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Database of current, planned and potential adaptation and mitigation measures

D4.1

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LOCALISED

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List of Abbreviations

KPI	Key Performance Indicator
CoM	Covenant of Mayors
SECAP	Sustainable Energy and Climate Action Plan
NDC	Nationally Determined Contributions
GHG	Greenhouse Gases
CDP	Carbon Disclosure Project
UNFCCC	United Nations Framework Convention on Climate Change
IPCC	Intergovernmental Panel on Climate Change
GCoM	Global Covenant of Mayors for Climate and Energy
C40	C40 Leadership Group
CNCA	Carbon Neutral City Alliance
ICLEI	Local Governments for Sustainability
PV	Photovoltaic
RESCCUE	RESilience to cope with Climate Change in Urban arEas
RESIN	Climate Resilient Cities and Infrastructures
EEA	European Environment Agency

SuM4All	Sustainable Mobility for All
TEG	Technical Expert Group
ENSU	Energy Sufficiency
BEI	Baseline Emission Inventory
RVA	Risk and Vulnerability Assessment
SOI	Sustainable development goals Oriented Indicators

Executive Summary

Deliverable 4.1, "Database of current, planned and potential adaptation and mitigation measures", compiles measures at the same level of abstraction in an integrated mitigation-adaptation approach and defined by a framework aligned with the Baseline Emission Inventories (BEI) and Risk Vulnerability Assessments (RVA) to develop Sustainable Energy and Climate Action Plans (SECAP) by Covenant of Mayors. The database contains relevant data for implementing the measures, such as costs, time for implementation, scale, and potential stakeholders, as well as possible synergies and trade-offs between mitigation and adaptation measures, sectors, and hazards.

On the one hand, the data in the database will be used for the optimisation model to suggest combinations of feasible mitigation and adaptation measures in European NUTS3 regions, locations, and municipalities (Task 4.2) and to serve as an essential input to further steps in the project. In particular, the SECAPs-aligned framework will facilitate the generation of SECAP documents with the support platform - Decarbonisation Profiler -, and is strongly connected with the work developed in task 5.2 about building a methodology to fill the BEIs and RVAs.

On the other hand, the database provides data to produce climate plans, following existing literature findings and SECAP requirements. Despite being unable to provide specific data for individual regions, it contains helpful information for climate planners, such as generic cost estimates, potential synergies and trade-offs, or most involved stakeholders in the implementation process. Thus, the database itself can already be used as a tool to develop climate plans.

Furthermore, a detailed methodology has been defined to systematically select and classify climate actions in the LOCALISED database based on its principles of maintaining the same level of abstraction and being aligned with the SECAPs. In this manner, the LOCALISED database can be expanded through the project's development without compromising its coherence and reliability.

The LOCALISED database compiles 314 measures from 12 different sources, which have been used to test the structure and methods of the database. It has 18 variables defining a measure, distributed into four types of data: measures' descriptors, main attributes, data for implementation, and associated instruments and Sustainable Development Goals Oriented Indicators (SOIs) (Ibañez Iralde, Pascual, 2022). The first three data types define a measure. Meanwhile, associated Instruments can be used by practitioners to facilitate a measure implementation, and SOIs provide a list of relevant indicators useful to assess the outcomes of a measure, concerning its target.

Public database

The database of current, planned and potential adaptation and mitigation measures can be publicly found in the following link, protected by the following password:

Link: https://zenodo.org/record/8248587

There are six different sheets available in the database:

_Display: Tool sheet. It allows exploration through the database with an interactive interface. This sheet is not fully functional without Macros.

_Summary: Compiles the number of items in the database, per category, per attribute.

_Measures: Dataset compiling adaptation and mitigation measures.

_Instruments: Dataset compiling associated instruments.

_SOI: Dataset compiling associated Sustainable Development Goals Oriented Indicators.

_Metadata: Brief description of the database elements.

To avoid downloading restrictions, we provide the database in two different formats:

Integrated database on adaptation and mitigation measures in Europe.zip:

The database is provided in .xlsx, without Macros. To run all the functionalities on the _Display sheet:

1. Download the .zip file and extract all files in a folder.
2. Open the .xlsx file, Min. 2019 Excel version required.
3. Open the VBA Editor in Microsoft Excel.
4. Go to File, and then Import file… Select the Macros (.bas) from the folder and import them.
5. Before opening it, go to the destination folder.
6. Right-click on the document and go to “Properties”.
7. Click “Unblock” on the “Security” section.
8. The database will run. Otherwise, the macros won’t work, and the tool will crash.

Integrated database on adaptation and mitigation measures in Europe.xlsm

The database is provided in .xlsm, with all Macros included and functional. To run all the functionalities on the _Display sheet:

1. Download the .xlsm file. Min. 2019 Excel version required.
2. Before opening it, go to the destination folder.
3. Right-click on the document and go to “Properties”.
4. Click “Unblock” on the “Security” section.
5. The database will run. Otherwise, the macros won’t work, and the tool will Crash.

1 Introduction

In the Paris Agreement, 196 countries agreed to limit global warming below 2ºC - preferably at 1.5 ºC - compared to the preindustrial levels (UNFCCC, 2015). To contribute to reaching that goal, governments present the Nationally Determined Contributions (NDC). However, research shows that the collectively planned actions to reduce greenhouse gas (GHG) emissions are potentially falling short of meeting the Paris Agreement (Stockwell et al., 2022). Following the NDC update at the 26th UNFCCC climate change conference in Glasgow, the world is heading towards 2.4°C warming (Stockwell et al., 2022; Carbon Disclosure Project - CDP). Similarly, in the 6th Assessment Report by IPCC (Arias et al. 2021), the 1.5ºC limit will be surpassed in all but one scenario in the early 2030s. Therefore, the same report stressed the need to speed up the implementation of climate action worldwide (Arias et al. 2021).

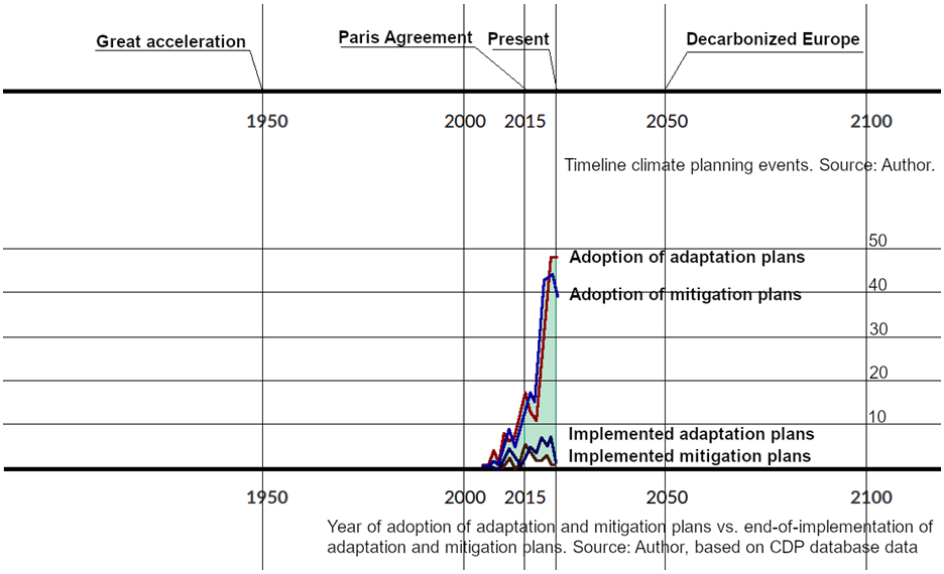

Figure 1 Year of adoption of adaptation and mitigation plans vs implementation of adaptation and mitigation plans. Source: Author, based on CDP Database data.

Climate actions are actions taken in response to an experienced or projected climate threat, risk or impact, allowing to either mitigate climate change or adapt to the impacts by building resilience to climate events (Horizon 2020 Online Manual). Climate actions are often planned and delivered as part of local, regional, or national climate plans or policies. International city initiatives, like the Covenant of Mayors for Climate and Energy (CoM), the Global Covenant of Mayors for Climate and Energy (GCoM), the C40 Leadership Group (C40), the Carbon Neutral City Alliance (CNCA), the Local Governments for Sustainability (ICLEI), and others, play an essential role in developing Local Climate Plans (Salvia et al., 2021). They offer tools and guidelines for developing local climate plans and networking platforms for peer-to-peer learning and exchange.

The CoM has 7.301 signatories as of January 2023, and all have committed to preparing and implementing Sustainable Energy and Climate Action Plans (SECAPs). In those documents, city officials should specify their climate goals, i.e. adaptation, mitigation, and energy poverty goals, and present the necessary climate actions to reach them in time, including certain details, like the sector or the hazard addressed.

Looking at these plans, many different climate actions are being planned, implemented and documented, covering a variety of hazards, sectors, and particular social or economic groups in municipalities. However, there is no uniform way of responding to the climate crisis. The variability of regional conditions throughout the world makes one size fits all approaches unfeasible (IPCC WGIII, 2022), as the implementation of actions depends on local and regional factors conditioning planned activities and their outcomes (IPCC, 2018; Nielsen et al., 2020; Williams et al. 2021; Rempel et al. 2022). Therefore, to ensure the implementation of climate actions, it is necessary to consider a region's specific context in planning mitigation and adaptation climate actions.

