D6.7 CLARITY Guideline v2

WP6 – Dissemination and Community Building

Deliverable Lead: AIT

Dissemination Level: Public

Deliverable due date: 31/05/2020

Actual submission date: 19/10/2020

Updated: 01/02/2021

Version 1.1

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730355

Document Control Page	
Title	CLARITY Guideline v1
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Description	This document presents practical step by step video guidelines that were designed to help stakeholders responsible for the planning and management of Urban Infrastructure to incorporate Climate Change and natural hazard adaptation in their preservation strategies. Version 1.1 of the document makes it easier for the reader to access the video tutorials that are mentioned in the text.
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Creation date	01/10/2020
Type	Text
Language	en-GB
Rights	copyright “CLARITY Consortium”
Audience	☒ Public ☐ Confidential ☐ Classified
Status	☐ In Progress ☐ For Review ☐ For Approval ☒ Approved

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CLARITY Project Overview

Urban areas and transportation infrastructure are highly vulnerable to climate change. Smart use of existing climate intelligence can increase urban resilience and generate added value for businesses and society at large. Based on the results of FP7 (7th Framework Programme) climate change, future internet and crisis preparedness projects (SUDPLAN, ENVIROFI, CRISMA) with an average Technical Readiness LEVEL (TRL) of 4-5 and following an agile and user-centred design process, end-users, purveyors and providers of climate intelligence CLARITY co-create an integrated Climate Services Information System (CSIS) to integrate resilience into urban infrastructure and look into the way to adjust the CSIS to transport infrastructure.

As a result, CLARITY provides an operational eco-system of cloud-based climate services to calculate and present the expected effects of Climate Change (CC)-induced and -amplified hazards at the level of risk, vulnerability and impact functions. CLARITY offers what-if decision support functions to investigate the effects of adaptation measures and risk reduction options in the specific project context and allow the comparison of alternative strategies. Three demonstration cases showcase CLARITY climate services in different climatic, regional, infrastructure and hazard contexts in Italy, Sweden, and Austria; focusing on the planning and implementation of urban infrastructure development projects. A fourth demonstration case in Spain illustrates how the expected effects of CC hazards and risk can be assessed in the case of road transport infrastructure and the flexibility of the CSIS system to adapt to other sectors.

CLARITY provides the practical means to include the effects of CC hazards and possible adaptation and risk management strategies into planning and implementation of such projects, focusing on increasing CC resilience. Decision makers involved in these projects will be empowered to perform climate proof and adaptive planning of adaptation and risk reduction options.

Abbreviations and Glossary

A common glossary of terms for all CLARITY deliverables, as well as a list of abbreviations, can be found in the public document "CLARITY Glossary" available at CLARITY-H2020.eu.

The following table was generated from http://cat.clarity-h2020.eu/glossary?machine_name%5B%5D=abbreviations_and_acronyms on February 11th, 2019 and contains all the acronyms of interest for this deliverable.

Name	Term description
AIT	Austrian Institute of Technology GmbH.
AR5	Fifth Assessment Report of the Intergovernmental Panel on Climate Change
CC	Climate Change
CLARITY	Integrated Climate Adaptation Service Tools for Improving Resilience Measure
CSIS	CLARITY Climate Services Information System
EC	European Commission
EU-GL	Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient (Document). Also, CLARITY methodology based on original EU-GL
IPCC	Intergovernmental Panel on Climate Change
PLINIVS-LUPT	Study Centre for Hydrogeological, Volcanic and Seismic Engineering of LUPT Research Interdepartmental Centre, University of Naples Federico II.
RCP	Representative Concentration Pathway
TRL	Technology Readiness Level
UHI	Urban Heat Islands
ZAMG	Zentralanstalt für Meteorologie und Geodynamik (Austria)

The following table contains EU-GL Methodology terms used in the CLARITY project. Complete description can be found in the "CLARITY Glossary" available at http://cat.clarity-h2020.eu/glossary?machine_name%5B%5D=eu_gl_methodology_terms.

Name	Term description
Hazard	The potential occurrence of a natural or human-induced physical *event* or trend or physical *impact* that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, *service* provision, ecosystems, and environmental resources (IPCC, 2014). In the IPCC context, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts. (IPCC, 2014).
Exposure	The presence of people, infrastructure, housing, production capacities and other tangible human assets in hazard-prone areas.
Vulnerability	The probability of a given element at risk, classified as part of a specific Vulnerability class, to be affected by a level of damage, according to a prefixed scale of damages, under a given hazard intensity (Glossary of the CLARITY Proposal).
Risk Analysis	Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. (IPCC, 2014). Risk Analysis is a systematic use of available information to determine how often specified events may occur and the magnitude of their likely consequences (CRISMA Project glossary).
Impact Scenario Analysis	In probabilistic terms choosing in a deterministic way one or more significant events, among actually occurred past events or as a result of numerical hazard simulation models, shall be obtained as damage evaluation following a specific event.
Adaptation Options	The array of strategies and measures that are available and appropriate for addressing adaptation needs. They include a wide range of actions that can be categorized as structural, institutional, or social (IPCC, 2014).
Decision Support	Functions that help in evaluating the data and deciding what to do.
Action Plan	Functions that help in establishing the report / implementation plan / guideline.
Integration	Integration of adaptation plan into the project.

Executive Summary

This document is deliverable D6.7 “CLARITY Guideline v2” of the CLARITY project (H2020, Contract number 730355).

CLARITY provides data and climate, risk and impact assessments at different levels of detail and accuracy. Each of these levels targets different needs and can be roughly separated into “screening” and “expert studies”. In addition, it also provides an online marketplace where the needs of the planners and decision makers are automatically matched to the know-how, data, service and product offers. **This deliverable is an update of the D6.6 “CLARITY Guideline v1” and presents the final guidelines for using the CLARITY online services.**

Users, who aren’t climate science experts, can use the online CLARITY services to rapidly assess the level of impact climate change will have at their projects and perform an initial analysis of the possible adaptation options and their effects. Screening services further subdivide in three distinct classes:

Simple screening allows service users to overlay 21 CLARITY climate hazard indices with land use data. This type of screening works in the whole Europe and allows the users to rapidly compare the past and future climate scenarios and estimate the change in the risk situation. The downside of the simple screening is the low spatial resolution of the hazard indices and lack of numeric values for the risk/impact estimates.

Advanced urban screening provides automated downscaling of two hazard/exposure pairs that are of great societal interest. These are heat/population and the flash floods / urban infrastructure. Service is available in the large number (over 450) of European urban areas where a large majority of all EU population lives and provides estimates (numeric values) of hazard, exposure and various impact parameters at a 500x500m^2 scale.

Finally, the ***transport infrastructure screening*** service targets the stakeholders involved in planning and management of transport infrastructures, as well as for agents involved in infrastructure design and maintenance activities in medium to long term time horizons and allows forecasting of human and material resources in seasonal periods. This screening is possible in the whole EU but provides improved functionality in Spain where additional input data is available.

1 Introduction

This document provides an overview of the "tutorial" materials that were produced by CLARITY project.

Reflecting the nature of the project and the zeitgeist, large majority of these materials is in the form of power point presentations and webinar videos rather than in the form of printable MS word or PDF documents. These video materials are available at **CLARITY Climate Adaptation GotoStage channel** **https://www.gotostage.com/channel/climate-adaptation**. and organised in a way that minimizes the time and effort required to understand what CLARITY does, why and how. As shown in the **Figure 1**, videos are grouped in "chapters", with first chapter starting with two very short (<2 min) introduction videos that are followed by four more rather short videos explaining specific project features (6-12 min). In the next chapter are three hands on tutorials. Remaining chapters feature the summaries of the expert study findings, complete webinar recordings in English and various videos in Italian, German and Spanish language.

