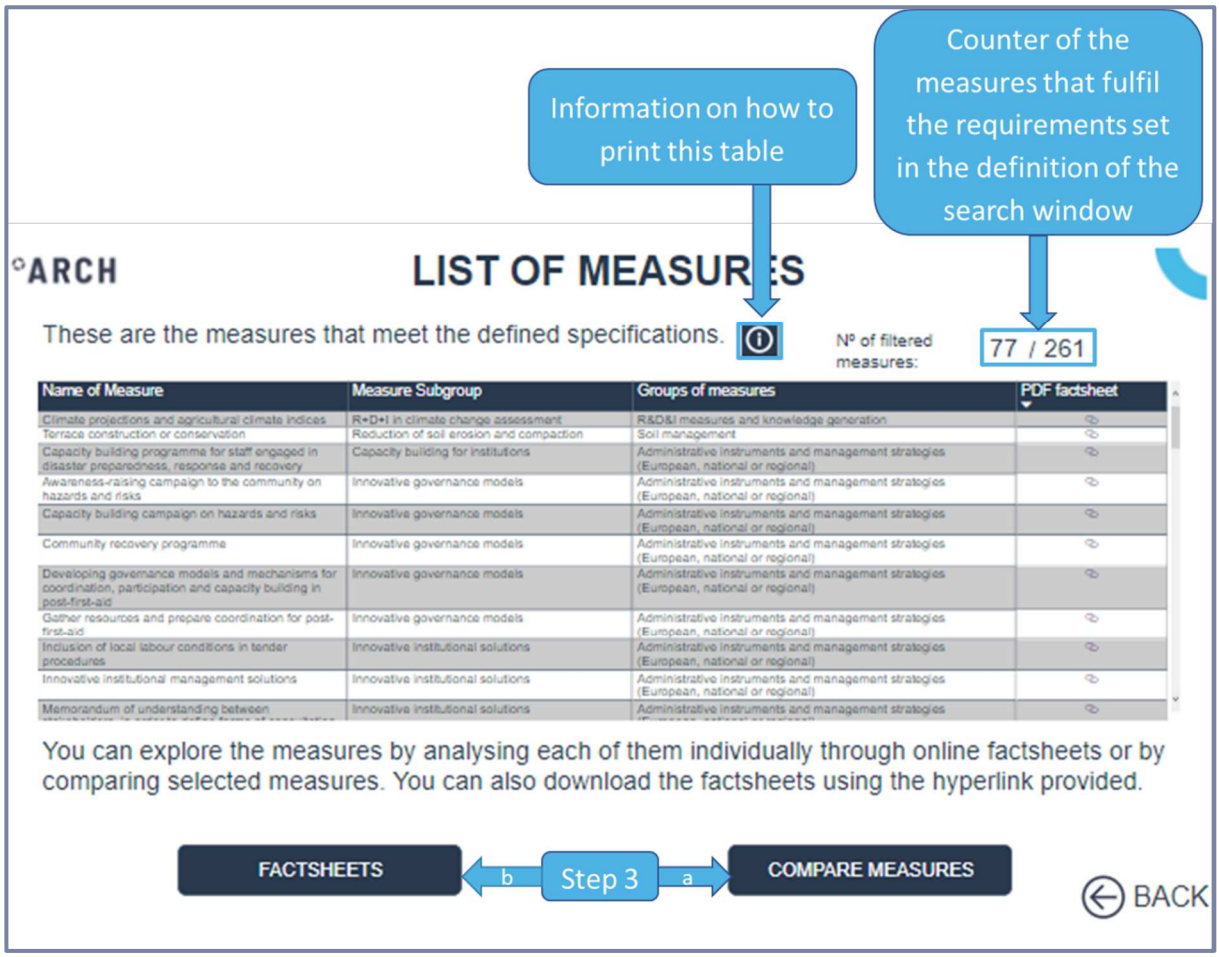


Figure 16. List of resilience measures results

While the RMI is not designed to export or download the table with measures, there is a “quick fix” to print the selection in PDF. Instructions can be found in the info box.

4.2.3. Step 3: Compare specific features

Once the preliminary list of resilience measures has been identified (Figure 16), there are two different options on how to proceed:

1. If further refinement is needed, click on ”**Compare measures**” button to compare the resilience measures with each other. This will lead to a new window (Figure 17) where all filtered measures are listed on the left, the benchmarking parameters are presented at the bottom on the window and the table with the comparing information is presented in the centre of the window. Select the parameters of interest for benchmarking the measures. There is no need to do anything if all parameters are of interest. However, the table may be a bit overwhelming if many measures and all parameters are selected.

2. If the comparing parameters are not clear click on the info boxes ⓘ (to the right of the parameter buttons). A new window will appear (Figure 18) with the description of the parameter and the alternatives of choice for each parameter.

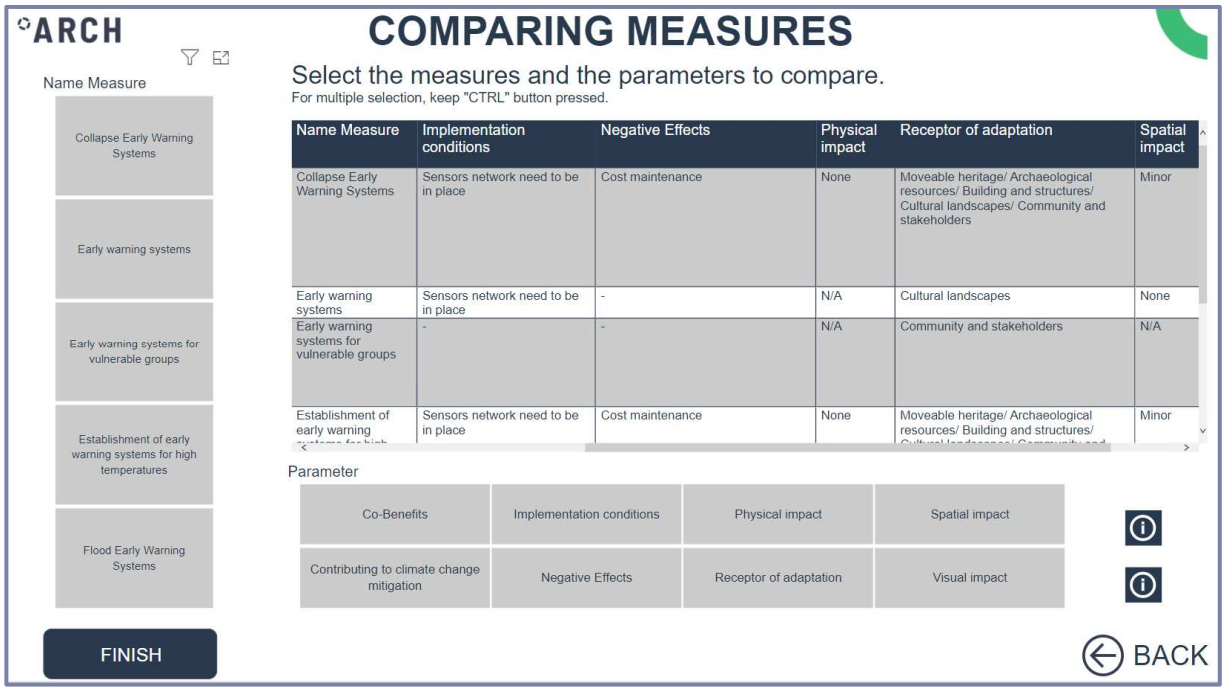


Figure 17. Benchmarking window of resilience measures

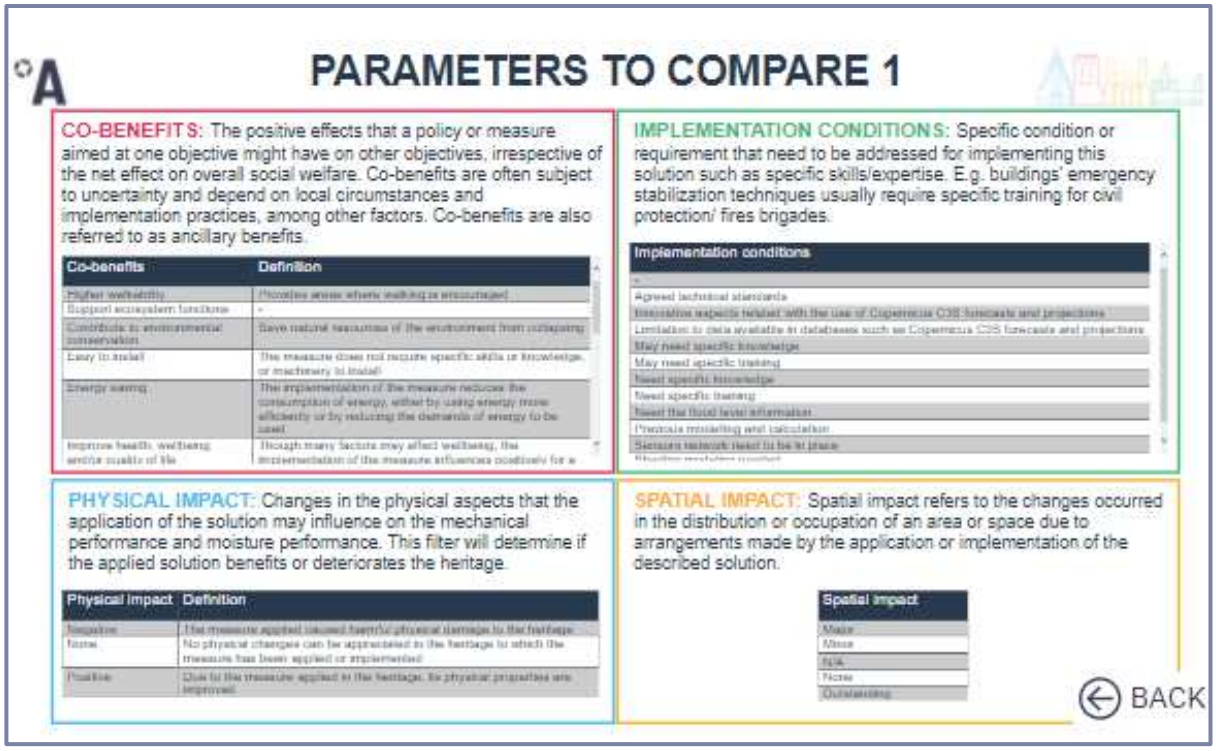


Figure 18. Parameter definition and characterisation information

3. To have comprehensive information about each specific measure without comparing them, click on "**Factsheets**" (Figure 16). A new window will appear (Figure 19). Click on the measure (on the left side of the window) of interest to visualize the information.