The regional specificity of context leads to a multitude of possible, feasible adaptation and mitigation actions. For regions to learn from each other, e.g. for laggards to learn from frontrunners, a comprehensive and integrated database of possible adaptation and mitigation options and their characteristics is needed. However, climate actions compiled in existent databases have different levels of abstraction, ranging from concrete and specific technological actions (installing PVs on public buildings' roofs) to generic societal changes (transition to renewable energies). This fact adds uncertainty to the planning process, impeding comparison and tests of feasibility and applicability. Therefore, Deliverable 4.1 develops a database of adaptation actions based on (1) a common framework to select, classify and categorise actions using relevant attributes for developing climate plans and (2) a unified level of abstraction of climate actions. Moreover, only 20% of the current SECAPs meet monitoring requirements, and according to the stakeholders interviewed in work package 5 of the LOCALISED project, any tool facilitating that stage will be a success (Ibañez Iralde, Pascual, 2022). Hence, the document will also provide relevant information for implementing measures and offer potential tools to facilitate their implementation and monitoring in a way that can facilitate the development of climate plans.

The database will support: (1) reaching an optimised selection of measures based on the regional mitigation and adaptation pathways, measures cost, and implementation time; (2) generating a climate plan based on the SECAP standards, providing relevant data for the planning and implementation process of each one of the measures.

2 Defining the LOCALISED Database

2.1 Integrated climate planning approach

The LOCALISED database is an integrated mitigation and adaptation measures database, considering measures as something that someone can implement and have a clear effect on a particular indicator. Any climate response on a more abstract level is called climate action or option.

The LOCALISED Climate Measures Database contains 150 mitigation measures, 102 adaptation measures, and 62 measures that can be used to address both types of responses. All measures are categorised using the same attributes, including potential trade-offs between them and containing approximate time and cost data, which will be later defined and downscaled within the Decarbonisation profiler. All attributes and data coincide with the SECAPs requirements to support the development of climate plans, facilitating and speeding up their design process. Moreover, all measures respond to the same level of abstraction. Finally, the database provides potential instruments and indicators that can be used to improve the implementation and monitoring of the measures.

Figure 2 captions the different concepts contained in the database. (1) The same level of abstraction allows differentiating the types of climate actions and safeguards that each measure responds to a mitigation or adaptation goal through a certain SOI. It also ensures that all measures and instruments are coherent and specific enough to be considered an implementable action. (2) Including basic data helps close the gap between planning and implementation by providing approximate values about the costs, time, and action's responsibility and scale. (3) The consideration of trade-offs between different sectors, hazards, adaptation and mitigation will help planners to understand the outcomes of a measure, allowing them to capture the whole complexity of developing a climate plan in an integrated way. (4) The common framework established based on the SECAPs' BEIs, and RVAs will facilitate the development of the SECAPs and writing climate plans. Moreover, having a common framework based on climate planning practices will enhance the transferability of information between practitioners.

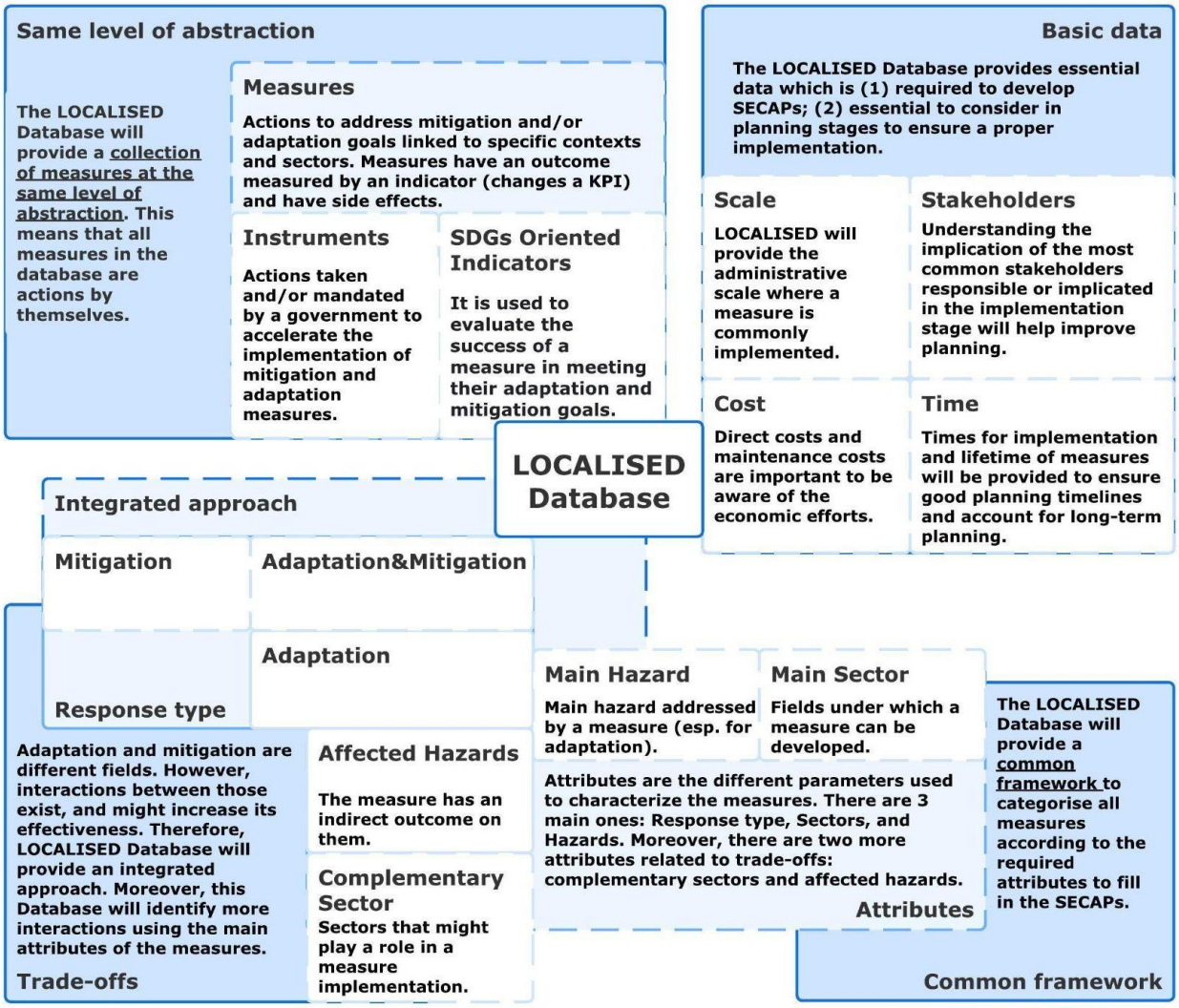

Figure 2 Conceptualisation of the database, with its four differentiative concepts. Source: Author.

2.2 Database structure

The LOCALISED database integrates adaptation and mitigation measures, with a total number of 150 mitigation measures, 102 adaptation measures, and 62 measures accounting for both. It provides a description/ definition of each measure as well as several details based on 18 different variables/attributes. The selection of these attributes is based on two different criteria.

- The data is intended to help close the gap between planning and implementing of measures. Therefore, it contains potentially relevant attributes of measures and their implementation. Measures are classified according to their temporal dimensions (time for implementation, and lifetime), the most appropriate scale (origin of the action), the costs (of implementation and maintenance), and responsible and potential actors involved in the process of implementation (stakeholders).
- The different attributes and characteristics match the fields that must be filled when developing the BEIs and RVAs for the SECAPs, for adaptation and for mitigation. In that way, the measures' attributes can support a direct translation of measures into the design of Sustainable Energy and Climate Action Plans.

Table 1 Structure of the database. What data does the database content, and what can be found there?

Measures' Descriptors	**Attributes of the measure**	**Data for implementation**	**Complementary items**
Name of the measure	Type of response	Time for implementation	Associated instruments
ID of the measure	Main sector	Lifetime	Key Performance Indicators
Description of the measure	*Mitigation sector (just for mitigation measures)*	Costs for implementation	
Sources	Complementary sectors	Maintenance costs	
	Main hazard	Origin of the action	
	Affected hazards	Stakeholders involved	

An example of how items can be found in the database is illustrated below:

1. All measures are listed and compiled under the sheet *_Measures* in the same format:

ID	Name of the measure	Sources	Definition
M049	Applying cool pavements	1. https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/climate-proofed-standards-for-road-design-construction-and-maintenance 2. https://doi.org/10.3390/su6084706 3. https://resin-aol.tecnalia.com/apps/adaptation/v4/#!/app/summary 4. https://clarity-h2020.eu/sites/clarity-h2020.eu/files/public/content-files/deliverables/CLARITY%20D3.3%20Annex.%20Adaptation%20Measures%20Technical%20Cards.pdf 5. https://doi.org/10.3390/su6084706 6. https://www.bbhub.io/dotorg/sites/32/2019/08/20190516_Cool-Pavement-Research-	Cool pavements have been adapted to reflect sunlight and prevent thermal transfer into the area surrounding buildings to reduce cooling demands. Painting light colors, using light colored materials (gravel), and adding light substrates all increase the albedo and reflective properties compared to darker materials. Preventing the absorption of solar energy as well helps prevent urban heat island effects.