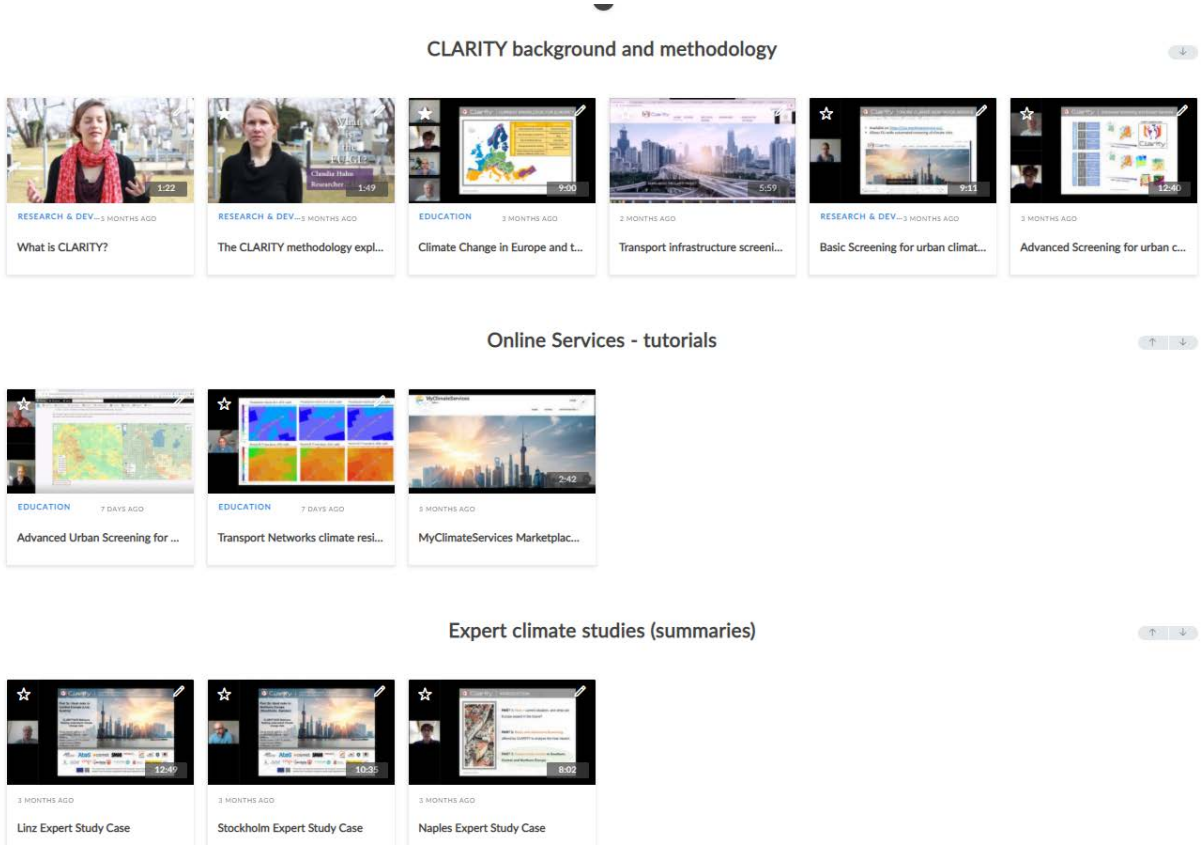

Figure 1: GotoStage channel organisation

Some of these videos are also available on YouTube, on https://myclimateservice.eu/ and on the CLARITY Zenodo channel. **To facilitate direct access, links to videos on the YouTube will be provided in the text throughout the document. We recommend use of GotoStage for the readers that prefer browsing the whole repository on their own.**

This document provides some background information on the project and annotated links to video tutorials. Direct links are provided to videos on YouTube, for several reasons: (1) these links are shorter than the ones to GotoStage platform; (2) YouTube is easier to use than Zenodo and doesn't require authentication like GotoStage; and (3) YouTube links are likely to remain valid for at least five years after the project end, probably longer.

1.1 Structure of Deliverables

Section 1 presents the structure of this deliverable and summarizes the main project objectives and outcomes. Section 2 presents the CLARITY methodology that is used for both the online services and for the expert studies. Section 3 explains what the CLARITY online services do and how to use them. Finally, the section 4 provides conclusions and outlook for a second release of this document.

1.2 What is CLARITY

CLARITY is a project designed to provide users with a baseline investigation of future climate hazards and their impacts in their chosen region. It provides data and climate, risk and impact assessments at different levels of detail and accuracy. Each of these levels targets different needs and can be roughly separated into **online "screening services"** (section 4) and **offline "expert services"** that are not in the scope of this document. More specifically, CLARITY's key objective is to examine climate-related effects and provide a risk assessment, evaluate climate-change adaption strategies and integrate these adaption measures for sustainable urban development.

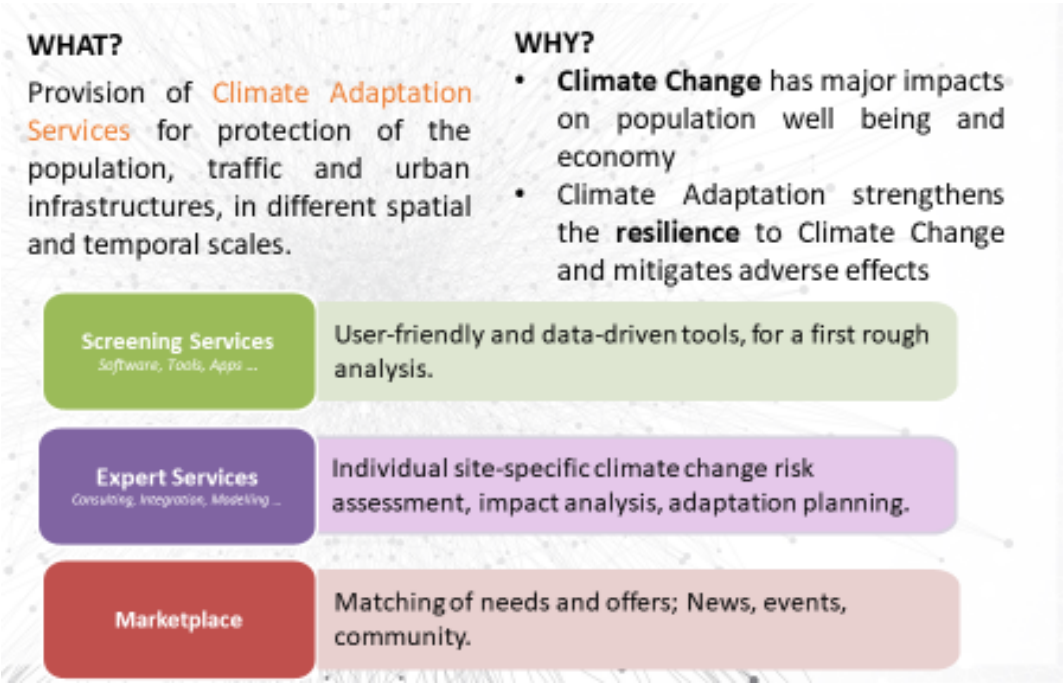

Figure 2: The nature and purpose of CLARITY

Several short videos explaining what CLARITY is are available on CLARITY GotoStage channel, as well as on YouTube:

- **"What is CLARITY": https://youtu.be/6yCgOnliE7c (1:22)**
- **"Introduction to CLARITY - What is CLARITY?": https://youtu.be/MatH5q9vv6o (1:45)**

1.3 The importance of CLARITY

Earth's climate is currently undergoing drastic changes. The global average temperature is continually rising due to the enhanced greenhouse gas effect. The anthropogenic-induced increased release of greenhouse gases such as CO_2 and CH_4 into the atmosphere have caused regional and continental fluctuations in earth's climate zones (Figure 2). Extreme weather events, heat and cold waves, heavy local precipitation and far-spreading droughts, all occurring at an increased frequency and magnitude as the burning of fossil fuels (among others) goes unchecked.