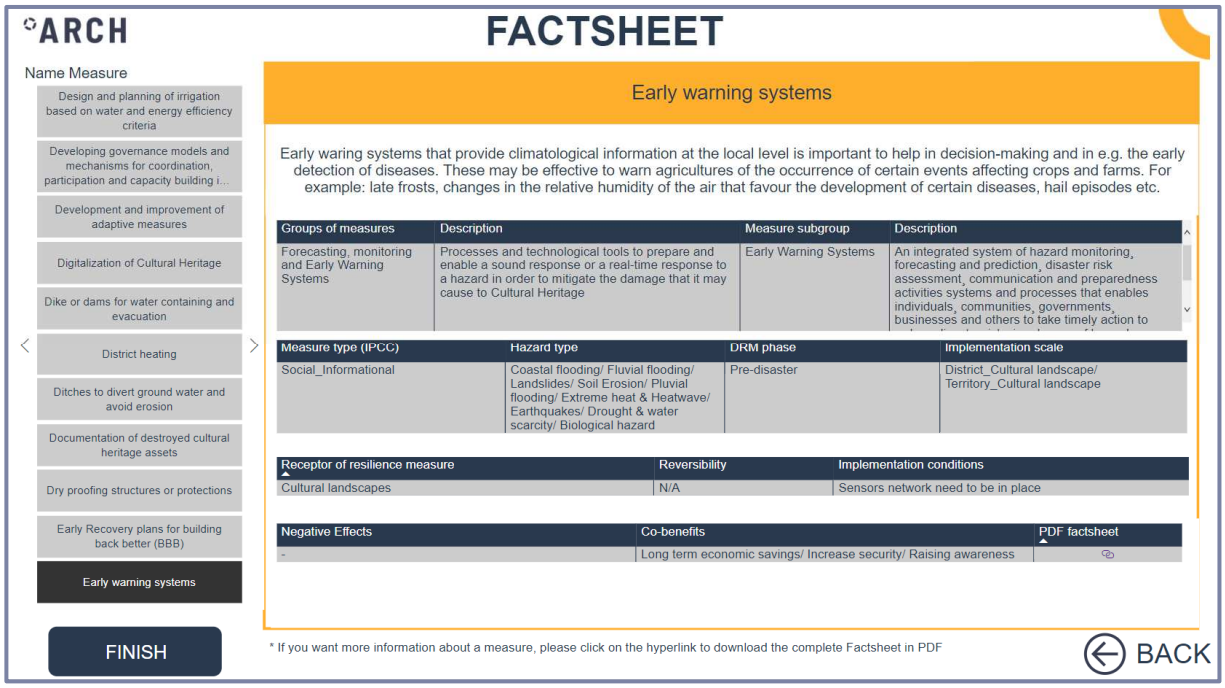


Figure 19. Factsheet window

4.2.4. Step 4: Download factsheets

If the selection of the resilience measures is finished, to save the factsheet for each resilience measure of interest as PDF files (Figure 20), click on each of the hyperlinks to download them (Figure 21).

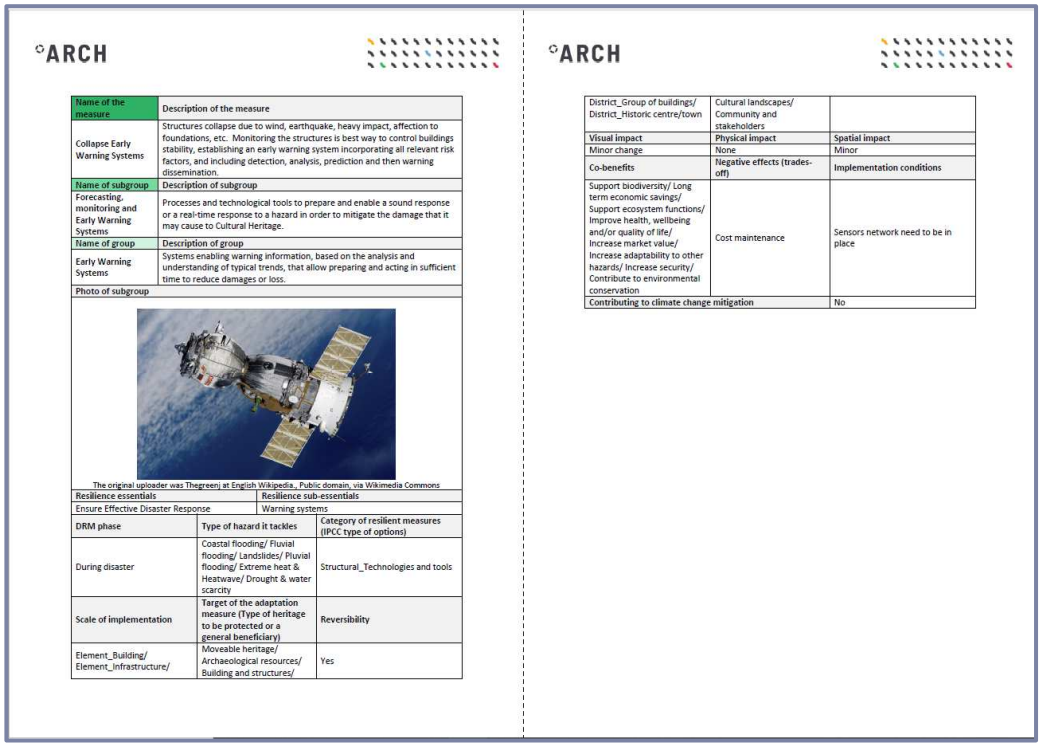


Figure 20. Example of a downloaded PDF factsheet

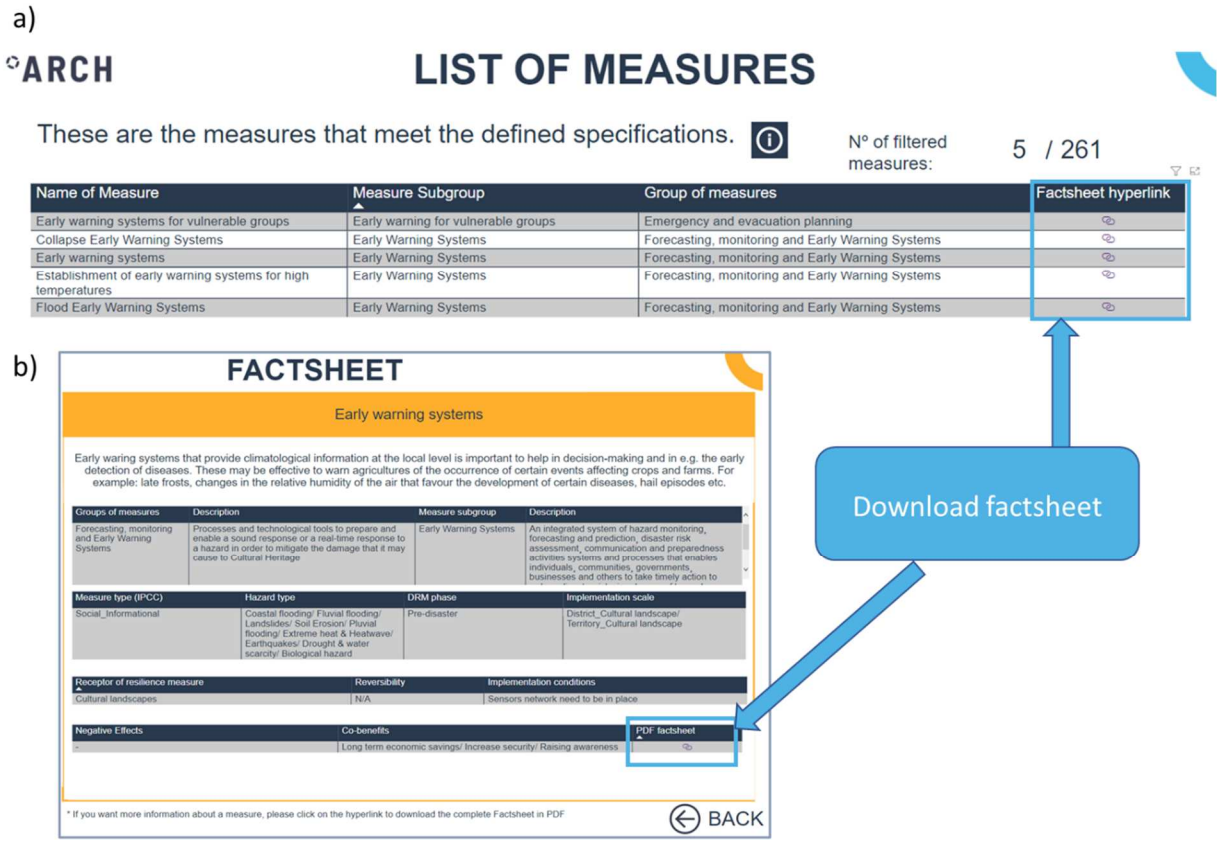


Figure 21. How to download the PDF factsheet. a) From the "List of measures" window and b) from the " factsheet" window

4.3. Other functions

Apart from all the functions that have been described in subsection **¡Error! No se encuentra el origen de la referencia.** to describe the sequence of search, three extra functions are presented such as how to expand the table for better visualization, see which filters apply (Figure 22) and how to re-arrange the list in a table by alphabetical order (Figure 23).