Figure 3 Example: Measures' Descriptors for *Applying cool pavements*

ID	Name of the measure	Response type	Main sector(s) addressed	Complementary sectors	Mitigation sectors	Main hazard(s) addressed	Affected hazards
M049	Applying cool pavements	Adaptation	Building; Transport	Environment&Biodiversity; Health; Land use planning	NA	Extreme heat	-

Figure 4 Example: Attributes of the measure for *Applying cool pavements*

ID	Name of the measure	Origin of the measure	Main stakeholders involved in the implementation	Cost	Maintenance cost	Lifetime	Installation period
M049	Applying cool pavements	Local authority	National government; Subnational government; Private sector	Estimate from 1,75-37,75$/sqm (1).	-	From 3 to 20 years. Albedo might decrease to 20% within the first year (1).	From 1 to 2 days (1).

Figure 5 Example: Data for implementation for *Applying cool pavements*

ID	Name of the measure	Related instruments	Potentially related SOIs
M049	Applying cool pavements	I06;I31;I32;I33;I57;I61;I132;I134;I140;I141;I149;I189;I190	K4;K6;K14;K26;K26;K38;K39;K40;K78;K79;K80;K81;K82;K83;K84;K87

Figure 6 Example: Complementary items for *Applying cool pavements*

2. Complementary items are shown as a list of different IDs. Complete complementary items can be found in a different dataset in the same sheets *_Instruments* and *_SOIs (*SDGs Oriented Indicators). More details on these items can be found in section *4. What is a measure?*, and in section *5.4 Associated Instruments*.

ID	Name of the instrument	Sources
I06	Heat health action plan	https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/heat-health-action-plans

Definition	Main sector(s) addressed	Main hazard(s) addressed	Origin of climate action (responsible for promotion)	Type
Developing a health action plan for extreme heat events' consequences and impacts on human health.	Health	Extreme heat	Local authority; Regional; National	Regulatory

Figure 7 Instrument example (I06) for the Related Instruments to M049.

ID	Name of the SOI	Source	Definition
K4	Number of deaths, missing persons and persons affected by disaster per 100,000 people	https://w3.unece.org/SDG/en/Indicator?id=59 https://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__92-SDG__01-sdgover/013_en_sdGoal13_r.px	This indicator measures the number of people who died, went missing or were directly affected by disasters per 100,000 population. Focus on poor and vulnerable groups needed

ID	Name of the SOI	Main sector(s) addressed	Main hazard(s) addressed	Method	Unit	Synergies with SDI
K4	Number of deaths, missing persons and persons affected by disaster per 100,000 people	Civil protection	All	Data available at UNECE, even though at higher level, the methodology to downscale the information needs to be established	Number of people or %	SDG01

Figure 8 SOI (SDG Oriented Indicator) example (K4) for Potentially Related SOIs to M049.

3. More details on how the connections between items are established and how they are displayed can be found in section *6. Using the LOCALISED database.*

2.3 Building the LOCALISED Database

Building the LOCALISED database can be summarised into three working lines converging to build the final product (see figure 3).

1. **Compilation of climate actions.** *See section 3 Compilation of climate actions.* The process started with a comprehensive compilation of adaptation and mitigation climate actions from the most relevant existing European databases and projects.

2. **Selection of measures.** *See section 4 What is a measure?* It was pivotal to the research to understand what types of climate actions to include in the database. From generic types to policies, everything was mixed. Concerning its implementation, a measure needs to be concrete and related to a specific target.

3. **Building the structure of the database and assigning attributes.** See section *5 Defining the main attributes* and *Annex I: How to define sectors, hazards, origin of the action, and stakeholders for the measures.* To build a helpful database for speeding up and facilitating climate planning and future implementation, identifying the different attributes and variables to define per each measure was crucial.

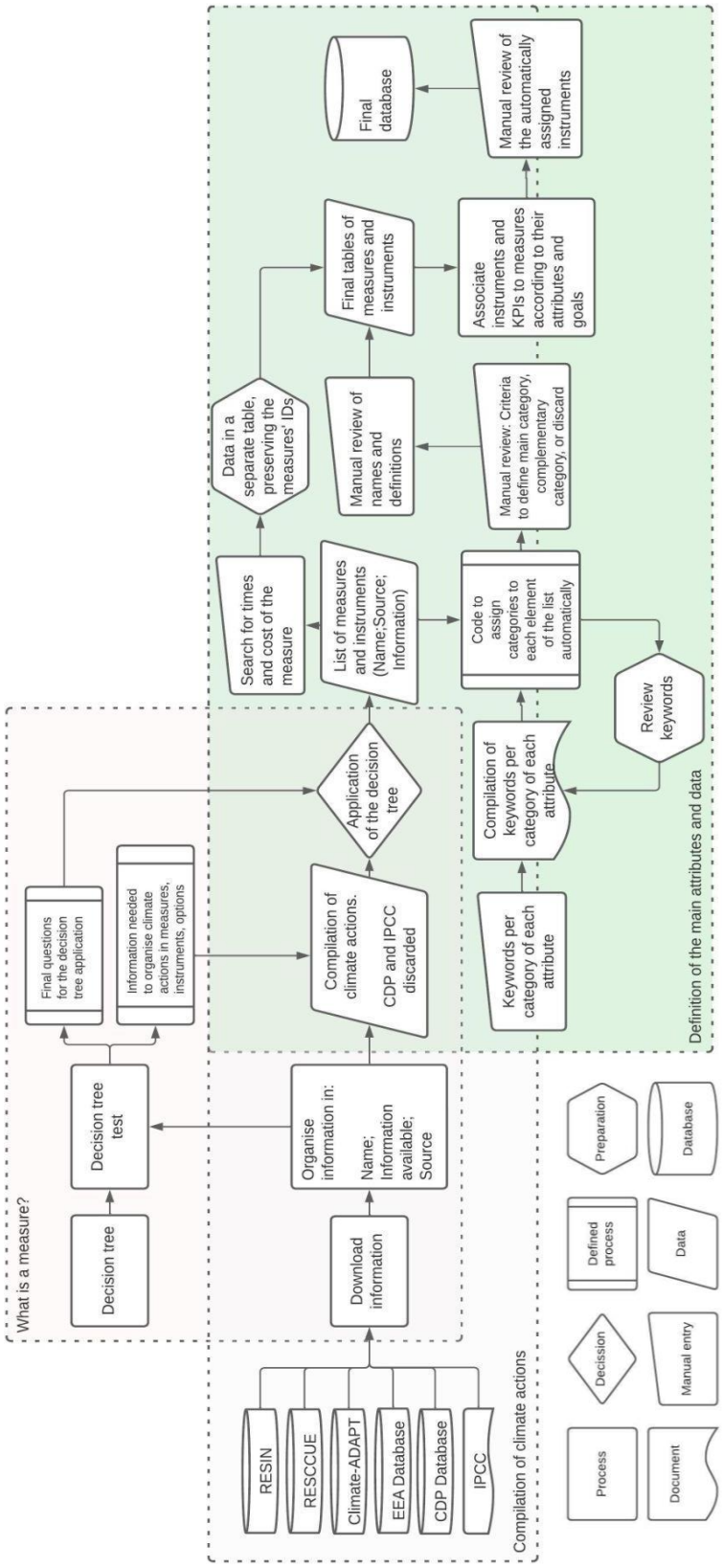

Figure 9 Workflow of the LOCALISED Database process. Source: Author.

3 Compilation of climate actions

Data from existing databases and projects was collected to select measures for the LOCALISED database, compiling all possible climate actions available in those sources. Since several databases are available for adaptation and mitigation, four databases were selected as baselines to compile climate actions, according to the following criteria: (1) databases developed within the European context; (2) climate actions in them are characterised and defined in detail; (3) climate actions in the databases come from on-ground research at a local or regional level. As LOCALISED aimed to build a unique and integrated mitigation and adaptation measures database, searching for adaptation and mitigation separately was necessary.

For adaptation, all actions targeting the adjustment of local and regional contexts to reduce the harm produced by the impacts of climate change were considered. The initial set of adaptation measures comes from the following databases:

Table 2 Selected adaptation databases, with the correspondent link, the procedure followed to extract the data from the online open source, and the number of items detected per each one of them. Source: Author.

Source	Procedure to extract the data	The initial number of climate actions
Climate-ADAPT Link: https://climate-adapt.eea.europa.eu/#t-database	Downloaded the document for adaptation actions (csv).	59
RESIN Link: https://resin-aol.tecnalia.com/apps/adaptation/v4/	Downloaded the document for adaptation actions (csv).	100
RESCCUE Link: https://adaptationstrategies.resccue.eu/measures	No downloadable document was available. Went through the online tool and copied the information into a separate file.	178
6th Assessment Report by IPCC, Work Group II	No specific list of actions. Searched in the document for the words "Adaptation option*" and "Adaptation measure*". From the 684 hits, extract	697

	the different potential adaptation measures mentioned. No specific list of actions.	
CDP Database Link: https://data.cdp.net/browse	Downloaded the dataset 2022.CitiesAdaptationActions.	977
CLARITY Project Link: https://clarity-h2020.eu/content/downloads	Downloaded .pdf file and copied actions and background information in an editable table	18

Mitigation actions were denoted as actions that seek to reduce sectoral emissions. LOCALISED comprised actions seeking to improve efficiency, reduce fuel consumption, shift to efficient alternatives, or directly reduce atmospheric concentrations or pollutant source emissions. A comprehensive set of mitigation actions were collected from the following data sources and peer-reviewed literature:

Table 3 Selected mitigation databases, with the correspondent link, the procedure followed to extract the data from the online open source, and the number of items detected per each one of them. Source: Author.