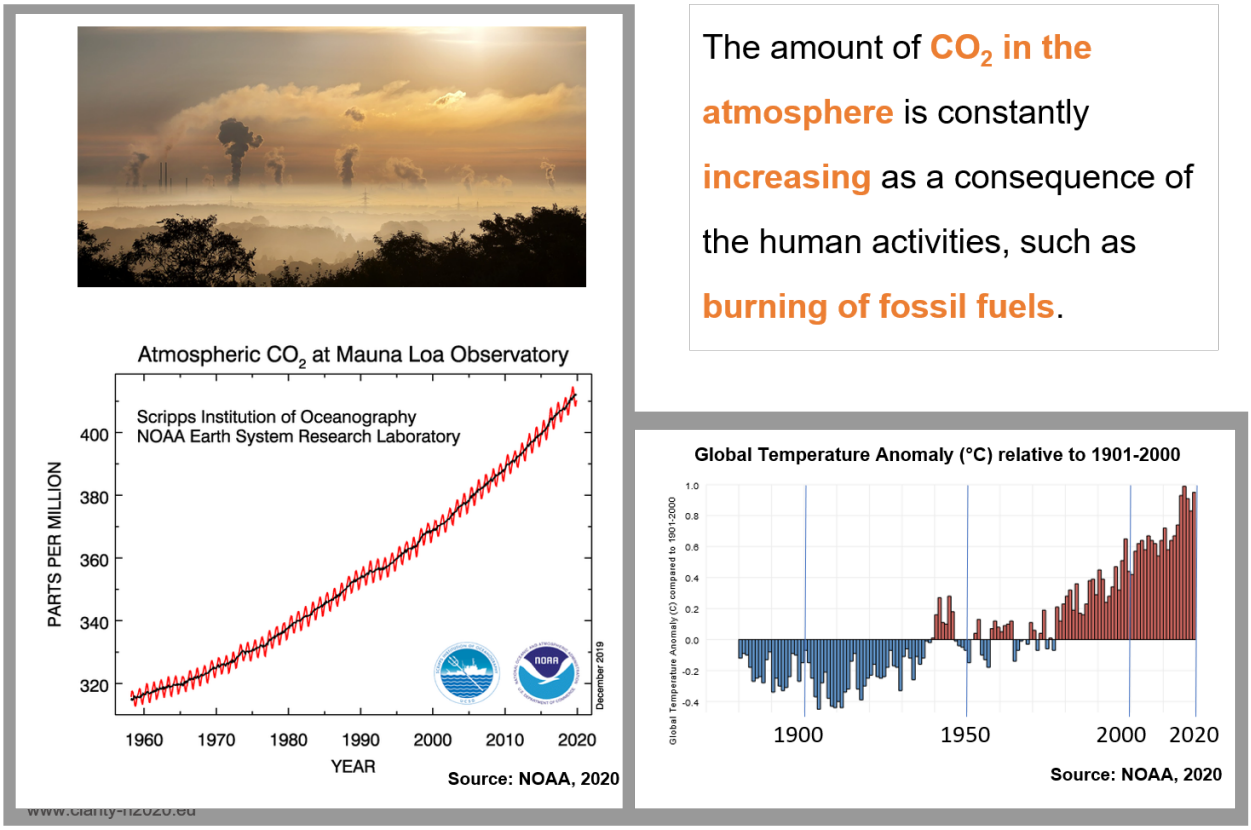

Figure 3: Changes in CO2 concentration and the global temperature anomaly (Source: NOAA).

Climate change is not "just a theory" or a possible future threat. Many people are already suffering from the consequences of climate change. The heat wave in 2003, for instance, has claimed more than 70 000 deaths in Europe alone[1]. Our models show that such heat waves could become very common in the future.

Following video highlights the importance of CLARITY in Climate Change Adaptation:

- **Climate Change in Europe and the importance of CLARITY: https://youtu.be/PbPmjD5ex30 (9min)**

It is considered impossible to completely reverse these effects of climatic hazards in foreseeable future. However, it is still possible to mitigate their impacts, especially in the urban areas where most people live. There are many adaptation and mitigation options and strategies available and CLARITY helps its users to find and select the options suitable for their selected regions and hazards. It is a simple, but powerful tool, which allows users to identify potential hazards, investigate their impacts on exposed elements (populations, etc.) select available adaptation options and examine their effect on the identified hazards in

[1] https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

less than a day. If the user requires more detailed information tailored to their needs, CLARITY offers so-called expert studies that provides in-depth customized studies for a user's intended region. In short, CLARITY delivers impactful data and vital information validated against more powerful systems that will help any stakeholder to get their important messages concerning climate change across. Following videos summarize the key heat-wave related findings in three of the CLARITY demonstration case regions:

- **Heat risk in Linz: https://youtu.be/SvRB_FLV8hM (12:50)**
- **Heat risk in Naples: https://youtu.be/as6FJ_zwG-w (8:03)**
- **Heat risk in Stockholm: https://youtu.be/9l7s500wNF4 (10:35)**

1.4 CLARITY Services

CLARITY offers services at two levels of detail: (1) online "screening" level services, which provide available data and climate evaluations at demand, and (2) offline "expert" level services, which supplements the screening level study with additional, high resolution data and climate analyses customized to the user needs and emphasis. Both service types follow the same methodology (Section 2), with the difference being that the expert level provides higher data resolution, additional datasets, and an analysis better tailored to the urban area or infrastructure project investigated (Figure 4).