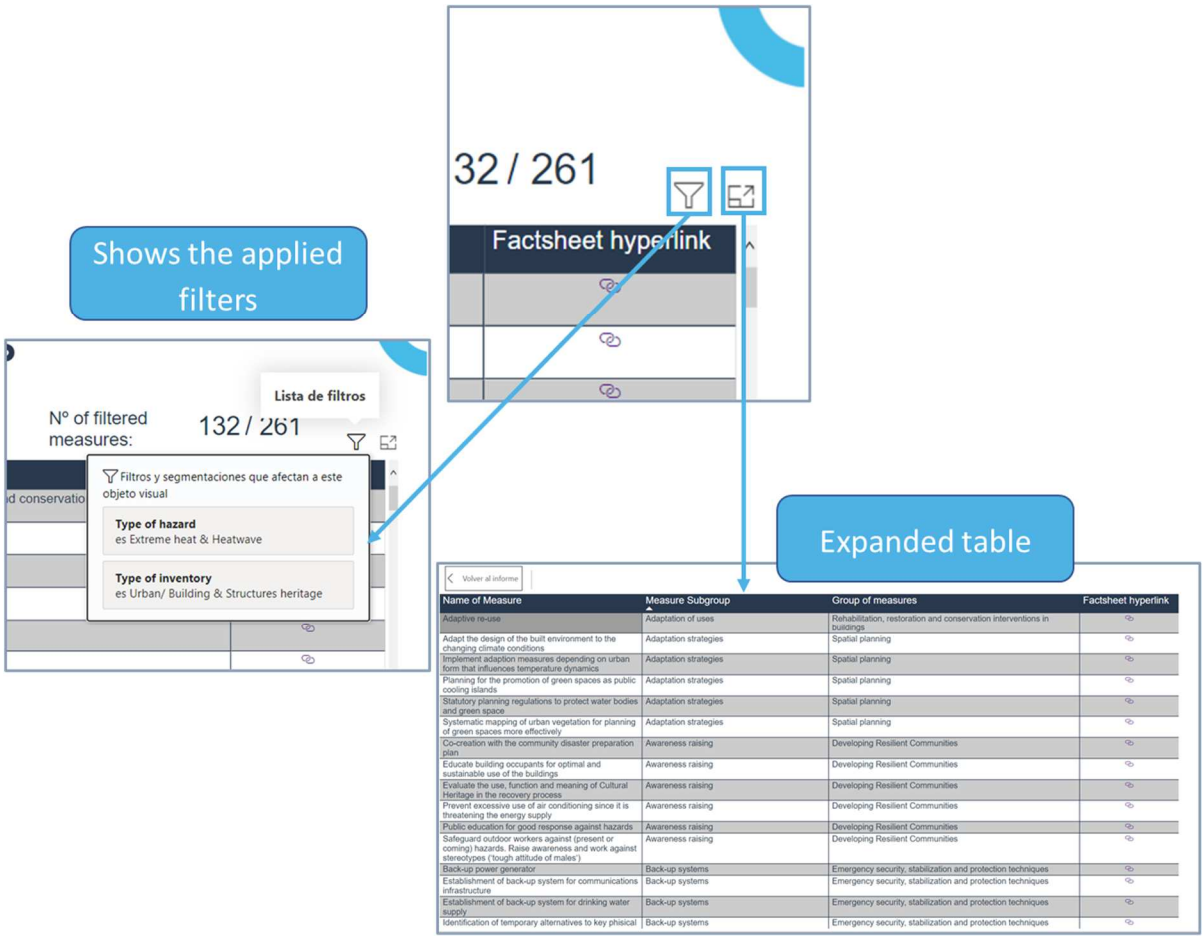


Figure 22. Buttons to expand the table for better visualization and to check which filters apply to the shown search

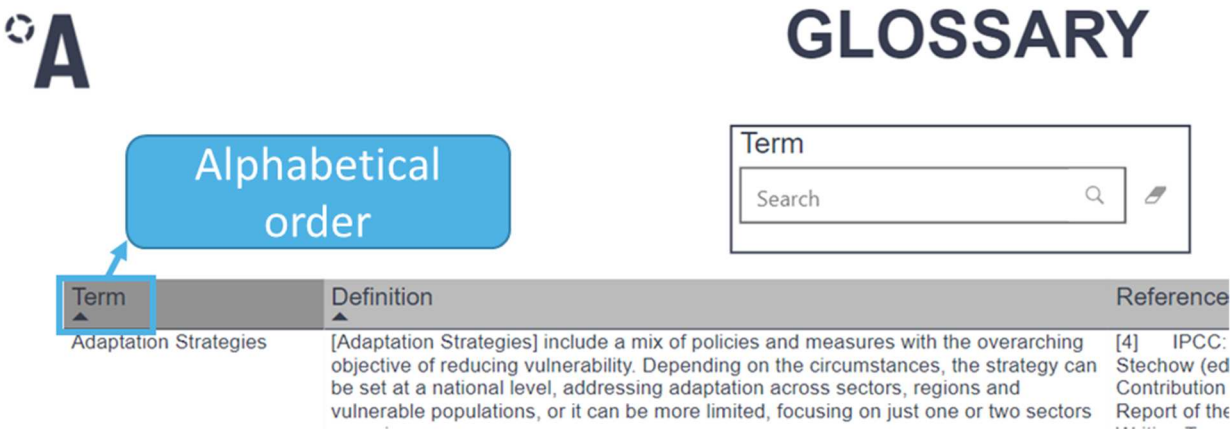


Figure 23. Button to order the content of the field alphabetically

4.4. Content and description of the RMI parameters

After having described the inventory structure and navigation sequence above, this section will introduce the different parameters used to organise the RMI, including search filters and other parameters.

Below all parameter categories are briefly outlined, followed by detailed descriptions of each.

4.4.1. Introduction to the inventory and the parameters to filter and characterise the measures

There are some filtering parameters which will allow to sift the measures. The available criteria for the identification of suitable measures are:

1. Type of inventory. The RMI has been divided in two sections
    a. For agricultural heritage: specially dedicated to protecting agricultural and natural heritage
    b. For historic urban/building & structures heritage: specially dedicated to protecting cultural heritage.
2. Group and subgroup of measures (see section 4.4.2)
3. Resilience essentials and sub-essentials (based on the UNDRR Resilience Scorecard)
4. Disaster Risk Management (DRM) phase (pre-, during, post-)
5. Type of hazard it tackles (coastal, fluvial, or pluvial flooding, landslides, soil erosion, extreme heat & heatwaves, earthquakes, drought & water scarcity
6. Type of measure according to the IPCC resilience options classification (Structural, Social or Institutional)
7. Scale of implementation (element, district, territory)
8. Reversibility (yes, no, partially)

Other parameters

The resilience measures are further characterised by the following. Additional criteria which do not appear as search filters, but can aid the comparison of measures once a shortlist is obtained are:

a) Co-benefits
b) Negative effects
c) Spatial impact
d) Physical impact
e) Visual impact

f) Implementation conditions

g) Resilience target

h) Contributing to climate change mitigation

4.4.2. Groups of resilience measures

The built **urban heritage** inventory includes 13 different groups of measures, as follows,

1. **Emergency and evacuation planning:** Definition and preparation of mechanisms and tools for first-aid response to an imminent threat, an ongoing threat, or a hazard to a historic area
2. **Risk assessment**: Analyses of the destructive capacity that a certain hazard may cause to a historic area, in function of the characteristics of the hazards, the cultural heritage itself and, also, the community that lives and manages at the site
3. **Damage evaluation:** Assessments of the damage that a certain hazard has caused to cultural heritage
4. **Emergency security, stabilization and protection techniques:** Tools and methods to protect the cultural heritage in order to reduce the damage that a certain hazard can cause to it
5. **Building codes and regulations**: Building scale legislation that enables hazard resilient cultural heritage
6. **Spatial planning:** Territorial or urban scale measures that enable hazard resilient historic areas.
7. **Rehabilitation, restoration and conservation interventions (buildings):** Interventions to carry out in buildings that help reduce the damage that a current or future hazard may cause to cultural heritage
8. **Relocation or removal:** Methods for comprehensive or partial displacing of heritage assets to guarantee its resistance to certain hazards
9. **Urban interventions:** Urban Interventions that help reduce the damage that a current or future hazard may cause to cultural heritage
10. **Forecasting, monitoring & early warning systems:** Processes and technological tools to prepare and enable a sound response or a real-time response to a hazard to mitigate the damage that it may cause to cultural heritage
11. **Administrative instruments & management strategies (European, national or regional):** These measures foster increasing resilience pre- or post-disaster by implementing economic, policy and governance measures promoted by public institutions and involving the public and/or private sector. They enable being prepared to answer to the risks and damages that a hazard may cause to cultural heritage and therefore to their community

12. **Developing Resilient Communities:** Community-based adaptation and preparation instruments aiming at the development of resilience against climate change-related hazards and others at both the level of the individual learner and at the level of socio-ecological systems including Cultural Heritage

13. **Traditional knowledge systems for disaster mitigation:** Use of vernacular tools and methods that enable a resilient cultural heritage and a resilient community against hazards

These groups are disaggregated into 58 subgroups (not further described in this deliverable). Each group contains 3 to 8 subgroups.

For **agricultural heritage** 7 groups have been defined, which are then disaggregated into 25 subgroups (not further described in this deliverable). Each group contains between 3 to 6 subgroups.

1. **Soil management:** Soil management measures, as a part of the integral land management, aim at defining specific interventions that protect, conserve, or enhance the soil quality and functionality

2. **Crop adaptation and sowing:** Sustainable crop and sowing practices that aim to adapt to climate change following specific crop protection measures to maintain crop productivity

3. **Sustainable and efficient water management:** Measures towards either increased water availability or the minimal but efficient use of water to maintain crop productivity and at the same time protect water environments, resources, and ecosystems from over abstraction

4. **RD&I measures and knowledge generation:** Research, Development and Innovation (RD&I) measures that promote local/regional knowledge generation to allow better climate change impact management, resilience building of cultural heritage and DRM/adaptation monitoring

5. **Forecasting, monitoring & early warning systems:** Processes and technological tools to prepare and enable a sound response or a real-time response to a hazard to mitigate the damage that it may cause to cultural heritage

6. **Administrative instruments & management strategies (European, national or regional):** These measures foster increasing resilience pre- or post-disaster by implementing economic, policy and governance measures promoted by public institutions and involving public and/or private sector. They enable being prepared to answer to the risks and damages that an hazard may cause to Cultural Heritage and therefore to the community

7. **Developing resilient communities:** Community-based adaptation and preparation instruments aiming at the development of resilience against climate change-related hazards and others at both the level of the individual learner and at the level

4.4.3. Resilience essentials and sub-essentials

The ten Essentials and their sub-Essentials are critical steps to be addressed to build and maintain resilience according to the UN Office for Disaster Risk Reduction (UNDRR)[7]. These have been adapted within ARCH to better account for historic areas[8].

Essential 01: Organise for Resilience

Manifesting an organizational structure as well as planning focus and processes for the historic area by linking the resilience factors, disaster risk reduction and climate change adaptation and social justice with heritage management. This requires appropriate strategies and plans as well as effective collaboration and sharing of information with internal and external stakeholders.

1.1 Planning for resilience
1.2 Organization, coordination and participation
1.3 Routine consideration of resilience issues in all decisions
1.4 Data capture, publication and sharing

Essential 02: Identify, Understand and Use Current and Future Risk Scenarios

Understanding of disaster risks and hazards that the historic area faces, or that can be foreseen given the combined impacts of external factors/threats/climate change and checking if these are combined with heritage preservation processes. Managers need a view of the evolution of risks, as currently unforeseen impacts are possible. (For the assessment a clarification of worst case and average case scenario is needed.)

2.1 General considerations: Up-to-date risk analysis for the historic area with considered multi-hazard risks, assumptions and methods aligned with approaches on city/regional level
2.2 Hazards: Known hazards (“general” and climate change related) and existence of hazard maps
2.3 Exposure: Knowledge of exposed elements and explicit consideration of vulnerable groups, existence of exposure maps
2.4 Vulnerability: Knowledge of vulnerability factors and maps
2.5 Impacts and Consequences: Known impacts on various dimensions of the social-ecological system dimension

Essential 03: Strengthen Financial Capacity for Resilience

Building a “financial architecture” of (disaster) resilience – funding aligned to clearly defined needs, budgeting for these, locating and applying for funds (which may not always come from

[7] UNDRR: https://www.unisdr.org/campaign/resilientcities/toolkit/article/the-ten-essentials-for-making-cities-resilient

[8] The description provided here, at the time of writing this report, are preliminary and likely undergoing revisions as part of the co-creation process. An updated description of the Resilience essentials and sub-essentials will be found in ARCH deliverable D7.6. (ongoing).

“obvious” sources), and protecting those funds. This includes the availability of contingency funds (for use pending payment of insurance and recovery funds).

This Essential builds on the risk understanding covered in Essential 2, since risks effectively drive the financial impacts that need to be planned for.