Source	**Procedure to extract the data**	**The initial number of climate actions**
European Environmental Agency Mitigation Measures and Policies Database (EEA MMPD) Link: http://pam.apps.eea.europa.eu/	Downloaded file (csv).	There are 2304 items. Since the database compiles individual measures, just individual measures have been selected. Final list of 498
CDP Database Link: https://data.cdp.net/browse	Downloaded the dataset 2020.CitiesEmissionsReductionActions and 2022.CitiesEmissionsReductionActions (csv).	1406
6th Assessment Report by IPCC, Work Group III	No specific list of actions. No specific list of actions. Searched into the document for the words "Mitigation option*" and	138

	"Mitigation measure*". From the 476 hits, extract the different potential mitigation measures mentioned.	
Sustainable Mobility for All (SuM4All) Catalogue of Policy Measures 2.0 https://www.sum4all.org/key-products/catalogue-policy-measures-cpm	Extracted from the downloadable document (pdf).	194
TEG Taxonomy Database https://finance.ec.europa.eu/system/files/2020-03/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf	Extracted measures from the website documentation (pdf).	-
ENSU 2022 Sufficiency Policy Database https://energysufficiency.de/en/policy-database-en/	Downloaded file (csv).	254

Climate actions were selected from these materials if the description of the measure was explicitly stated as an implementable solution. Solutions were cross-referenced with literature to ensure relevant information exists to characterise their impact, and measures were only selected if sources indicated the underlying technologies would be viable by the year 2050.

The information available in the sources (e.g., name and description, sectors and other labels attached to them, and other qualitative data) was copied in a table containing the source, the name of the action, and all the background information available in the sources.

Subsequently, the authors carefully read the background information, searching for duplicates in the different databases and merging information, as the same climate actions might be included in more than one database. In those cases, background information and sources were put together. It was important to read the background information and do the process manually since some climate actions could have different names (E.g., "cooling pavement with water" or "Pavement watering").

4 What is a measure?

After consulting existing databases of mitigation and adaptation measures and going deep into the IPCC 6th Assessment Report and the Carbon Disclosure Project, two main questions arose, essential for the development of the database:

- Defining what a measure is;
- Defining and harmonising the main attributes and data to provide for each measure.

4.1 Definition of measures, instruments, and options

It was found that the specificity (abstraction) level of what can be understood as a climate action depends on the authors of the databases. It impedes comparison and feasibility tests between them, making the design of a climate plan difficult.

For example, both Climate-ADAPT and RESIN compiled what they called adaptation options. However, not all are specific enough to be integrated directly into a climate plan. The RESIN project database named their climate actions as options. However, their level of abstraction was highly variable. For instance, the option "District Energy Development" refers to a shift in energy production but is a sum of different particular actions - decentralised energy, heat pumps, etc. On the other hand, "Air conditioning" is also included in the database, but this particular action can be taken to face adaptation. The same lack of consensus can be found in other databases consulted (RESCCUE, European Environmental Agency (EEA) Mitigation Measures' database, CLARITY project), global projects and reports (IPCC's 6th Assessment Report, Carbon Disclosure Project, Covenant of Mayors), or in the climate plans for different regions themselves.

Hence, a literature search was conducted to clarify the use of terms such as "option", "measure", "intervention", or "response", concerning "Climate", in the scholarly literature. Findings reveal that the term "options" have been used to refer to a bundle of particular measures sharing the same sectors or targets (Williams et al., 2021; IPCC, 2018; Rempel et al., 2022). Meanwhile, "measures" are defined in mitigation as technologies or practices that reduce GHG emissions or enhance sinks (IPCC, 2018: Annex I; Busch et al., 2022). However, no clear definition can be found in the adaptation field, and sometimes the word is used as a synonym for options. "Response" refers to any action taken against climate change, and "intervention" was barely used in the literature without significant results.

Based on the literature review and submitting the conclusion to discussion among the LOCALISED members, a series of definitions were proposed:

- Measures: Actions to address mitigation and/or adaptation goals linked to specific contexts and sectors. Measures have an outcome measured by an indicator and have side effects;
- Instruments: Actions taken and/or mandated by a government or other stakeholder to initiate or accelerate the implementation of mitigation and adaptation measures;
- Options: a suite of related measures and/or instruments by sector, same KPI, hazard, etc. E.g., Resilient Energy Systems. Affecting the same indicators.

Figure 4 illustrates how those different types of climate actions relate between them. Measures are planned in a specific context for their implementation and aim to change a targeted indicator to achieve a mitigation or adaptation goal. Instruments can facilitate this implementation process. Measures and instruments can be grouped into more generic options. Those, as well as the mitigation and adaptation goals, are typically integrated into climate plans.

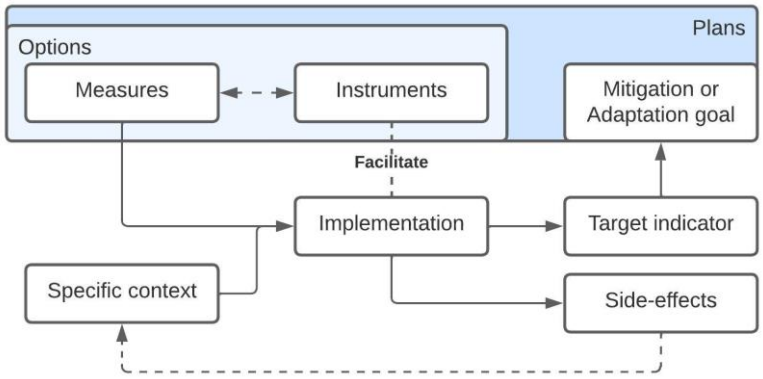

Figure 10 What role does each climate action play in the planning process? Source: Authors.

4.2 How to distinguish a measure from an instrument and an option?

The LOCALISED database distinguishes between the above three types of climate actions, focusing on collecting adaptation and mitigation measures and the associated instruments that facilitate their implementation. A decision tree was designed to do this classification based on five binary yes/no questions: *(1) Can someone implement the action?; (2) Does the climate action have a mitigation and/or adaptation goal?; (3) Considering an option as a suite of measures and instruments, is the action composed of other more specific actions?; (4) Does the action directly affect one or more specific assets of the implementation's environment?; (5) If a policy, law, or regulation is the*

action being used to facilitate or promote the implementation of other actions? In the end, this decision tree is the one that will be used to expand the database with further measures and instruments along the project.

The questions are formulated based on the literature-based definitions of the three terms and allow the user to accept or not an item as climate action and automatically define if it is a measure, instrument, or option. Since the information varied a lot between items, the process should be conducted manually.

To ensure the reliability and solidity of the questions, the decision tree was tested with five climate planning researchers from different institutions: University of Twente, Catalonia Institute for Energy Research, and Potsdam Institute for Climate Impact Research. They all got the same list of ten randomly selected climate actions. They should answer the five yes/no questions for each one of the climate actions two times, without having any contact or discussion with each other. Firstly, just relying on the name of the action and then using the background information provided. The initial hypothesis was that if all of them could answer the same, the question was specific and solid enough to be answered without bias.

Table 4 Original questions distributed to the participants.

Nº	Question
1	Can the action be implemented?
2	Does the action have a mitigation and/or adaptation goal?
3	Does the action relate to a specific KPI?
4	Is the action composed of other actions?
5	Is the action contributing to facilitating the implementation of further actions?

Results showed different levels of agreement in each one of the questions per climate action. The experts' agreement level increased significantly when providing certain background information. Even so, there were still some discrepancies. Subjects were asked to provide the information they sought to answer the questions. According to their answers, there was specific information that needed to be included in the background section to be able to give a response to the question. The action is discarded if the information available on the source does not contain the information needed to answer the questions. For example, climate action number 6 (Emissions Trading System EU ETS) produced certain disagreements within the answers, and subjects were unable to provide a clear answer. Thus, including a minimum amount of information to conduct the test consistently became central for the decision tree.

On the other hand, when looking at the level of agreement of the answers, Questions 1, 2, and 4, seemed to be consistently interpreted in the same way by the subjects. Question 5 had a lower agreement, and Question 3 did not reach a comprehensive outcome. Subjects were asked to rate the structure, clarity, usability of background

information, and coherency of the questions from 1 to 5 (five being the maximum) and give written feedback on improving the tree. Main gaps were also detected in the clarity of the questions and their coherency with definitions. Feedback from the participants suggested adapting wording and making questions and concepts more precise, clarifying the type of information that can be used, and including more specific definitions in the same question. Thus, more information was included, questions were reformulated, and the decision tree was restructured.

Table 5 Changes after feedback.

Original position	Original question	Final position	Final question
1	Can the action be implemented?	1	Can someone implement the climate action?
2	Does the action have a mitigation and/or adaptation goal?	2	Does the climate action have a mitigation and/or adaptation goal?
3	Does the action relate to a specific KPI?	4	Does the action directly affect one or more specific assets of the implementation's environment?
4	Is the action composed of other actions?	3	Considering an option as a suite of measures and instruments, is the action composed of other more specific actions?
5	Is the action contributing to facilitating the implementation of further actions?	5	If a policy, law, or regulation; is the action being used to facilitate or promote the implementation of other actions?