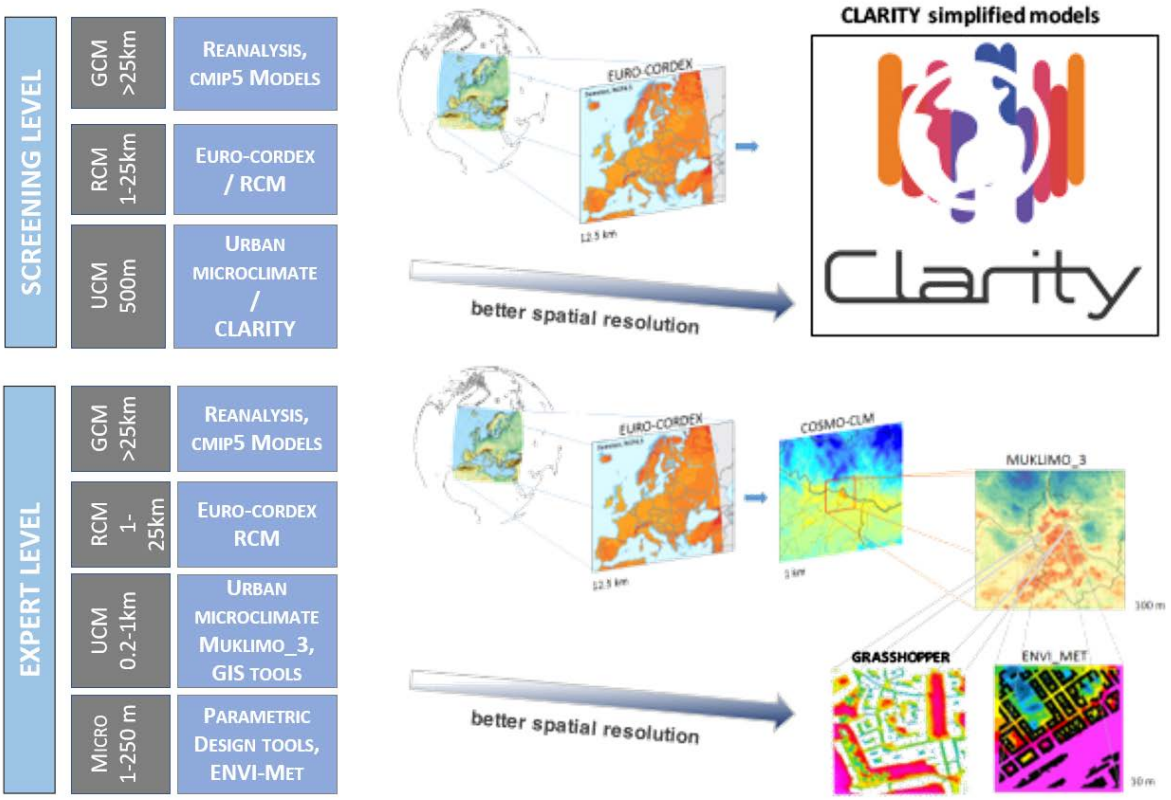

Figure 4: Models used in CLARITY screening and expert studies.

Depending on the user needs, the expert analysis can also focus on certain steps of the CLARITY methodology, such as hazard characterisation and adaptation option assessment only. In this case, the CLARITY framework and CSIS (climate system information service) screening study help to ensure that the remaining steps are considered in a qualitative way. CLARITY allows users to explore various resilience scenarios for their projects considering

1. variable local context
2. climate intelligence provided by experts
3. for the project customized risk analysis
4. varying impact scenarios
5. flexible adaptation and alternative options
6. integration into action plans

1.5 The Marketplace

The marketplace provides users with the possibility to connect with similarly orientated people, initiatives and organizations from various backgrounds. The marketplace is a service that allows experts to present their ideas, concepts and strategies and advertise their solutions to given problems. Project managers on the other hand can promote their project, look at similar projects or search for options offered that might be suitable for their projects. Alternatively, they can also seek to collaborate on a (new) project through calling for partners. This opportunity is open to experts and project managers also on peer-level in order to drive co-development and knowledge transfer (**Figure 5**).

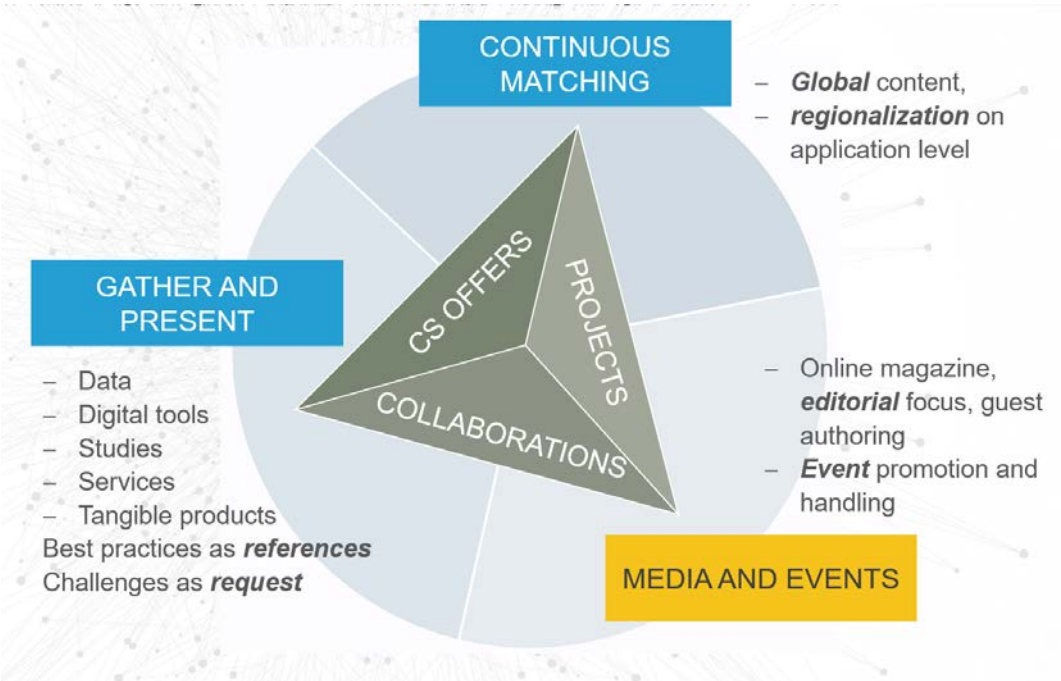

Figure 5: Three main facets of the Clarity Climate Adaptation Marketplace

Following videos explain the importance and main functions of the Marketplace:

- **How to promote and market climate services: https://youtu.be/71Bz0lSVPBs (5:28)**
- **MyClimateServices Marketplace – Introduction: https://youtu.be/shtEMiWhI_I (2:42)**

2 CLARITY Methodology and Data

All clarity services and studies follow the same methodological approach, which is based on the "Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient" (EU-GL) [1] The EU-GL methodology has been updated by CLARITY to comply with the Fifth Assessment Report (AR5) [2] of the Intergovernmental Panel on Climate Change (IPCC) in order to promote an integrated modelling approach of Disaster Risk Reduction and Climate Change Adaptation

In this document, we will primarily illustrate how EU-GL is supported in CLARTIY online tools, most notably in the advanced urban screening workflow.

At a functional level, there is no difference between the "old" EU-GL and the updated CLARITY methodology. For convenience, we have therefore decided to continue calling the updated methodology EU-GL and recommend its use for all climate adaptation/resilience planning tools and studies in and beyond Europe. "CLARITY methodology" or "CLARITY EU-GL" will be used when differentiation is deemed necessary in this document.

The 7 steps of the updated "CLARITY EU-GL" methodology are illustrated in **Figure 6** and explained in details in CLARITY public deliverable "D3.1 Science Support Plan and Concept".

Figure 6: The 7 steps of the CLARITY methodology

Following video explain the CLARITY methodology:

- **The CLARITY methodology explained "in a nutshell": https://youtu.be/_MvO_MqTPA0 (1:50)**
- **Detailed explanations & examples of application: https://youtu.be/AIb30nuX0H4 (1:36:53)**

Detailed descriptions of methodology and models that were used in CLARITY is available in **CLARITY public deliverable "D3.3 Science Support Plan and Concept v2"** [3]. In this document, we will primarily illustrate how EU-GL is supported in CLARTIY online tools, most notably in the advanced urban screening workflow.

For the start **Table 1** explains the meaning of the terms used in CLARITY EU-GL methodology. Please note that the meaning of some of these terms as well as the way risk and impact were calculated was slightly different in original EU-GL methodology and had to be updated to align it with the methodology and naming conventions that are used in the fifth IPCC assessment report.

Table 1: CLARITY EU-GL methodology naming conventions, aligned with AR5 report of the IPCC

Hazard	The potential occurrence of a natural or human-induced physical *event* or trend or physical *impact* that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, *service* provision, ecosystems, and environmental resources (IPCC, 2014). In the IPCC context, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts. (IPCC, 2014).
Exposure	The presence of people, infrastructure, housing, production capacities and other tangible human assets in hazard-prone areas.
Vulnerability	The probability of a given element at risk, classified as part of a specific Vulnerability class, to be affected by a level of damage, according to a prefixed scale of damages, under a given hazard intensity (Glossary of the CLARITY Proposal).
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Impact Scenario Analysis	In probabilistic terms choosing in a deterministic way one or more significant events, among actually occurred past events or as a result of numerical hazard simulation models, shall be obtained as damage evaluation following a specific event.
Adaptation Options	The array of strategies and measures that are available and appropriate for addressing adaptation needs. They include a wide range of actions that can be categorized as structural, institutional, or social (IPCC, 2014).
Decision Support	Functions that help in evaluating the data and deciding what to do.
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2.1 Hazard Characterisation in EU-GL

The Hazard Characterisation comprises the first step of the EU-GL methodology. This section identifies potential hazards in the selected study area and predicts a future climate.