3.1 Financial planning and budgeting: Understanding of likely costs due to disasters, financing plans for resilience improvements, knowledge about funding opportunities and funds for existing projects
3.2 Insurance coverage for building damage
3.3 Incentives and financing for business, community organizations and citizens

Essential 04: Pursue Resilient Development

Recognising that historic areas are subject to dynamic forces in the economic, social, cultural, and political spheres by mapping, assessing, and understanding the natural, cultural, and human resources in the historic area as well as the socio-economic and climate change-related pressures affecting it. Local communities need to be included in planning and consultation for heritage management aims and actions. Heritage values and vulnerabilities need to be included in development frameworks, which also need to consider appropriate (public-private) partnerships and local management frameworks. This in turn requires specific mechanisms for coordination of the different actors. Lastly, building codes, regulations, and standards that meet or exceed resilience requirements need to be developed (or existing ones need to be adapted).

4.1 Assessment of natural, cultural, and human resources
4.2 Participatory planning and stakeholder consultation in heritage management
4.3 Assessment of socio-economic pressures and climate change impacts
4.4 Integrating heritage values and vulnerabilities in wider development planning
4.5 Policies and actions for heritage management and development
4.6 Partnerships and local management frameworks
4.7 Coordination mechanisms
4.8 Building codes & standards

Essential 05: Safeguard Natural Buffers

The protective functions offered by natural ecosystems are preserved, or even better, enhanced by identifying, protecting, and monitoring critical ecosystem services. This includes natural ecosystems that are linked to the historic area as well as natural ecosystems elements that are essential parts of the historic area. Examples may include ecosystem elements (such as rain gardens, tree cover for water absorption and/or heat mitigation, green roofs, bio-swales) and other natural infrastructure that reduce impacts from disasters.

5.1 Existing natural environment and ecosystem health
5.2 Integration of green and blue infrastructure into policy and projects
5.3 Transboundary environmental issues
5.4 Management of ecosystem impact

Essential 06: Strengthen Institutional Capacity for Resilience

The capability of the historic area management to identify risks and plan, prepare for, respond to and recover from disasters. The historic area management and relevant stakeholder and community groups have the according and required skills and relevant information are available and accessible, respectively.

6.1 Skills and experience
6.2 Public education and awareness
6.3 Training delivery: Updated resilience training
6.4 Languages: Accessibility of education and training to all linguistic groups relevant for the historic area
6.5 Learning from others: Learning from other historic areas

Essential 07: Increase Social and Cultural Resilience

Ensuring and strengthening the role of the social and cultural structures for the resilience of the historic area, and vice versa. Cultivating an environment for social connectedness which promotes a culture of mutual help through recognition of the role of cultural heritage and education in disaster risk reduction. The community is part of the historic area and the historic area is unlikely to be resilient without community engagement (for example in ensuring that the workforce can get to work after a disaster).Community or 'grass roots' organizations

7.2 Social networks & vulnerable population groups
7.3 Private sector / employers
7.4 Citizen engagement techniques

Essential 08: Increase Infrastructure Resilience

Adequate coping of critical infrastructure systems within and around the historic area with the natural and man-made hazards/shocks they might experience and development of adaptive measures and contingencies to manage the risks. Protective infrastructure & general considerations

8.2 Water sanitation
8.3 Energy – Electricity
8.4 Energy - Gas
8.5 Transportation
8.6 Communications
8.7 Healthcare
8.8 Education
8.9 Administrative operations

Essential 09: Ensure Effective Disaster Response

Effectiveness and completeness of disaster preparations by the heritage management, in conjunction with those of the city, other agencies or stakeholder groups. This includes the planning, preparation, and training of disaster responses. Warning systems

9.2 Event response plans
9.3 Staffing, responder needs, and emergency equipment
9.4 Shelters and depots
9.5 Interoperability and inter-agency working
9.6 Drills

Essential 10: Expedite Recovery and Build Back Better

Ensuring sufficient pre-disaster plans according to risks identified, and that after any disaster, the needs of the affected are at the centre of recovery and reconstruction, with their support to design and implement rebuilding. Preparedness / planning for post disaster recovery

10.2 Damage and needs assessment
10.3 Learning from experience - building back better
10.4 Building back faster

4.4.4. Disaster Risk Management phase

Disaster Risk Management (DRM)[9] is concerned with preparedness for all activities to be undertaken before, during and after the disaster. The experience of responding to and recovering from a disaster provides an opportunity to review the DRM plan for the property, based on its successes and failures. In fact, periodic communication and monitoring are essential considerations throughout the DRM cycle.

The fields included under the three DRM stages are differentiated as:

- **Pre-disaster** (Risk Prevention-Emergency preparedness): these include preparedness activities to be undertaken before a disaster, which include risk assessment, prevention and mitigation measures for specific hazards (maintenance and monitoring and formulating and implementing various disaster management policies and programmes). This phase also includes those measures aimed at creating an emergency team, an evacuation plan and procedures, warning systems, drills, and temporary storage.
- **During disaster**: include those activities for saving people as well as heritage during the first 72 hours after an incident need to be developed and practised beforehand.
- **Post-disaster**: these activities include damage assessment, treatment of damaged components of the heritage property through interventions such as repairs, restoration and retrofitting and recovery or rehabilitation activities.

4.4.5. Type of hazard it tackles

A hazard is the external source of a disaster, which has the potential to cause disruption or damage to a cultural heritage site or object. This filter includes the different types of hazards the measure described solves (*Note: The inventory will not provide an exhaustive list of hazards, but those identified as most relevant for the ARCH project. Special attention will be given to those in bold*).

- Multi-hazard: occurrence of more than one hazard in a given place, and the interrelations or potential interactions between these hazards.
- **Earthquakes**: sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks.
- **Pluvial flooding**: high-water stage in which an area overflows due to rainwater.

[9]UNESCO: http://icorp.icomos.org/wp-content/uploads/2017/10/Managing-Disaster-Risks-for-World-Heritage.pdf

- **Fluvial flooding**: high-water stage in which water overflows normally dry land due to river inundating its floodplain.
- **Coastal flooding**: high-water stage in which water overflows normally dry land due to sea water inundating its floodplain.
- **Drought & water scarcity**: lack or insufficiency of rain for an extended period
- **Extreme heat & Heatwaves**: Period of prolonged abnormally high temperatures above to those normally expected.
- Landslides: movement of a mass of earth or soil downslope
- Biological hazard: biological substances that pose a threat to the health of living organisms.
- Soil erosion: a form of soil degradation as gradual process of movement and transport of the upper layer of soil occurs.

4.4.6. Type of measure according to IPCC

According to the Intergovernmental Panel on Climate Change (IPCC), the United Nations body for assessing the science related to climate change, the categories of resilience measures fall into the Structural, Social or Institutional categories[10].

Taking ARCH's focus on historic area and its particularities into account, these categories have been slightly broken down to introduce (or highlight) the architectural solutions, which may be described as: Those options referring to solutions that have direct affection on the built heritage, its integrity, design, or refurbishment.

- Structural_ Engineered and built environment (Grey)
- Structural_ Ecosystem-based Adaptation (Green- blue)
- Structural_ Technologies and tools
- Structural_ Architectural solutions
- Structural_ Services
- Social_ Educational
- Social_ Informational
- Social_ Behavioural
- Institutional_ Economic
- Institutional_ Laws and regulations
- Institutional _ Government policies and programs

[10] See definitions by IPCC for these types of categories on Adaptation Needs and Options from the Intergovernmental Panel on Climate Change (IPCC). UNITED NATIONS (2014) [10]

4.4.7. Scale of implementation

Scale of implementation refers to the scale at which the solution is applicable. It can be either any of the following, which are further broken down into different categories or all at the same time:

- Element_ building, infrastructure, archaeological find, work of art (immovable), movable element
- District_ group of buildings, historic centre/town, archaeological site, cultural landscape (agricultural and others)
- Territory_ cultural landscape (agricultural and others), natural heritage
- All, includes element, district, and territory

Element represents the smallest geographical scale where resilience measures may be implemented. Element is referred to a component which sizes would be equal or smaller to a building or infrastructure.

Examples of the type of elements are presented below:

- Building: A church, a house
- Infrastructure: A train station, a bridge, a communication antenna
- Archaeological find: Pottery, inscriptions
- Work of art (immovable):
- Movable elements: Paintings, books

The two other scales of implementation (district and territory) may also include a socio-spatial organization component associated with the bounded geographical area. The district scale covers an area equivalent to a group of buildings (separate or connected), an historical nuclei and parks or small combined works of nature and humankind. The territory scale would encompass an area beyond a village or towns and would include combined works of nature and humankind such as agricultural landscapes, a network of municipalities and /or natural landscapes.

4.4.8. Reversibility

Reversibility is a conservation concept aiming at minimising the damage to existing building fabric caused through removal of retrofit measures. Ideally any such addition should be reversible, such that the original structure can be returned to its former state, should a better form of intervention become available.

- Yes: changes can be reversed when circumstances permit
- No: Non-reversible change should only be used as an alternative and should not prevent future conservation action.
- Partially: Reversible changes considered temporary

4.4.9. Co-benefits

“The positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Co-benefits are often subject

to uncertainty and depend on local circumstances and implementation practices, among other factors. Co-benefits are also referred to as ancillary benefits."[11]

4.4.10. Negative effects

Negative effects of implementing this solution (in addition to those negative impacts already included such as an increase in CO_2 emissions, visual or physical impacts).

4.4.11. Spatial impact

Spatial impact refers to changes in the distribution or occupation of an area or space due to arrangements made by the application or implementation of the described measure.

4.4.12. Physical impact

Changes in physical aspects that may influence the mechanical performance and moisture performance.

This filter will determine if the applied solution benefits or deteriorates the heritage.

- None: No physical changes are expected for the heritage to which the measure has been applied or implemented
- Negative: The applied measure caused harmful physical damage to the heritage
    - Positive: Due to the applied measure the physical properties of the heritage are improved.

4.4.13. Visual impact

Visual impact refers to the aesthetic or appearance change resulting when applying the described measure. The filter evaluates the degree of impact:

- No change: No visible changes are expected for the heritage to which the measure has been applied or implemented
- Negligible change: not worth considering or insignificant change
- Minor changer: Minor visible changes are expected for the heritage to which the measure has been applied or implemented
- Moderate change: Negative effect due to the changes resulted when applying the described measure
- Mayor change: significant negative visual effect to the heritage resulted from applying the described measure

[11] RESIN: http://www.resin-cities.eu/. Allaby, M., 2004. A Dictionary of Ecology. Oxford University Press, Oxford

4.4.14. Implementation conditions

Specific condition or requirement that needs to be addressed for implementing this measure, such as specific skills/expertise. For example, building emergency stabilization techniques usually require specific training for civil protection/fire brigades.

Other implementation conditions, not incorporated in the RMI, are those derived from the final measure's characteristics. For example, building technical standards are usually documents that establish a set technical requirement criteria, methods, processes, and practices. Thus, a document on how to search standards can be found in the Annex A.