The final structure, questions, and needed information to answer them were formulated as the following:

1. Can someone implement the climate action?
    a. If yes, keep the climate action in the list.
    b. If not, take out the climate action from the list.
    c. Information needed: Can someone or something do it? Is there any specific action envisaged?

2. Does the climate action have a mitigation and/or adaptation goal?
    a. If yes, keep the climate action in the list.
    b. If not, take out the climate action from the list.
    c. Information needed: Is there a direct link to GHG emission reduction, direct link to hazards, or clearly defines a goal related to CC impacts?
3. Considering an option as a suite of measures and instruments, is the action composed of other more specific actions?
    a. If yes, the climate action is an option.
    b. If not, the climate action is a measure or an instrument.
    c. Information needed: Are there different ways to implement it? Has the action more than one measure to be undertaken? How is the level of specificity in the description?
4. Does the action directly affect one or more specific assets of the implementation's environment?
    a. If yes, the climate action is a measure.
    b. If not, the climate action is an instrument.
    c. Information needed: Is there a clear definition of the asset? If it is a structural action, can it be built in a specific context?
5. If a policy, law, or regulation; is the action being used to facilitate or promote the implementation of other actions?
    a. If yes, the climate action is an instrument.
    b. If not, the climate action a measure.
    c. Information needed: If it's not a physical action, what implies its implementation? Is it a specific prohibition?

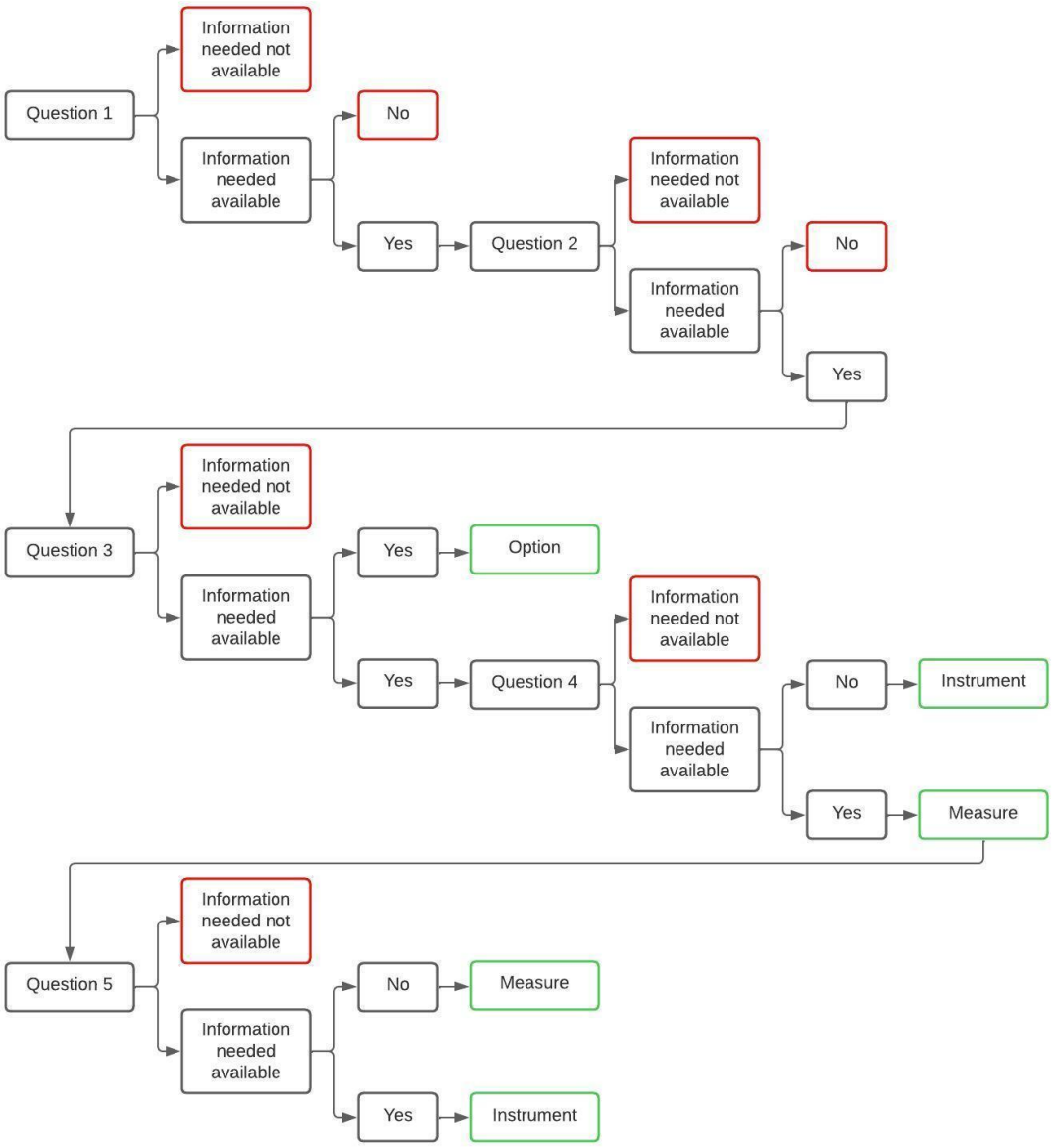

Figure 11 Decision tree procedure. Paths leading to discard climate action (red) and paths leading to classify the climate action (green). Source: Author.

To apply the decision tree to all climate actions collected, those were listed in one common Excel table with the ID, name of the climate action, and background information available. The available information was checked to see whether the information on the databases was sufficient enough to run the process to all of them. However, it was found that two databases had not enough information to be initially included, and their compiled climate actions were discarded:

- In the identified IPCC adaptation and mitigation measures, the only actions with sufficient background information referred to options - e.g., non-specific actions - like "shift to public transport". No further information is provided on specific

actions that could be considered measures, so most of them do not contain sufficient background information.

- CDP Database. As the climate actions reported came from particular cases, the information was written in several languages, and even if categories were established, some measures didn't follow the standards. Thus, it was decided to be processed and integrated into the database once the methods were clarified, and the first version of the database was available.

The decision tree was manually applied to the remaining 966 listed items to accept or discard them and then classify them into options, measures, or instruments. Moreover, as the process required reading all backgrounds and, in some cases, looking for extra sources, more duplicated measures were deleted. Some climate actions were split into more items (for example, in Climate-ADAPT, the option "Cliff strengthening" clearly contained separate definitions for "Cliff reshaping", "Cliff drainage", "Rock bolting", "Concrete buttress and riprap strips", and "Reinforced geogrid and pinned nets". In those cases, climate actions were divided into different measures). On the other hand, some mitigation measure descriptions may contain source-specific and technical terminology. Those measures were aggregated by method, and a representative mitigation measure was assigned to each merged set.

5 Defining the main attributes and variables

Each one of the source databases was found to assign different attributes to their measures. For instance:

- In the case of Climate-ADAPT, measures - called adaptation options - are categorised according to their sector, climate impact, region, adaptation elements (type of measure), funding program, item from third party (source), and country.
- Regarding RESIN, measures are classified according to the hazard addressed, the application scale, measure type, its target, and three effectiveness-related parameters: heat-effectiveness, flood-effectiveness, and cost-effectiveness.
- In the RESCCUE project measures are categorised based on the hazard addressing, the key benefits they provide, measure type, spatial scale, urban sector, and response type. It offers the opportunity to look for the co-benefits.
- The EEA database classifies the mitigation measures in a more detailed way. Up to 15 different ways to categorise the measures can be found in the tool: by country, GHG(s) affected, sectors, objectives, type of policy instrument, status of implementation, entities responsible, implementation period start, relation to EU policies, which policy is related, projection scenario, policy impact, GHG emissions reduction in 2030 and 2035, and relation to air pollution.

As seen in Table 4, even if some of the databases include similar attributes in some cases - like sectors, type, or hazard addressed - no common categories were found between them. In fact, the same phenomenon happens when reading well-recognised reports and global initiatives. For instance, when checking the 6th Assessment report by the IPCC, it was found that not even its adaptation and mitigation options followed the same categories of any previously consulted literature and databases.

Table 6 Categories per each attribute and other characteristics of the source Databases. Source: Author.