2.1.1 Hazard characterisation- pan European hazard indices

In CLARITY online tools, this is done by establishing historical climate data as a baseline for the predicted future climate in order to assess what changes will occur. The Hazard characterization is performed using the CLARITY pan-European data package**.** This data package includes a range of pre-calculated **climate**

indices related to heat (e.g. summer days, tropical nights), cold (e.g. frost days, ice days), wind (e.g. maximum daily wind speed) and precipitation (e.g. heavy precipitation days). These indices have been calculated by CLARITY team for the whole Europe with a resolution of 12km x 12km based on bias corrected (with the exception of wind) EURO-CORDEX data. Full list of CLARITY hazard indices is included in Table 2.

Table 2: CLARITY pan-European climate hazard indices.

Hazard	Index
HEAT: Heat waves	Consecutive summer days
	Consecutive hot days $\geq 75^{th}$ percentile
HEAT: Extreme heat	Hot days
	Summer days
	Tropical nights
	Maximum temperature $\geq 75^{th}$ percentile
COLD: Cold waves	Consecutive frost days
COLD: Extreme cold	Frost days
	Ice days
	Minimum temperature $\leq 10^{th}$ percentile
Thermal stress	Extreme temperature range
FLOODS: Extreme precipitation	Maximum 1-day precipitation
	Maximum 5-day precipitation
	Snow days
FLOODS: Wet periods	Consecutive wet days
	Wet days
	Heavy precipitation days
	Days where daily precipitation $\geq 90^{th}$ percentile
FLOODS: River flooding	Flood recurrence
	River flow
FLOODS: Pluvial flood	Water runoff
STORMS: Extreme wind speed	98^{th} percentile wind speed

	Maximum wind speed
	Days with wind speed ≥ 17 m/s
DROUGHTS	Consecutive dry days
FOREST FIRES	Fire weather index

All CLARITY climate hazard indices were calculated for a baseline period (1971-2000) and **three future time-periods (2011-2040, 2041-2070, 2071-2100)** using bias corrected EURO-CORDEX data [4]. For the future time periods, **three different greenhouse gas emissions scenarios** (Representative Concentration Pathways - RCP), which were also used in the AR5 of the IPCC, are used: **RCP2.6 (early response), RCP4.5 (effective measures) and RCP8.5 (business as usual / worst case scenario)** [2].

As illustrated in **Figure 7**, the end of century prediction for Europe in RCP8.5 scenario is nothing short of alarming, RCP4.5 predictions are slightly less alarming, but still bad enough to require widespread adaptation activities, whereas the RCP2.8 scenario predicts peaking of the changes in mid-century and gradual return towards normality thereafter.

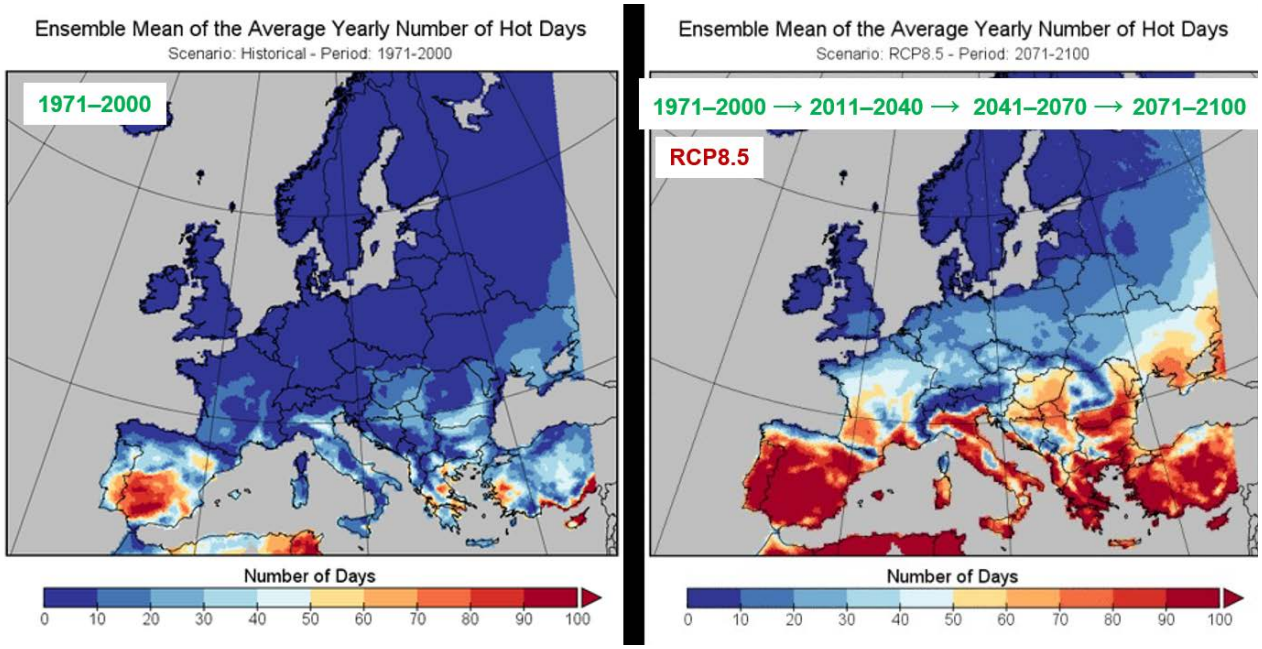


Figure 7: In the "worst case" climate scenario, end of the century yearly heat occurrences in Europe are predicted to be worse than the catastrophic heat wave of 2003 (CLARITY EURO-CORDEX predictions)

Currently, the RCP2.6 is seen as far too optimistic by the experts and the worst-case scenario as very likely. If exponential trends in electro mobility, teleworking and renewable energy persist, the likely outcome by the end of the century is expected to be similar to RCP4.5 predictions.

To account for the uncertainty in model predictions, all CLARITY climate indices were calculated using several climate models and the resulting ensemble standard deviation is also included in CLARITY online services, as a measure of reliability of the prediction. More information regarding the indices, their definition and results, as well as the data and models used to derive the climate indices is provided in annex