4.4.15. Resilience target

This field includes the information related to the type of heritage[12] to be protected or the general target or receptor once the measure is applied or implemented.

- Moveable heritage: refers to works of monumental sculpture and paintings, including wall paints, furniture...etc. which is or has been skilfully made or produced
- Archaeological resources: refers to space in which evidence of past activity is preserved and investigated using archaeology and represents a part of the archaeological record. They can take the form of finds (*e.g.* potter, inscriptions), material (*e.g.* bones, textiles), sites (*e.g.* tombs, caves), monuments (*e.g.* sacred places, temples) or stratigraphic elements (*e.g.* stratigraphic test and finds)
- Building and structures: historic and monumental groups of separate or connected roofed and walled structures built for permanent use, including historical nuclei type
- Cultural landscapes[13:] interaction between humankind and its natural environment (*e.g.* agricultural landscapes, mining landscapes) as well as parks and gardens (*e.g.* cemeteries, botanical gardens)
- Community and Stakeholders: inhabitants of a city or town including traditional groups, communities, and individuals such as indigenous people; or also, cultural heritage owner, policymaker and/or first responders.
- All: all the above are the target of the solution implemented at the related heritage site

4.4.16. Contributing to climate change mitigation

This parameter aims at defining those resilience measures that could contribute to mitigating the greenhouse effect such as CO_2.

[12] Aligned with the dimensions of cultural heritage considered in V. Rebollo and V. Latinos, "ARCH D7.2 Mapping and characterisation of good practices in cultural heritage resilience" H2020 ARCH, GA no. 820999, 2020.
[13] https://whc.unesco.org/en/culturallandscape/

5. Use cases of the resilience measure inventory

5.1. Use Case 1: social resilience in an agricultural community

I would like to increase social resilience in an agricultural community. Which subgroup of measures would be appropriate for this purpose?

We present three different strategies to search for this information.

The quickest (Option A), but the one that would give less comprehensive information would be to follow the instructions under subsection Step 1: Overview of the two sections of inventory (Figure 9). That is, from the **main window** click on the blue button **Agricultural Heritage.** A new window will appear with the classification of group and subgroup. By exploring the groups, the user can see that there is one group entitled "**Developing resilient communities** ". The subgroups included in this group of measures are: i) communication and awareness raising, ii) training communities and iii) communities ties. However, the end user will not be able to know what each subgroup implies.

A second option (option B) will provide not only the name of the subgroup of resilience measures that increase social resilience, but the resilience measures itself. After clinking on "**Click on the inventory to get started"** from the **main window** a new window will appear. The steps to follow are described below (Figure 24):

1. Select Agricultural heritage choice from **Type of inventory** filter.
2. Click on **Group of measure** filter and after revising the list of options, select **Developing resilient communities.**
3. Click on the dark blue button "**Check compatible measures".** A new window will appear with the list of measures that are compatible with this search. In the table the different subgroups of measures under the "**Developing resilient communities"** group will be visible as well as the resilience measures under each of the subgroups.

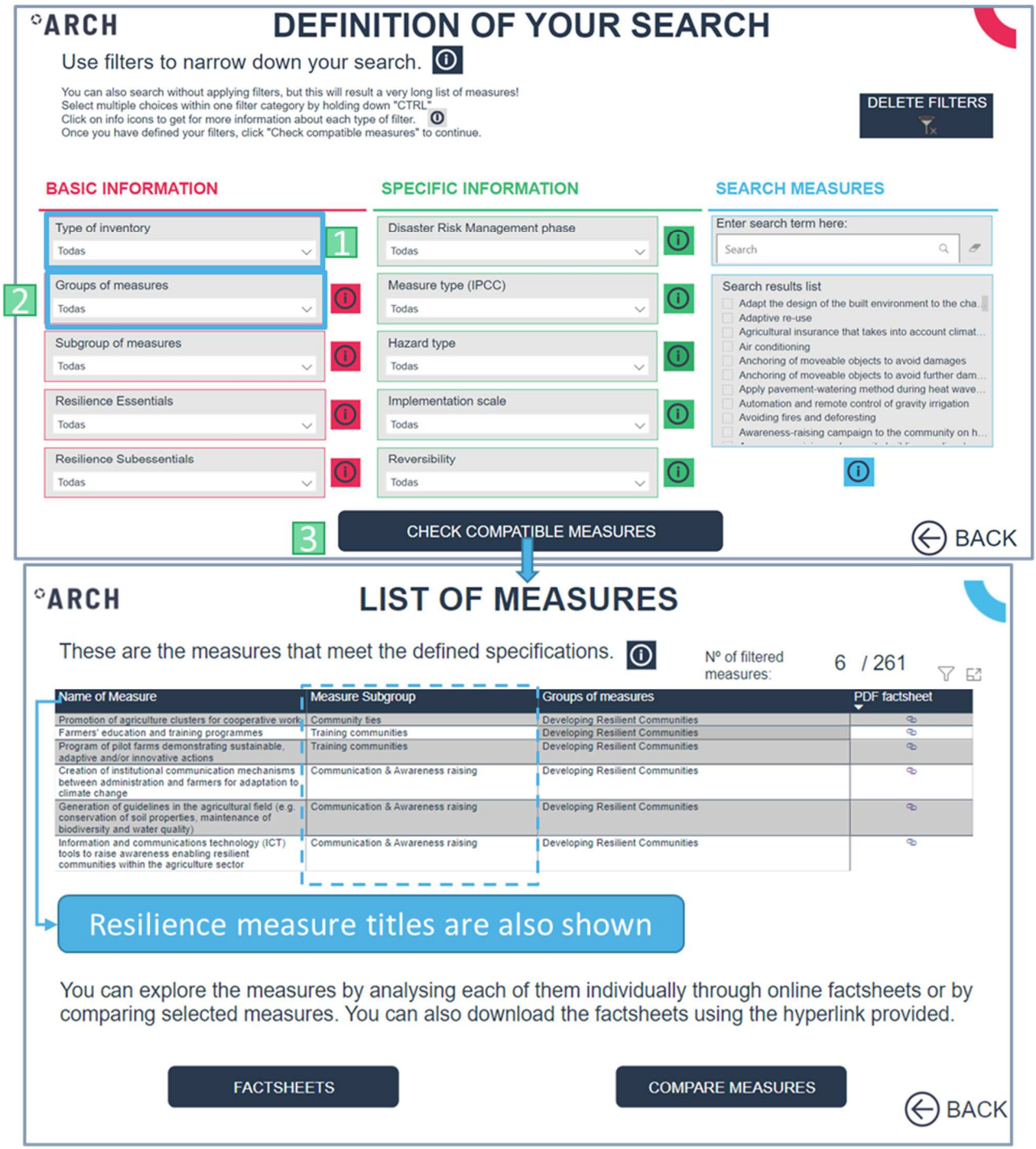


Figure 24. Steps 1 to 3 from use case, option B, and the result window from the search

In case the names of the groups are not self-explanatory enough, a third option (C) is available (Figure 25).

1. First, select Agriculture sector choice from **Type of inventory** filter.
2. Click on the info-box linked to **group of measures** filter.
3. A new window will appear where the list of the groups of measures (bottom as grey squares) and their definition (top) can be explored. By clicking on the appropriate group of measures, in this case **Developing Resilient Communities,** the box turns black

which means this alternative has been selected. This is the same as selecting on the previous window the desired choices on a filter

4. Click on the **back button**
5. Check on the info box linked to **Subgroup of measures** where all the subgroups associated to **Developing Resilient Communities** and their definitions will appear. Considering the subgroup definition, the user is in a better position of selecting those ones of real interest.

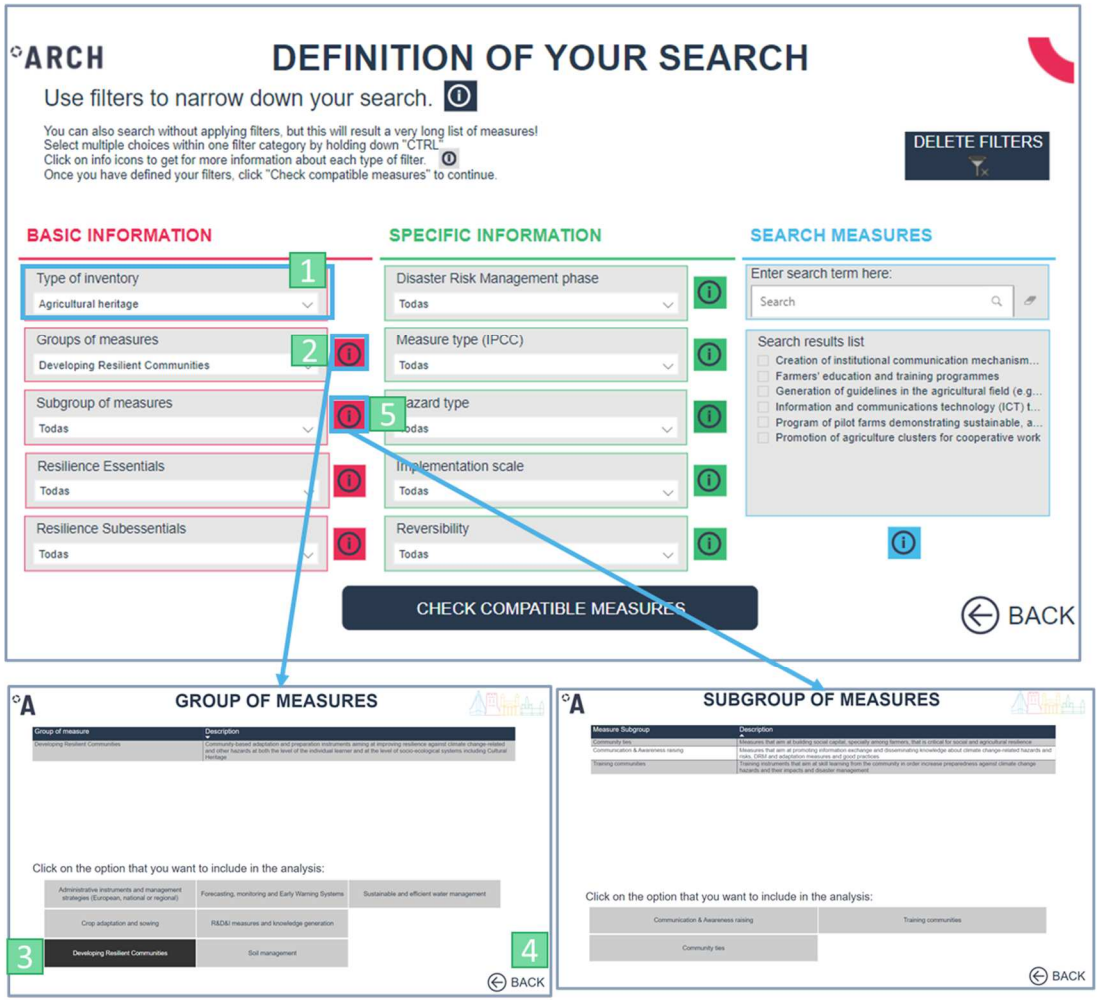


Figure 25. Steps 1 to 5 from option C from use case 1

5.2. Use Case 2: Flood management

I would like to know which measures can be applied during a flood to understand if I could incorporate new measures in my flood management plan. I would also like to explore what type of implementation conditions and negative effects those measures have.