	Climate-ADAPT	**Climate Resilient Cities and Infrastructures (RESIN)**	**RESilience to cope with Climate Change in Urban arEas – (RESCCUE)**	**European Environment Agency Database on Greenhouse Gas Policies and Measures in Europe**
Name of climate actions	Options	Options	Measures	Measures
Focus	Adaptation	Adaptation	Adaptation & Mitigation	Mitigation
Hazard	1. Drought 2. Extreme Temperatures 3. Flooding 4. Ice and Snow 5. Sea Level Rise 6. Storms 7. Water Scarcity 8. NONSPECIFIC	1. Drought 2. Fluvial flooding 3. Heat waves 4. Multiple types of flooding 5. Pluvial flooding 6. Sea level rise and storm surge 7. Wind storm	1. Combined Sewer Overflow 2. Drought 3. Flood 4. Heat wave 5. Sea Level Rise 6. Wide-ranging events	-
Scale	-	1. Building block/garden/square 2. Building/ infrastructure 3. District/ neighbourhood 4. Region 5. Street 6. Village/City	1. Building 2. Street 3. Neighbourhood 4. City 5. River Basin 6. Telecom	(Responsible for implementation) 1. Companies/ businesses/ industrial associations 2. Local government 3. No information 4. Others 5. Regional entities

				6. Research institutions
Sectors	1. Agriculture 2. Biodiversity 3. Buildings 4. Coastal areas 5. Disaster Risk Reduction 6. Ecosystem Based approaches 7. Energy 8. Financial 9. Forestry 10. Health 11. Marine and fisheries 12. Transport 13. Urban 14. Water management 15. NONSPECIFIC	-	1. Emergency 2. Energy 3. Environment 4. Health 5. Mobility 6. Power 7. Social 8. Telecom 9. Waste 10. Water	1. Agriculture 2. Energy Consumption 3. Energy Supply 4. Industrial Processes 5. Land use, land use change and forestry 6. No information 7. Other Sectors 8. Transport 9. Waste
Type	-	1. Economic 2. Ecosystem based adaptation 3. Educational 4. Engineered and built environment 5. Government policies and programs 6. Informational 7. Laws and regulations 8. Service options 9. Technological	1. Engineered and built environment 2. Technological 3. Ecosystem based 4. Educational 5. Informational 6. Behavioural 7. Economic 8. Laws and regulations 9. Government policies and programs	1. Economic 2. Education 3. Fiscal 4. Information 5. No information 6. Other 7. Planning 8. Regulatory 9. Research 10. Voluntary/negotiated agreements

Throughout the scientific literature, scholars also used their own ways to categorise climate actions, according to different attributes. However, even when using different categories for the same attributes, some ways of categorising measures seemed relevant, as appeared in the literature several times: by type of response (e.g. adaptation/mitigation) (Heyward, 2013; Boucher, 2014), by sector or areas (Smits et al. 2021; Biagini et al. 2014), by co-benefits (Deng et al. 2017), by time (Smits et al. 2000), or by actor or social aspects (Hegger et al. 2017; Cavici et al. 2021).

As explained before, the LOCALISED database aims to help local and regional planners to improve and speed up their planning process and help close the planning-implementation gap. The BEIs and RVAs for SECAPs templates provided by the Covenant of Mayors offer a systematic way to develop climate planning. International organisations play an important role in local climate planning (Reckien et al. 2015), so using their tools might offer a powerful solution. These documents must contain a list of key actions. Furthermore, those actions must be characterised according to certain standards, whose information is provided by the planner: the name of the action, description of the action, type of action, the origin of the action, the responsible body for the implementation, implementation timeframe, implementation status, stakeholders involved, and total implementation costs. In fact, the type of action, the origin of the action, implementation timeframe, stakeholders involved, and total implementation costs must be filled out for all actions involved in the plan. Moreover, SECAPs are thought to respond to certain vulnerable sectors and hazards. Thus, it is important to understand the sectors and hazards the measures are addressing.

Based on the SECAPs development procedures and the findings in the planning literature, the LOCALISED database identified a total of 18 variables that will try to fill the gaps existing in the planning, implementation, and monitoring process, and will be provided for each measure. According to its final aim within LOCALISED, those variables are divided into four types of data: measure's descriptors, attributes of the measure, data for implementation, and complementary items. A detailed overview of each can be found in the following sections. The process to assign the different attributes and basic data to each one of the measures can be found in *Annex I: How to define sectors, hazards, origin of the action, and stakeholders for the measures.*

Figure 12 The 18 variables of the database, with the different categories included in them, grouped by type of data. Source: Author.

5.1 Measures' descriptors

Measures' descriptors refer to the data explaining the measure itself. There are four types of those:

Table 7 Types of measures' descriptors. Source: Author.

Name of the measure	Name given to the measure.
Measure ID	ID assigned to a measure. Each measure has a unique ID.
Description of the measure	Brief description of the measure.
Sources	References, links, and other information sources used to fill the database, per measure.

5.2 Main attributes of a measure

The main attributes are the ones related to the target of the measure. From the previous literature, databases, and SECAPs approach, it can be concluded that there are three essential types of attributes for measures: type of response (Heyward, 2013; Boucher, 2014; RESCCUE; EEA), sector (SECAPs; Climate-ADAPT; RESCCUE; RESIN; EEA; Smits et al. 2021; Biagini et al. 2014), and - in the case of adaptation - the hazard(s) addressed (RESCCUE; Climate-ADAPT; RESIN; SECAPs). The different categories within each one of those are aligned with the SECAPs.

Table 8 Main attributes. Source: Author.

Response type	Defines the goal of the measure. Measures can belong to three different response types, as the LOCALISED database integrates mitigation and adaptation measures. - Adaptation: The measures are used to cope with climate impacts. - Mitigation: The mesures' ultimate goal is to reduce GHG emissions. - Adaptation & Mitigation: The measure can be used for both.
Sectors	The fields to which a measure addresses. LOCALISED will provide two tiers of sectors. The main sectors are related to the highest level of categorisation of the measures. According to the SECAPs framework (BEIs and RVAs), there are two main sectors types: mitigation and adaptation. - BEIs Mitigation sectors: Municipal buildings & equipment/facilities; Tertiary (non-municipal) buildings & equipment/facilities; Residential buildings; Industry; Transport; Waste; Local Electricity Production; Local Heat/Cold Production; Others. - RVAs Vulnerable Adaptation sectors: Buildings; Transport; Energy; Water; Waste; Land Use Planning; Agriculture & Forestry; Environment & Biodiversity; Health; Civil Protection & Emergency; Tourism; Education; ICT (Information & Communication Technologies); Others. RVAs vulnerable adaptation sectors cover more economic, environmental, and social areas than mitigation sectors. A number of sectors serve both, mitigation and adaptation. For example, Agriculture and Forestry is also

	an important sector for mitigation (IPCC, 2022), although not mentioned as a mitigation sector in the BEIs for the SECAPs. Likewise, some mitigation measures, e.g. those related to tourism (like promoting local commerce), Environment and Biodiversity (creating parks and green areas), and Education (any course related to shift into behaviour), can also relate to adaptation sectors. Therefore, our database adopted the Adaptation sectors as the standard sector categorisation for all measures. However, mitigation measures are also categorised according to the BEIs SECAPs mitigation sectors.
Hazard	Hazard categories will follow the categorisation of hazards in the SECAPs' RVAs, which are also mostly coincident with some international standards, like EM-DAT. The main hazards are: Extreme heat; extreme cold; heavy precipitation; coastal flood; fluvial flood; sea level rise; droughts and water scarcity; storms; mass movements; wildfires; chemical change; biological hazards; others.

Furthermore, both in the literature and the RESCCUE database, the co-benefits (or synergies) of measures were highlighted (Deng et al. 2017; Brito et al. 2020). According to the 6th Assessment Report of the IPCC, identifying those interactions between climate actions - known as co-benefits/synergies, conflicts and/or trade-offs - might increase their effectiveness. Since the LOCALISED database aims to facilitate climate planning for each NUTS3 region, including those synergies and trade-offs was important. However, the implementation conditions of measures vary according to their local and regional context (Reckien et al., 2015; Williams et al., 2021; Hagen et al., 2022; de Coninck et al., 2018; IPCC WGIII, 2022; IPCC WGII, 2022). Therefore, the database will not provide specific, quantifiable data for each measure's synergies but a complementary list of sectors and hazards that might be affected by the implementation of the measure. Here are a couple of examples:

- "Installing Air conditioning" is an adaptation measure that belongs to the Building sector and offers a solution for the hazard Extreme Heat events. However, it implies the Energy sector and might also be used to deal with cold waves in some locations.
- "Cooling pavements with water" is another adaptation measure which belongs to the Transport sector and deals with the hazard of Extreme Heat. Still, it has implications for the Energy and Water sector and should be reconsidered in periods of Drought.

Table 9 Main attributes related to trade-offs. Source: Author.

Complementary sectors	There are existent trade-offs between different sectors, as shown in the previous examples. Thus, LOCALISED Database provides other sectors that might be affected by implementing a measure, offering a broader comprehension of what a planner should consider when planning for a certain action.
Affected hazards	Are the ones that might be affected in terms of frequency, intensity, or impact when the measure is applied but are not the main target of the measure. It is important to remark that some mitigation measures might have some synergies with certain hazards, which are not exclusive for adaptation in our database.

5.3 Basic data for implementation

Basic data for implementation refers to data accounting for the inputs of the measure and important data to develop a plan coherently. Literature and reports in the climate science community claim that the gap between planning and implementation of climate actions might be occurring due to an inappropriate planning scale (CDP; IPCC, 2022), the poor consideration of implementation times and long term planning (IPCC, 2022), and the lack of consideration of justice (Hughes et al. 2020). Moreover, knowing who is responsible for the action, the duration for its implementation, and the needed budget will increase the quality of the climate plans (Reckien et al., 2023). Thus, the database will also contain generic data on the aspects mentioned above, which, following the used logic, are as far as possible aligned with the SECAPs.

Table 10 Basic data for implementation. Source: Author.