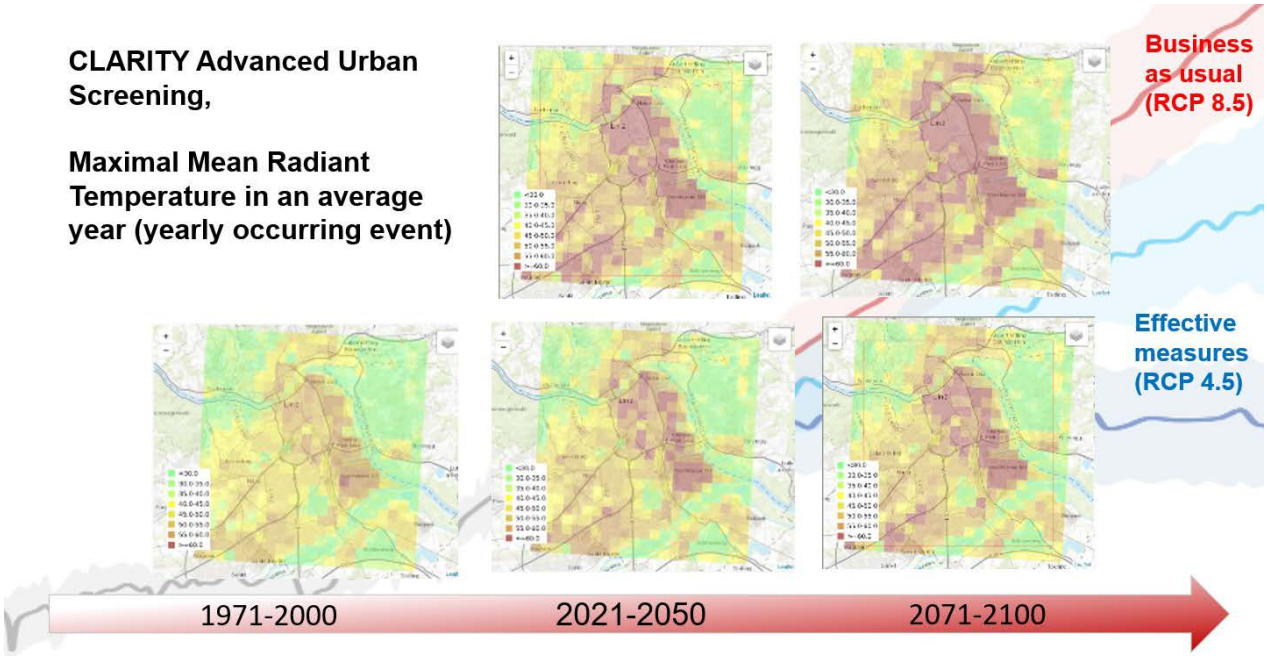
of the CLARITY D3.3 deliverable. This information is also available online, in form of the metadata describing the resources at the CLARITY online service[2].

Spatial resolution of these indices is too coarse for urban scale studies. Therefore, these indices are typically used as input for downscaling models in urban studies. In CLARITY, several downscaling models were used in screening and expert studies, with spatial resolutions ranging from ~500m (screening) down to ~1m in detailed expert calculations.

2.1.2 Hazard characterisation- Local effects

Urban heat islands (UHI) effect and pluvial flooding have been identified as two hazards of special interest for the urban areas. The UHI occurs when high energy absorption on paved surfaces as well as heat storage by build-up structures lead to high temperatures in densely build or industrial areas. In the vicinity of water, trees and vegetation, temperatures are usually lower due to shade, evaporative cooling and a better circulation of air. Moreover, temperature also changes with the height and the differences can be significant for cities that are built at hillsides. Similarly, pluvial flooding is caused by intense periods of heavy rainfall and the risk of this type of flooding to occur can increase not only due to a change in climate, but also due to growing cities and an increase in sealed surfaces. Urban characteristics (permeability of surfaces, drainage system capacity, etc.) influence how much rain is being converted to surface runoff. Topography determines where the water will flow and potentially accumulate.

To simplify the task of assessing the effect of climate change and urban adaptation measures on the potential variation of such climate signals, CLARITY project team has developed automated downscaling models for these two hazards. These models essentially use the detailed information on land cover and topography that is available in many European urban regions to modulate the pre-calculated hazard indices, thus increasing the heat wave and pluvial flood local effect resolution to 500x500 m^2. As illustrated in **Figure 8** and **Figure 9**, urban fabric effects are already recognisable at this resolution and the automated downscaling model predictions are coherent with the predictions of more detailed expert studies.



[2] https://csis.myclimateservice.eu/

Figure 8: Urban heat island estimates in Linz, Austria – automated CLARITY downscaling

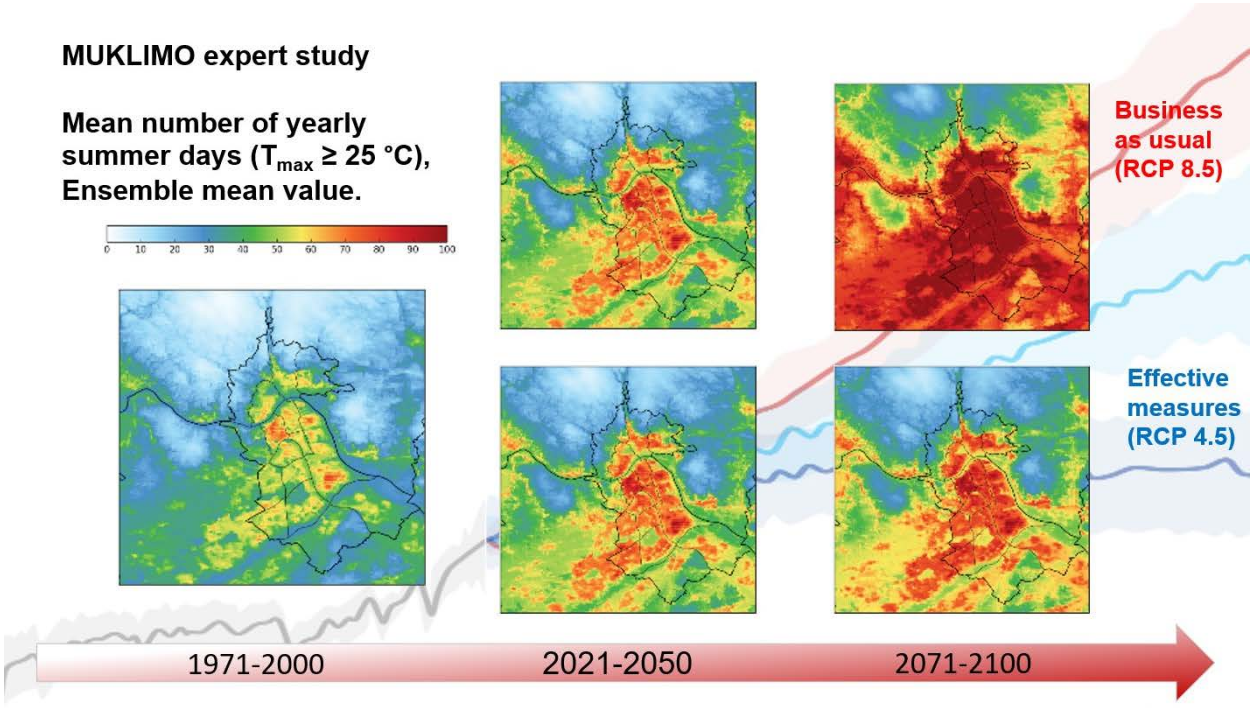


Figure 9: Urban heat island effects in Linz, Austria – expert study at a resolution of 100x100m^2

2.2 Exposure Evaluation

The Exposure Analysis assesses who or what is affected by the hazard in place. Once the hazard characterization in the project area has been completed, the next step is to evaluate exposure to climate hazards of the elements at risk considered (e.g. population, buildings, infrastructures, etc.) relevant at the project location(s). The exposure is the quantitative distribution, in space and time, of elements exposed (people, buildings, infrastructures, etc.) grouped on the base of their behaviour under effect of the hazard into categories (called "vulnerability classes"), defined on the base of specific characteristics (i.e., age for people, structural-typological characteristics for buildings, etc.), able to influence the damageability of the elements exposed against hazards.

EU-GL recognises two types of exposure:

- **Baseline exposure** that is based on the current distribution of the elements at risk in the area of interest. Baseline exposure can be estimated by combining the available data on e.g. population distribution, land use and land cover. Exposure must be calculated separately for each element at risk type.
- **Future exposure** that is based on the planned distribution of the elements at risk in the future. In CLARITY, this will usually correspond to the planned project and the expected distribution of the elements at risk will have to be provided by the user or by an expert working on their behalf.