First from the **Main window**, click the Inventory button "**Search the Inventory**". You will arrive to the "**Definition of your search"** window (Figure 11). Then, follow the described steps (Figure 26):

1. Select in **Type of Inventory** filter: Urban /building & Structures heritage
2. Select in **Disaster Risk Management Phase** filter: 2. During disaster.
3. Select in **Type of hazard** filter: Coastal flooding, fluvial flooding, and pluvial flooding. Press "Ctrl" from the computer keyboard when selecting more than one option.
4. Click on the dark blue button **Check compatible measures**

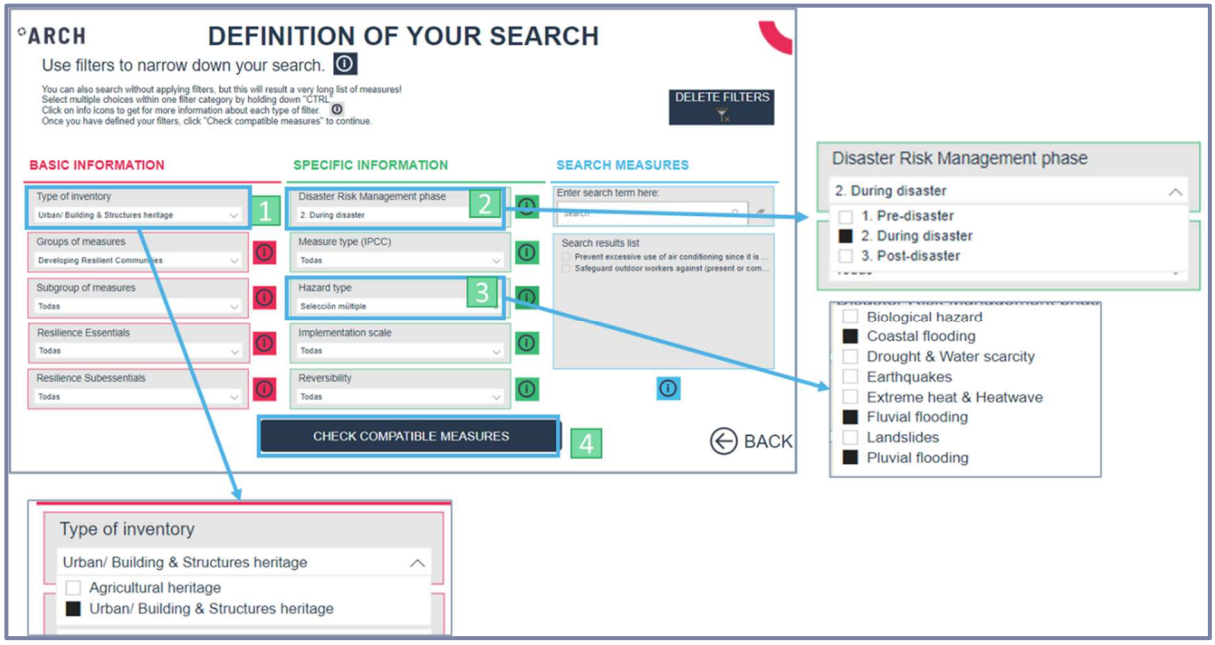


Figure 26. Steps 1 to 4 from use case 3

5. The list of measures compatible with the search will appear in the next window. To explore what type of implementation conditions and negative effects those measures have, please, click on the dark blue button **Compare measures (**Figure 27**).**

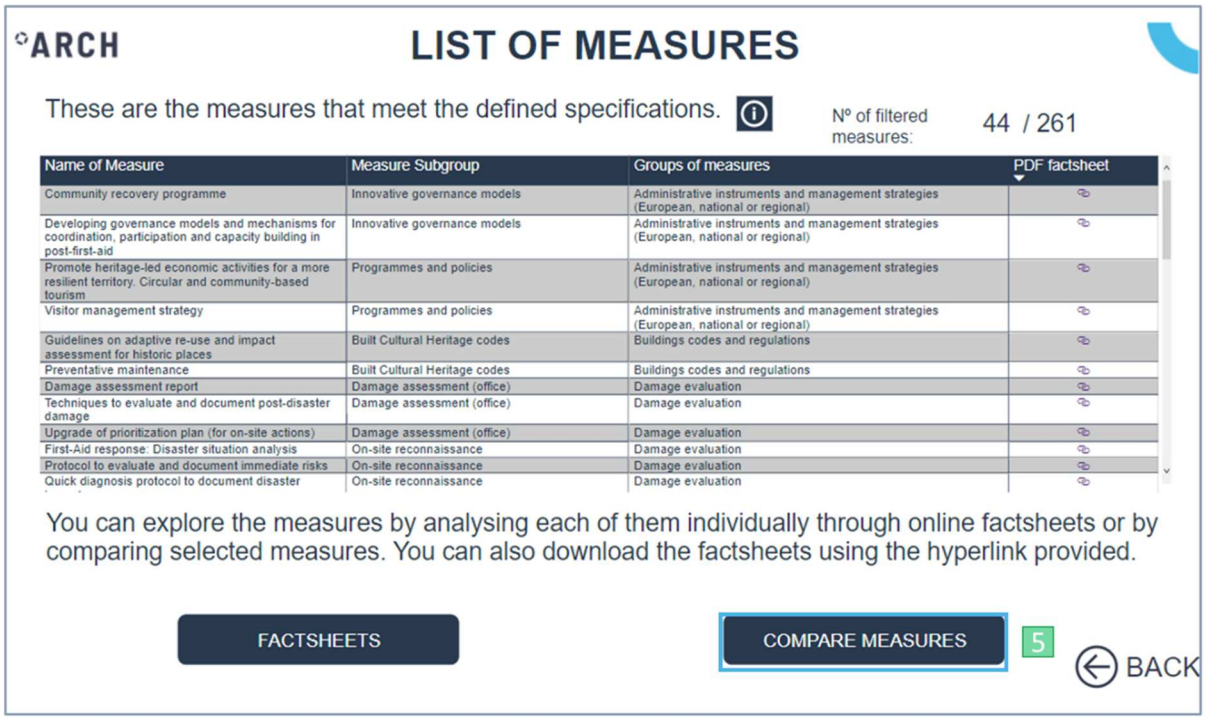


Figure 27. Step 5 from use case 3

6. Again, a new window will appear with the information table in the centre (Figure 28). The compatible measures to the left and the parameters to benchmark the measures at the bottom. Click on the parameters entitled **Implementation conditions** and **Negative effects** to limit the visualization to this information.

7. To know what type of information the parameters contain or its definition, please click on the info boxes (Figure 18).

8. There is a scroll function to the right to be able to see the information for all the measures.

9. When the evaluation of these parameters is finalized, click on the dark button **Finish** or start a new search. If the **Finish** button is clicked the back-cover window will pop up (Figure 29). From here the user can re-start[14] a search or visit the ARCH project's website by clicking on the ARCH button.

[14] If the re-start button is clicked the user can see on the "**Definition of your search**" that the previous choices are saved. At this point there are two choices, (i) to click on the "**Delete filters**" button to start a new search or (ii) apply extra filters to continue narrowing down the search.