Time	Time becomes an important factor because of the need to speed up mitigation and adaptation action and comply with climate goals (IPCC, 2022). Time information will come from databases from

	previous projects and initiatives and literature. There will be two types of time information: - Time for implementing a measure. It is mandatory for the SECAPs, and is essential to come up with a good quality plan. It is the period between the official publication of a measure into a plan and when the measure starts having an outcome on the targeted KPI. - An estimated value of the lifetime of a measure. Even if it is not included in the SECAPs, it will help planners to account for long-term planning and avoid undesired obsolescence or lack of continuity in the measures.
Scale	Planning the measure at an appropriate scale will help reduce the possible gaps between the planning stage and its implementation. Databases like RESCCUE are already defining the spatial scale of the measures, categorising them between Building, Street, Neighborhood, City, River basin, or Telecom. However, LOCALISED will follow the SECAPs criteria, and offer to planners and policy-makers the administrative scale of a measure. The SECAPs' Origin of the action category fits perfectly in that sense. According to that, a measure can be planned at local level (local authority), regional (need to plan at a regional scale), national (planned at a national scale), covenant coordinator or supporter (when it is planned by a consortium of several local or regional entities), mixed, or others.
Costs	Costs vary depending on the region, country, and time. However, having an estimate would help climate planners better understand their possibilities and plan the measures according to the available budget. Two main types of costs are associated with a measure: installation and maintenance. - Installation costs refer to building costs or implementation costs (making a measure operational). - Maintenance costs refer to keeping the measure operating the closest possible to its original condition and losing the least effectiveness possible. Maintenance costs are typically calculated annually, and typically increase through time due to the measure obsolescence or price inflation. Costs are given as approximates or ranges using data available at the end of 2022 from available data sources, which can be found in the Sources column of the database per each measure. On the one hand, double-checking the costs suggested within the

	regional resources available at the time of implementation is important due to the monetary value fluctuations and inflation rates. Even if more than one source has been consulted, this doesn't mean that the costs can't vary depending on the context. On the other hand, greater availability of technology is expected to reduce the cost of some measures. When possible, the database provided an estimate of cost variation for 2050. Cost values in the database are always provided per unitary costs, like millions of € per meter raised in 1 km dike in the case of Heightening dikes, or 30000$ per 100m of road covered with Road Drainage Systems. This way, the measure's cost is provided independently of the size of the project and becomes comparable within the same measure. Monetary and measure units might vary throughout the database, as the data is collected from secondary data and, thus, subject to the original content. When working with the lightweight model, if different costs depending on the region are available, the model will automatically select the one closer to reality for the region.
Responsability	The most commonly intervening stakeholders can be identified as a helping asset for identifying the measures' responsibility. The stakeholders will be listed according to the list provided in the SECAPs, following the same logic as other sections. Stakeholders can be National government and/or agencies; Sub-national governments and/or agencies; Business & Private sector; Trade unions; Academia; Education sector; NGOs & Civil society; and Citizens. However, the responsibility for taking or implementing the measure can vary depending on the region's regulations, policies, or instruments associated with the measures. Therefore, uncertainty about responsible actors for a measure is high.

5.4 Associated elements

5.4.1. Associated instruments

Instruments are the actions taken and/or mandated by a government or other stakeholder to initiate or accelerate the implementation of mitigation and adaptation measures. They are also included in plans. Several instruments were collected during the measure compilation process, achieving a final list of 214 instruments that were included in the database and attached to specific measures.

Knowing potential instruments can be useful for the planning process, complementing the development of a climate plan. Like measures, instruments can be categorised according to their sector, hazard, scale and, besides, their type. The first three attributes are coincident with their measures' categories' equivalents, while *Type* is exclusively for instruments. Five types of instruments have been identified: financial, regulatory, participatory, legislatory, and knowledge instruments. In the end, eight different variables define each instrument.

Table 11 Instruments' variables.

Instruments' Descriptors	**Attributes of the measure**	**Data for implementation**
Name of the instrument	Main sector addressed	Origin of the action
ID of the instrument	Main hazard addressed	
Description of the instrument	Type	
Sources		

Using these parameters, a list of potential instruments is associated with each measure, allowing the users to choose the most appropriate and adapt it from a series of examples.

Table 12 Examples of Related Instruments to measures.

Measure	**Instruments**
Heightening dikes	Flood management plan Collecting high-quality data for flood recovery Updating flood hazard maps Monitoring infrastructures
Floating roads	Flood management plan Sustainable mobility plans in the cities Include a buffer height for sea level rise when planning new developments

The database includes a series of instruments related to each measure (sheet *_Instruments* in the database), which can be potentially included in a plan. It is remarkable to say that the instruments provided shall be used as guidelines and be adapted to each region and locality according to their needs and desires.

5.4.1. Sustainable development goals Oriented Indicators

A quantifiable goal for a measure helps improve a climate plan's quality (Reckien et al., 2023). GHG emissions reduction has been set as a standard way to quantify mitigation

measures. However, quantifying the outcomes of the measures in the adaptation field is more complex. Moreover, a measure can have side effects that might be interesting to quantify.

The LOCALISED database provides a list of potential indicators associated with each measure, which can be useful for quantifying the outcomes.

D5.1 (Ibañez Iralde, N. S., Pascual, J., 2022) in the LOCALISED Project worked on identifying the most relevant and useful indicators related to compliance of the SDGs for different response types - mitigation, and adaptation – to be used in the SECAPs development. The LOCALISED database worked on assigning those potential indicators to the measures. Those indicators are useful to understand what planners can potentially look at when trying to quantify or measure the outcomes of the measures, while establishing a connection to the SDGs. However, it must not be taken as a definitive list.

6 Using the LOCALISED database

The LOCALISED database is a relational database. That means the data is stored in several tables related to a predefined relationship. The database has ten different tables: measures' descriptors; type of response; sector; hazard; origin of the action; stakeholders; time data; cost data; related instruments; related indicators. Eight are based on a one-to-one relationship, while two are connected with a many-to-many relationship.

6.1 One-to-one connections

There are eight tables which are connected one-to-one. All of these tables share the same Primary key, the measure ID. Each measure has been assigned a unique numerical ID, which is different for all.

The main table contains the list of measures: Measure ID, the name of the measure, the definition, and the source. As each measure can have a particular combination of each one of the other attributes - determined by the process defined in Annex I - the one-to-one connections can be summarised in the following schema:

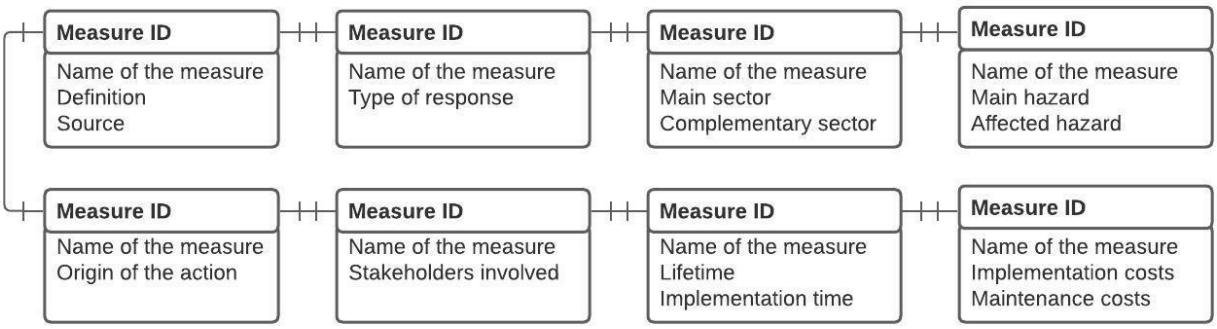

Figure 13 Database schema one-to-one. Source: Author.

6.2 Many-to-many connections

Key Performance Indicators and Instruments will be associated with the measures. However, in this case, many measures can be linked to more than one instrument and SOIs. Reversely, one instrument might be linked to many measures, and one SOI can be linked to many.

A pivot table has been created using the primary keys Measures ID and Instruments ID as foreign keys. Each row of this table creates an association between the measures and the instruments, solving the many-to-many relationship.

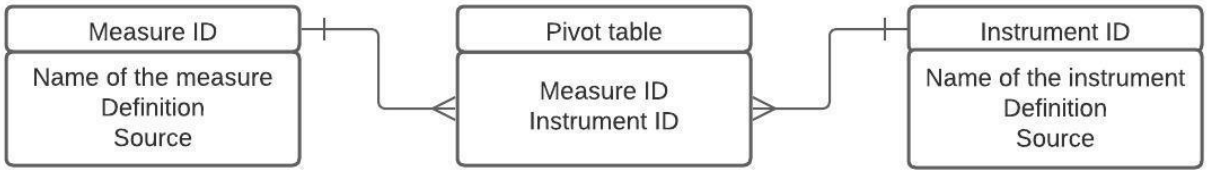

Figure 14 Database schema many-to-many. Source: Author.

6.3 The role of the LOCALISED database within the LOCALISED project

Apart from its public use as an independent tool, the database will play a key role in the LOCALISED project. Therefore, connections with previous and upcoming tasks and work packages have been established.

On the one hand, the data feeding the database will be the same data used to feed the lightweight model (Task 4.2), which will allow the calculation of the best decarbonisation pathways for each European NUTS3 region and the residual adaptation pathways. All cost and timely data in the public database are averages based on (1) a compilation of data from existing projects and literature or (2) market price and installation process data from different European regions and companies. They should be contrasted with the local authorities when developing a final plan.

On the other hand, categories and attributes are aligned with the development of the RVAs, and BEIs required to develop the SECAPs (WP5). The different SOIs linked to the measures result from WP5 and will be used to assess the outcomes of the measures. In that sense, the database included at least one measure per sector and hazard, either through a main attribute relation or a synergy. As for adaptation measures, at least one adaptation measure is available per climate impact in the climate scenarios projections calculated in Work Package 2.