In CLARITY, the screening studies are always performed using the baseline exposure, whereas the expert studies use estimated future exposure when appropriate (for more information view Section 2.4 of D3.2).

2.3 Vulnerability Analysis

In addition to exposure, the vulnerability of the elements at risk to the current and to the expected future climate is assessed. The Vulnerability Analysis estimates how susceptible the element at risk is (be it people, buildings, infrastructure, objects, etc.) with respect to the hazard in question. In other words, vulnerability is defined as the probability that an element at risk, belonging to a specific a vulnerability class, experiences a level of damage, according a predefined damage scale, as a response to a hazard event of given intensity. It is expressed in terms of a vulnerability matrix that indicates which percentage of the elements of risk of a certain type belongs to which vulnerability class for which hazard in this area. An example of such matrix, for a generic element at risk category, is shown in **Table 3** below.

Table 3: Example of a vulnerability matrix for a specific vulnerability class of a given element at risk under effect of a specific hazard.

VULNERABILITY CLASS i				
Level of Damage	Hazard Intensity			
	HI 1	HI 2	HI 3	…
Low	5 %	20 %	50 %	…
Medium	10 %	30 %	70 %	…
High	20 %	50 %	80 %	…

The vulnerability classes for the relevant elements at risk have been defined both for heat wave and flooding, defining also the different levels of damage for those elements. For instance, population as a risk element in the case of heat waves and was initially distinguished by age in three classes (under 14, 15 – 64 and over 65). Table 4 shows an example of a damage classification of people's health for heat waves. More information can be found in Section 2.5 of D3.2.

Table 4: People damage classification.

Level of damage	Description
D0	No damage
D1	Fatigue, discomfort
D2	Heat cramps, heat exhaustion
D3	Heat cramps, heatstroke
D4	Heatstroke, sunstroke
D5	Death

Due to lack of data, the **calculation of heat hazard impact at the screening level is performed with a single vulnerability class for all population groups**[4]. To account for adaptation to local climate conditions, two versions of vulnerability function were developed, one for the Southern Europe and another for central and Northern Europe.

Similar classification has been carried out also for the elements at risk in the case of flooding. In that context, two typologies of damages, namely direct and indirect costs, have been taken into account. The former is related to the restoration cost, while the latter is due to the loss of production. Five levels of damages have been identified for both typologies. Due to lack of available data at European level, **the quality of buildings is not accounted for in the screening studies**[3].

In the case of road transport infrastructures, it has not been possible to define vulnerability curves due to the lack of data and reliable statistics. Therefore, the **vulnerability assessment for the road infrastructure must be done by a technician with a profound knowledge of the different elements of the road**.

2.4 Risk and Impact Assessment

The Risk and Impact Assessment provides a structured method for analysing climate hazards and their impacts to provide the fundamental information for decision-making. In line with the updated approach as outlined in the IPCC-AR5, this evaluation is derived by the general relation

Risk/**I**mpact=**H**azard x **E**xposure x **V**ulnerability.

The risk and impact assessments consider the magnitudes and impacts associated with climate hazards identified in exposure evaluation. Here it should be mentioned that risk is a probabilistic measure that relates to a cumulative effect of all (likely) hazard occurrences, whereas the impact merely indicates the effects of specific reference events.

[3] Adding this type of functionality would be relatively simple for specific regions where the data is available. Please contact denis.havlik@ait.ac.at us if you are interested in improved screening models for specific regions.

- **Risk assessments**: aims at defining a synthetic index/coefficient, representing the convolution of the probabilities of different hazard intensities (H), in relation to the exposure (E) and vulnerability (V) conditions in a given area. Such a risk index is useful to allow high-level comparisons between alternative project options but does not allow detailed quantification of impacts on considered elements at risk.

To obtain reliable results that can serve as a sound basis for decision making in the field of infrastructure development, risk assessment should be always based on numerical modelling procedures. Probabilistic quantitative risk assessments can be undertaken in the early phases of the asset lifecycle, with different levels of detail (including the spatial resolution of the models' output) depending on the availability of exposure and vulnerability. This requires running various scenarios and comparing the results with respect to the frequency of event occurrence and event magnitude by means of a probability distribution.

- **Impact scenario analysis**: as a complement to the risk assessment, by choosing in a "deterministic" way one or more reference events (among actually occurred past events or as a result of numerical hazard simulation models) the corresponding "impact scenario analyses" can be performed using numerical impact models, providing detailed damage evaluation on selected elements at risk following specific event(s).

Unlike the risk assessment, the impact scenario analysis represents a simulation of the expected impacts of a specific hazard (in terms of intensity, location, etc.), derived from the application of an impact model able to correlate hazard (H), exposure (E) and vulnerability (V) characteristics to produce a detailed quantification of damage on elements at risk considered (e.g. population, buildings). An analysis based on the output of the impact models can be used to support decision-making, e.g. by applying multi-criteria and/or cost-benefit analyses on a number of relevant impact scenarios. Probabilistic assessment and uncertainty evaluation are provided also in relation to impact scenario analyses, mainly related to the probability of occurrence of the hazard type and intensity at the location of the analysis.

CLARITY advanced urban screening incorporates several simple impact models that correlate heat hazard indices and population density with health impact and the pluvial flood hazard indices and different types of infrastructure with economic damage.

In the case of road transport infrastructures, we couldn't identify sufficiently accurate screening risk or impact models. Therefore, **the risk/impact assessment for the road infrastructure is done on the basis of an "informed decision"**, which means that there is an expert who knows the road section from the point of view of exposure and vulnerability and, with the help of the hazard information produced under CSIS, is able to assess the impact and the risk.

2.5 Identification of Adaptation Options

In CLARITY project, **a list of 35 effective adaptation options** has been established through literature research and discussion with the stakeholders. This list is attached as an annex document of D3.3 and also available in CLARITY online services (**Figure 10**).