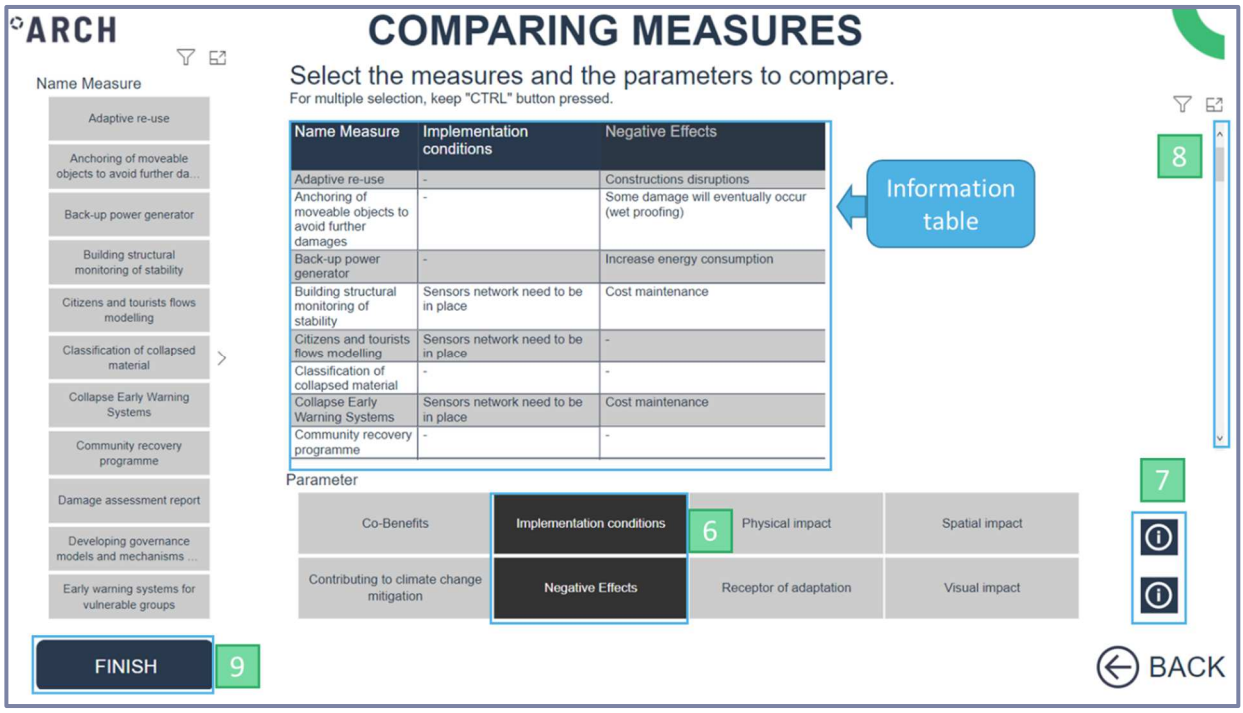


Figure 28. Steps 6 to 9 from use case 3

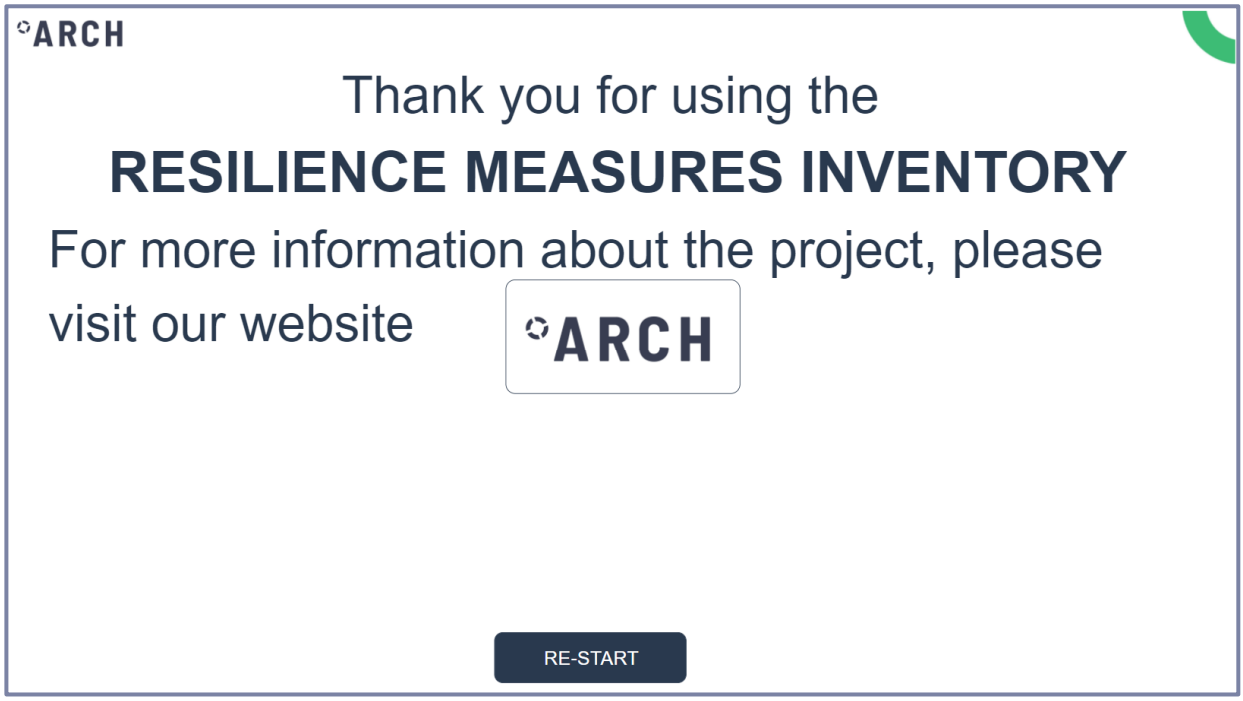


Figure 29. Back cover of the RMI

5.3. Use case 3: Early warning systems

I am interested in early warning systems; thus, I would like to explore this type of measures within the RMI and the information that is provided (factsheets)

This use case aims at answering the following questions: Are early warning systems present as a resilience measure? At group/subgroup or measure level?

1. To know exactly what type of measures to search for, click the **"Search the Inventory"** button on the **main window**. The window **Definition of your search** window will appear. The quickest way to proceed would be to type "early warning system" under the **Search Measures** filter (Figure 30).

2. Click on the magnifying glass icon to apply the filter. A list with resilience measures containing "early warning system" will appear under **Search Result List**.

3. Select under the **Search Result List** all the measures that are relevant. In this case all of them. Press "Ctrl" from the computer keyboard when selecting more than one option.

4. Click on the dark blue button **Check compatible measures** to proceed. A new window (Figure 31) will show with the **List of measures** containing the search term. The result shows 5 out of 261 measures within the RMI contain the "early warning system" term on it, which belong to two subgroups and 2 group of measures.

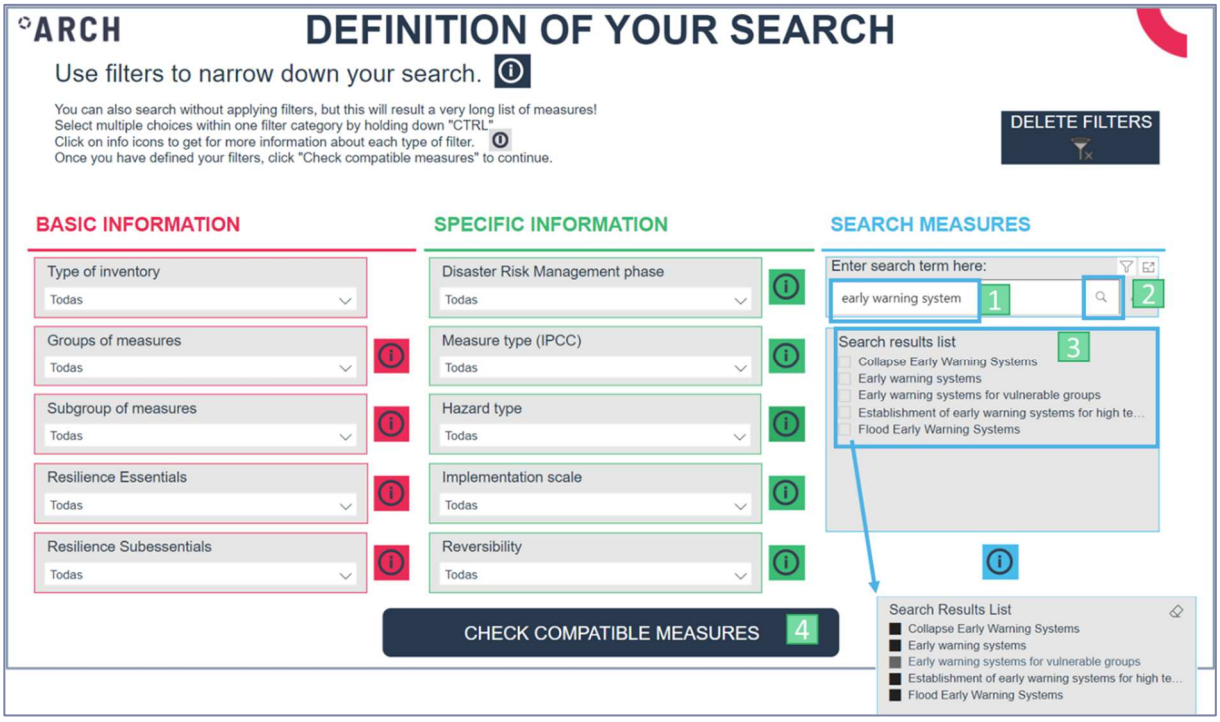


Figure 30. Steps 1 to 4 from use case 3

5. Click on the factsheets if extra characterisation information is desired about the selected measures. Click either in the PDF factsheets, which can be downloaded by clicking on the symbol (5), or on the online factsheet by clicking the button **factsheets** (5B). Factsheets allow a quicker switch from one measure to another while

the hyperlink to the PDF files allows to download the information and save the measures on the computer. Note that similar measures come from the two type of inventories, thus if a clear receptor has been identified, it may be pertinent to complement this search with **Type of inventory** filter.

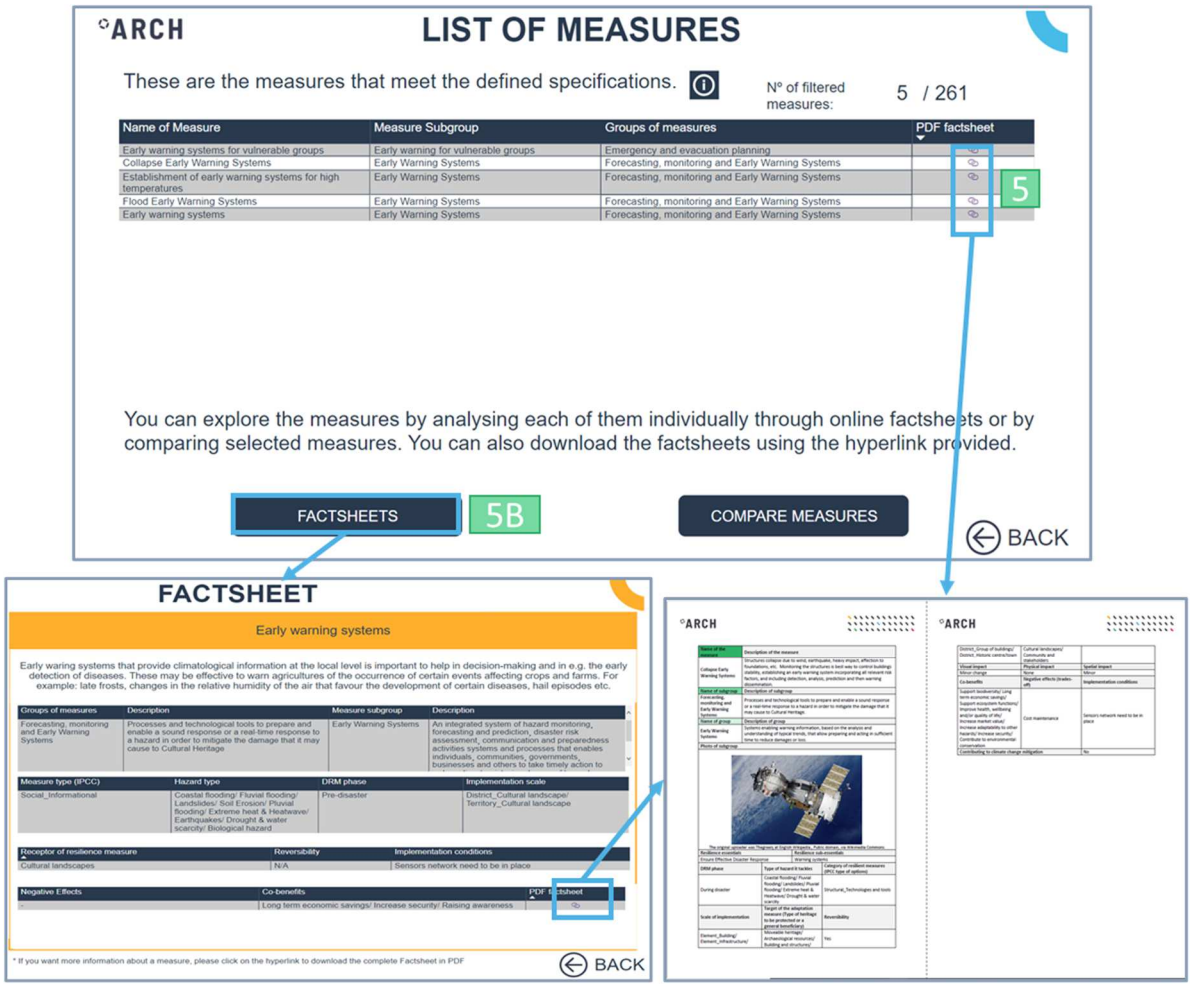


Figure 31. Step 5 in use case 3

6. References

[1] K.Milde D.Lückerath O.Ullrich., "'ARCH D7.3 ARCH Disaster Risk Management Framework.'" H2020 ARCH, GA no. 820999, 2020.