Combined with the complementary sectors and affected hazards, this relation will also allow an understanding of the impacts' side effects through the implemented measures. A couple of examples can be found in Table 9:

- If the hazard "Heatwave" impact is "Fraction of mortality attributable to heat", "Installing air conditioning" will be a measure to cope with the impact. However, the measure will decrease vulnerable people's exposure and increase residencies' energy demand.

- The impact of the hazard "Drought" can be "Yield falls below the 2.5th percentile of the baseline or crop failure/yield neither related to droughts". To cope with this impact, "Using climate-adapted crops and varieties" will be the chosen measure. Direct SOI to quantify the impact and measure outcome would be "Production in Agriculture". However, as the measure also has synergies with mitigation, there will be a positive change in the emissions from agriculture.

Table 13 Example of the interlinks of D4.1. Source: Author.

Climate impact (D2.4)	Adaptation measure (D4.1)	SOI (D5.1)
Yield falls below the 2.5th percentile of the baseline or crop failure/yield neither related to droughts.	M076-Using climate-adapted crops and varieties	K9-Production in Agriculture K63-Emissions from agriculture
Fraction of mortality attributable to heat (ISIMIP publication).	M127-Installing air conditioning	K4-Exposure of vulnerable people to heat waves K38-Energy demand of residencies

Nevertheless, not all information in the database will be used in the project development, or be used in the same way, mainly due to data availability issues:

- From the measures' side, not all measures can be quantified in terms of cost, time, and effectiveness in a reliable way. Thus, from all the selection of measures, just those with significant and reliable associated data per each hazard accounted in the project will be integrated into further modelling steps. The same issue applies to instruments. Even so, at least two measures with associated instruments per sector and hazard are available with sufficient data to feed the model.
- From the impact approach, not all hazards will be covered by the project, since not all hazards will have available data to understand their associated residual risks. This is the case, for instance, of chemical and biological hazards.
- To deal with the regional variability, data included in the database will be downscaled and disaggregated when necessary. Costs, time, and effectiveness can vary according to geographical, technological, economic, social, institutional, or environmental aspects (IPCC, 2022). Thus, when needed and possible, measures will be disaggregated according to it.

7 Conclusions

The main product/outcome of the deliverable is the compilation of 314 measures framed into a planning practitioners' approach, with its associated instruments, and SOIs, and the capacity of the database to be used independently by the public.

Some relevant conclusions can be extracted from the process of building the database:

1) Measures need a certain level of specificity to be included in a plan. Not just because of the possible uncertainty that might add the lack of precision but to quantify their inputs and outcomes. Time data, cost data, stakeholders involved, and scale, among others, are data that improve the quality of a plan and might help reduce the gap between planning and implementation. These data cannot be known if the measure isn't somewhat specific.

2) Following existing literature and the SECAPs framework, there have been identified 18 different variables that need to be known by the practitioners to integrate climate action into their plans. This data is divided into four groups: measure descriptors, main attributes of the measure, basic data for implementation, and associated instruments and SOIs.

3) Not all climate actions are measures addressing a mitigation or adaptation goal. Some climate actions are thought to facilitate the implementation of other actions to reach a goal. Those actions are named instruments. Instruments are linked to measures, and their definition and level of detail might affect the level of proper implementation of a measure. The development of the five binary questions decision tree allowed to make this distinction on climate actions and labelling them accordingly.

4) Climate response is diverse, but existing tools aim to help local and regional organisations develop quality climate plans. Defining a common framework of the attributes and data that need to be known to create a high-quality climate plan. LOCALISED database offers a framework based on the SECAPs requirements.

5) Working to associate different instruments and SOIs to the measures allows to explore further relations and synergies. Linking the Sustainable development goals Oriented Indicators to the different measures also might help to understand how well the SDGs are represented from the measures' point of view.

6) Implementation of climate planning is dependent on the local and regional context. Moreover, instruments can highly influence the implementation of measures. Therefore, giving specific data on the synergies and trade-offs between the measures is impossible. However, some measures might interact

with other sectors and hazards, favouring or worsening their effectiveness. LOCALISED database provides these sectors and hazards.

7) Coming from the same root as the previous point, it is also highly difficult to understand who takes responsibility for the implementation of the action, as it will vary according to the implementation process. LOCALISED database provides a list of implied actors in the implementation process that will help planners to account for that and understand the stakeholder implication. Other data that can just be estimated is cost and time data. The variability of local and regional conditions makes it impossible to give a fixed name. Therefore, the LOCALISED database provides typical ranges of values in Europe.

8 Next steps

Climate actions are constantly being updated. Technology innovations and scientific findings on fighting climate change are top priorities for several communities, as it is crucial to limit further impacts and cope with existing ones. Besides, due to the variability of taken climate actions in different regions, the database might lack specific actions taken in specific regions. Thus, the importance of providing replicable and systematic methods acquires a central role in this deliverable.

During the project's duration, the LOCALISED database will be internally updated following the methods described in the deliverable. Two main sources are expected to be included in our actual range of measures:

1. The CDP database. As stated in section *4.2 How to distinguish a measure from an instrument?* "the climate actions reported came from particular cases, the information was written in several languages, and even if categories were established, some measures did not follow the standards. Thus, it was decided to be processed and integrated into the database once the methods were clarified, and the first version of the database was available". Thus, the database will be updated in the upcoming months with data from the CDP datasets.
2. Existing mitigation and adaptation plans. Several adaptation and mitigation plans in European NUTS3 regions will be analysed during the project's development. When possible, measures and instruments and their corresponding data identified in those plans will be integrated into the database.

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Annex I: How to define sectors, hazards, origin of the action, and stakeholders for the measures.

Categorising measures into hazards, sectors, origin of the action, and their stakeholders is not straight forward. Even if some of the final categories coincide with those from the background, they can cover a different scope. For example, RESIN and RESCCUE cover the "Heat wave" hazard, while Climate-ADAPT takes a more generic scope and covers "Extreme temperature". Regarding sectors, Climate-ADAPT has a much more detailed division than RESCCUE, and a different approach than RESIN, which also has a detailed classification, but using other categories (see Table 8). Same problem occurs when trying to assign the LOCALISED Database categories the action, making it unclear to decide to which sector one measure belongs.

To tackle that problem, a systematic keyword approach has been taken. Some information is available for each one of the measures. Then, searching for keywords related to the categories in each one of the measures' accessible information can allow to create potential matches. Those matches could not only allow to identify the category of the measure, but to identify possible synergies with other ones. The method used has three different steps:

1) First step was to identify keywords related to each category. A first list of 10 keywords per category was proposed, and a first test was conducted using a sample of measures and an automatic searching code using Microsoft Excel. However, it was found that the number of measures was not sufficient since some related terms or synonyms were ignored in the process.

   To increase the method's reliability, different project member institutions from different backgrounds and nationalities were asked to propose a series of keywords per category. Then, those keywords were put together. After erasing the duplicate ones, a second iteration with a sample was conducted. Measures were better assigned to the categories. However, some words distorted the results because of their generalised semantic uses. This can be exemplified with terms like "Building" - word associated to the "Building" sector -, or "System" - word proposed for the sector "Energy". Since some measures showed a relation to an anomalous number of categories, the following criteria was incorporated:

   - The word itself should have semantic relation with the title of the category in at least one of their meanings.

   - After running the code for all measures, if the word appears related to more than 50% of the measures, then the word is discarded.

- If a word is a derivative from another, just the root of the word is used.
- If the keyword comprises two or more elements, take only the one more deterministic for the category. E.g. from "Water management", just use water.

After applying the criteria, the list of keywords was drastically reduced. The final list of keywords showed more coherence within the categorisation of measures, offering sets of potential categories and measure data for each one of the measures.

2) Using Microsoft Excel software and its functionalities, an automatic code has been used to search for the keywords in the available information. To prepare the data for the process, measures were placed in a table with their ID, Name of the measure, Source, and Background information. The ID and Name of the measure remained as the original before the application of the decision tree. The source column was updated if any new sources were found. All text available in the measures' available definition, abstracts, attributes, and origin was placed in the Background information cells.

   Next step consists in searching for the keywords in the name of the measure or in the Background information. To do so, the functionality (ISNUMBER(SEARCH())) was used. This function lets the user know if a certain cell contains a specific text. The function returns a "TRUE" value if the text contains the word. To better understand the process, each keyword has been searched individually. Doing this also facilitated the process of identifying conflictive words and applying some of the criteria for choosing the keywords. Finally, if any keyword related to a certain category matched positively, then the measure was associated with that category.

3) Once the different categories have been assigned to the measures, those must be checked. From the 618 measures included in the database, 431 were found to be related to more than one sector; 260 were associated with more than one hazard; 81 to have more than one origin of the action related; and 176 matched with more than one stakeholder. The role of the keyword in the measure definition could not be evaluated by the code and needed to be done manually. Therefore, the matches with keywords were classified using the following template for each one of the measures:

Table 14 Criteria to assign potential matches to main sectors, hazards, complementary sectors, affected hazards, or discard them. Source: Author.

The measure explicitly accounts for that, and the attribute is the principal in the definition.	The measure is indirectly related to the category, the attribute acts as a complement of the definition.	The word does not play any role in the definition, and the match was due to word misuse or different semantic meaning.
Main sector	Complementary sector	Discard
Main hazard	Affected hazard	Discard
Origin of the action	-	Discard
Stakeholders involved	-	Discard

Moreover, if any keyword synonym is found in the definition during the process, the attribute related to it is included.

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