[2] A. Gondová, M.Musilova; M.Mendizabal, S.Zorita, M.Musacchio, A.Costanzo; D.Lückerath, M.I.Pannaccione Apa; E.Rome, K.Milde, O.Ullrich; V.Rebollo, T.Rangil-Escribano, E.Chapman; A.Schäfer, S.Maresch, "ARCH D7.1 State-of-the-Art Reports of concepts, approaches, standards and technologies." H2020 ARCH, GA no. 820999, 2020.

[3] Eleanor Chapman Serene Hanania et al., "'ARCH D3.3 ARCH city baseline report.'" H2020 ARCH, GA no. 820999, 2020.

[4] K. Nickel, K.Milde, D.Lückerath, E.Rome, "ARCH D7.4. Requirements Description." H2020 ARCH, GA no. 820999, 2020.

[5] L. A. Arika Virapongse, Samantha Brooks, Elizabeth Covelli Metcalf, Morgan Zedalis, Jim Gosz, Andrew Kliskey, "A social-ecological systems approach for environmental management," *J. Environ. Manage.*, vol. Volume 178, pp. 83–91, 2016.

[6] UNESCO, ICCROM, ICOMOS, and IUCN, *"Managing disaster risks for World Heritage."* Paris, 2010.

[7] ICOMOS, *Post Trauma Recovery and Reconstruction for World Heritage and Cultural Properties*. Paris, 2017.

[8] ICCROM Aparna Tandon., *"First Aid to Cultural Heritage in Times of Crisis."* Rome, 2015.

[9] Australian Journal of Emergency, *Sendai framework for disaster risk reduction 2015-2030*. Japan, 2015.

[10] IPCC; R.K. Pachauri and L.A. Meyer (eds.), "Intergovernmental Panel on Climate Change: Climate Change 2014: Synthesis Report - Summary Chapter for Policymakers," *Contrib. Work. Groups I, II III to Fifth Assess. Rep. Intergov. Panel Clim. Chang.*, 2014.

[11] C. Perry, J & Falzon, *"Climate Change Adaptation for Natural World Heritage Sites. A Practical Guide,"* vol. 37, no. September. Paris, 2014.

[12] World Bank Group, "Promoting Disaster Resilient Cultural Heritage," *Knowl. Note*, no. 1, pp. 1–19, 2017.

[13] Historic England; David Pickles et al., "Flooding and Historic Buildings Summary," 2015.

[14] Ministero per i Beni e le Attività Culturali Italia., *"Linee guida per la valutazione e la riduzione del rischio sismico del patrimonio culturale con riferimento alle Norme tecniche per le costruzioni di cui al decreto del Ministero delle Infrastrutture e dei trasporti del 14 gennaio 2008" Rome*. 2008.

[15] M. J. Hintz, C. Luederitz, D. J. Lang, and H. von Wehrden, "Facing the heat: A systematic literature review exploring the transferability of solutions to cope with urban heat waves," *Urban Clim.*, 2018.

[16] GOB Menorca, *"Resiliència climàtica en la gestió agrària: Guia pràctica de mesures per a l'adaptació al canvi climàtic."* Maó, 2018.

[17] United States Department of Agriculture. Maria K. Janowiak et al, *"Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the*

Midwest and Northeast." Washington, DC, 2016.

[18] Unión de Pequeños Agricultores y Ganaderos (UPA), "Manual de Adaptación Frente al Cambio Climático: cultivos herbáceos de secano," 2018.

[19] Ministerio de Agricultura Alimentación y Medio Ambiente, *Impactos, vulnerabilidad y adaptación al cambio climático en el sector agrario: Aproximación al conocimiento y prácticas de gestión en España*. Madrid, 2016.

[20] Food and Agriculture Organization of the United Nations (FAO). Keith Forbes and Jeremy Broadhead ., *"Forest and landslides: The role of the trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia."* Bangkok, 2013.

[21] "SUSDRAIN," *Community for sustainable drainage. CIRIA.* [Online]. Available: https://www.susdrain.org/.

[22] "RESIN," *European Commission H2020 Grant Agreement nº 653522. 2015-2018.* [Online]. Available: https://resin-cities.eu/home/.

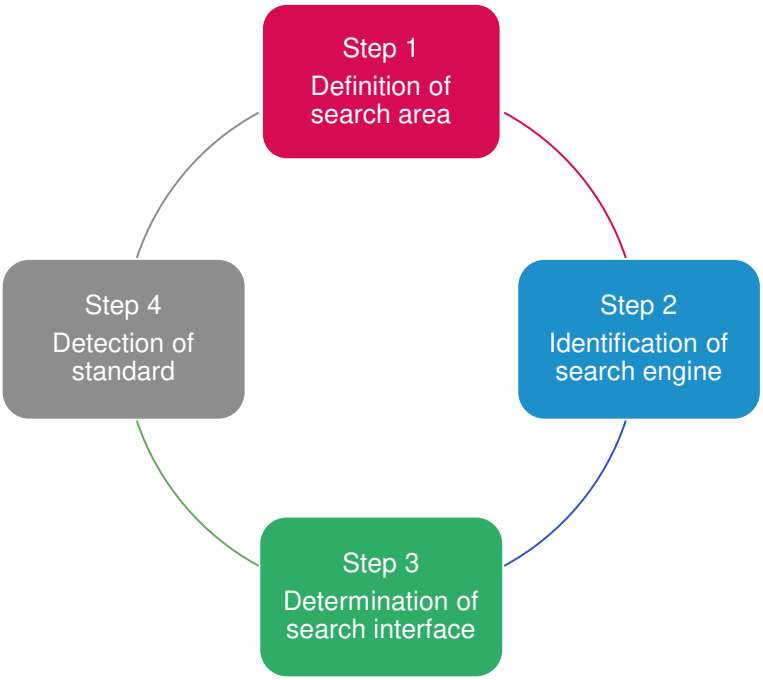
[23] "SCAN4RECO," *European Commission H2020 Grant Agreement nº 665091.* [Online]. Available: https://scan4reco.iti.gr/demos.

[24] "ProteCH2save," *INTERREG Central Europe 2007-2013.* [Online]. Available: https://www.interreg-central.eu/Content.Node/ProteCHt2save.html.

[25] "STORM," *European Commission H2020 Grant Agreement nº 700191.* [Online]. Available: http://www.storm-project.eu/.

Annex A

Standards – How can I find them?



Step 1: Based on the groups and subgroups of the ARCH Resilience Measures Inventory a search area can be defined that leads to Step 2. It is important to narrow down the search step-by-step to identify the most suitable standards for your product, service or process.

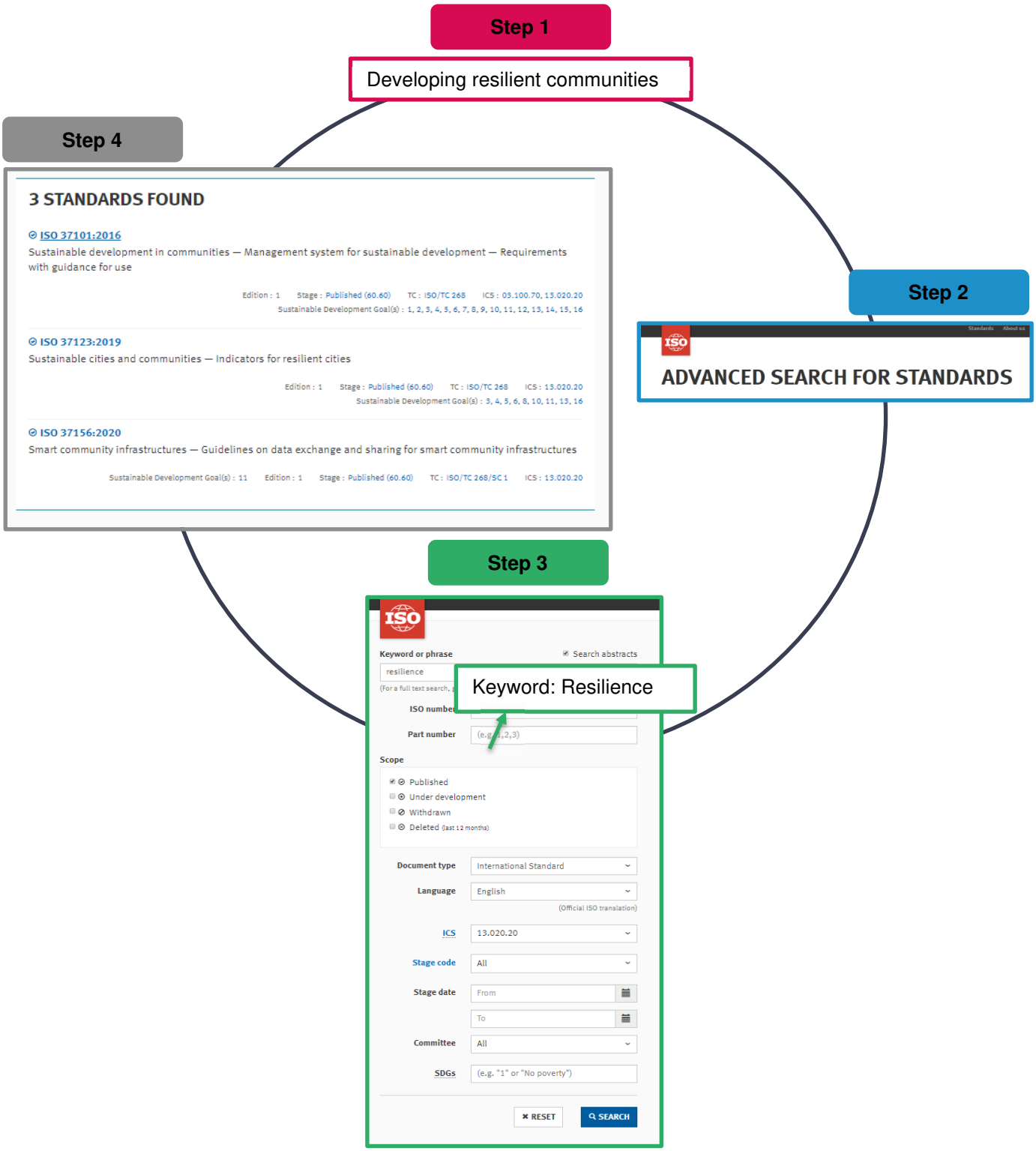
Step 2: Different search engines support you in identifying standards.
Search engines for general standards: CEN, ISO, IEEE, ASTM, Perinorm
Search engines for electro-technical standards: CENELEC, IEC
Support and other tools: European National Standardisation Organisation

Step 3: The groups and subgroups of the ARCH Resilience Measures Inventory help you to determine search terms and the corresponding standard classes (ICS). Most search engines also offer to search for standards of Committees and different types of documents (*e.g.* Standard, Technical Report, Technical Specification, and Agreement).

Step 4: Skim the standard titles and numbers in the list of standards provided by the search engine. The title usually consists of an introductory, main and complementary element. The standard identifier starts with the organisation that developed the document, followed by the type of document, the number and the publication year.

Standards – Example on how to find them

Example of a research question: "I am interested in knowing if there is a series of standards describing processes to build on resilience"



Standardisation – Good to know