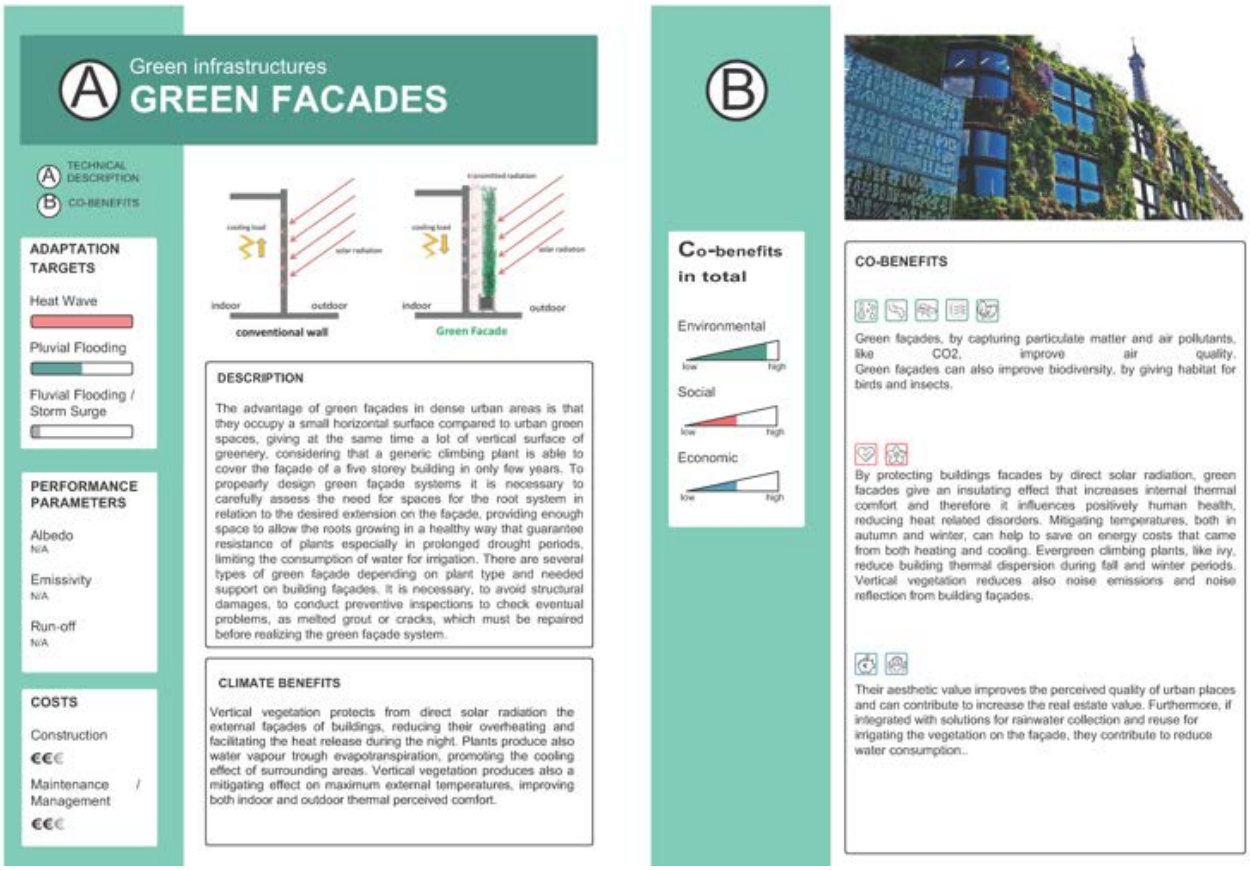


Figure 10: One of 35 effective CLARITY adaptation options for urban and traffic infrastructure.

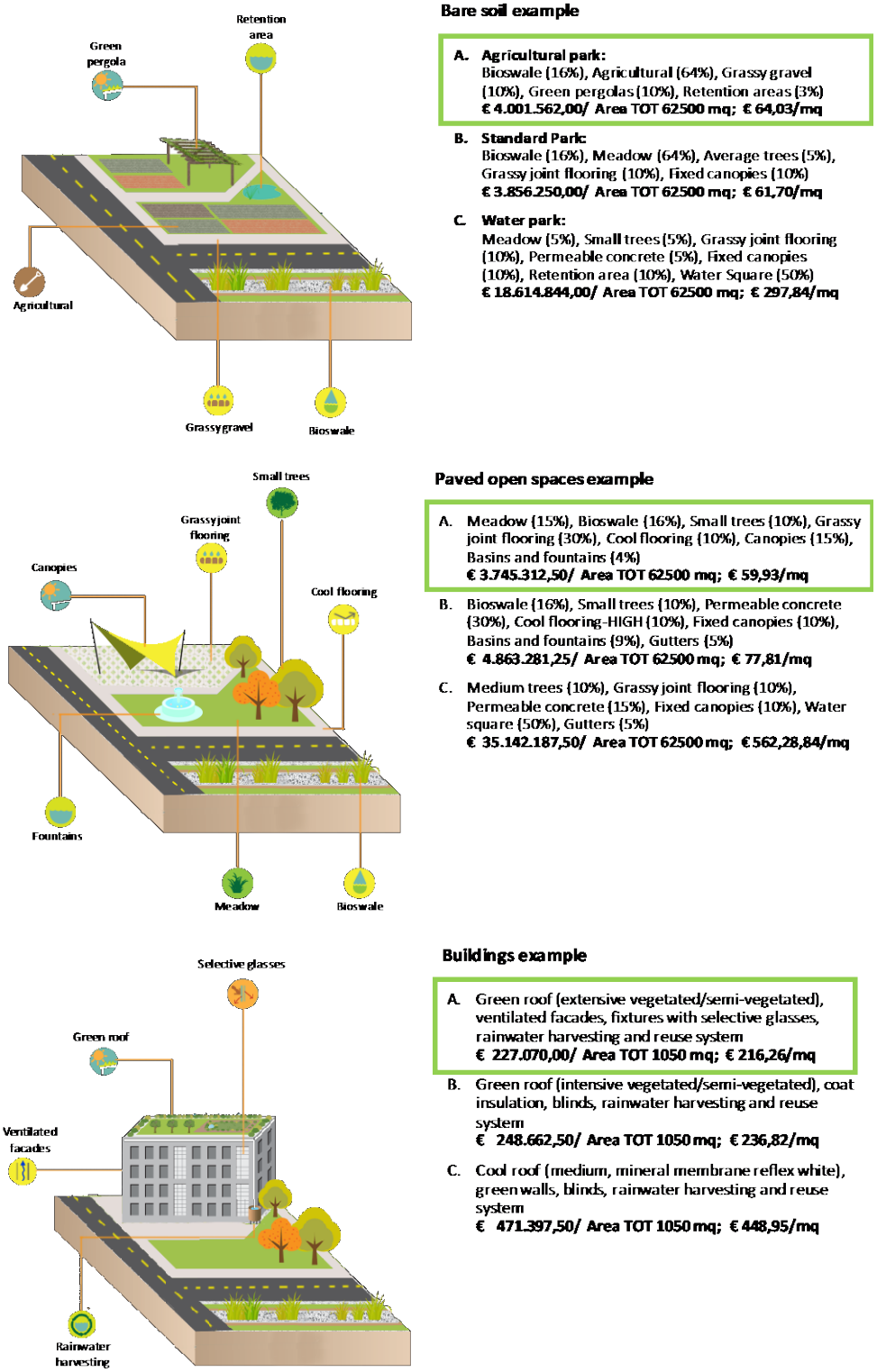
For each of the pre-defined adaptation options, a set of parameters has been defined to facilitate the next step in the EU-GL workflow: adaptation targets, performance parameters, construction, retrofitting and maintenance costs and co-benefits. This information is available in Annex documents of D3.2 as well as in the CLARITY online tools.

In CLARITY screening workflows, "identification" of the adaptation options step allows the users to inspect these pre-defined adaptation options, study their characteristics and include the relevant ones in a shortlist for the specific project. This automatically includes the information related to benefits of the selected adaptation options in the study report, in terms of hazard, exposure and vulnerability reduction, as well as in terms of related socio-economic co-benefits (such as increase in liveability, biodiversity, and selection ability to respond to multiple hazards, etc.)

2.6 Appraisal of Adaptation Options

In the "appraisal" step, the costs, benefits and co-benefits of the adaptation options are assessed.

In CLARITY screening workflow, this step has been simplified through definition of the "adaptation strategies" pertinent to vegetated areas, buildings, built open spaces and transport infrastructure (roads and railways). This is illustrated in Figure 11.



Bare soil example

A. **Agricultural park:**
Bioswale (16%), Agricultural (64%), Grassy gravel (10%), Green pergolas (10%), Retention areas (3%)
€ 4.001.562,00/ Area TOT 62500 mq; € 64,03/mq

B. **Standard Park:**
Bioswale (16%), Meadow (64%), Average trees (5%), Grassy joint flooring (10%), Fixed canopies (10%)
€ 3.856.250,00/ Area TOT 62500 mq; € 61,70/mq

C. **Water park:**
Meadow (5%), Small trees (5%), Grassy joint flooring (10%), Permeable concrete (5%), Fixed canopies (10%), Retention area (10%), Water Square (50%)
€ 18.614.844,00/ Area TOT 62500 mq; € 297,84/mq

Paved open spaces example

A. Meadow (15%), Bioswale (16%), Small trees (10%), Grassy joint flooring (30%), Cool flooring (10%), Canopies (15%), Basins and fountains (4%)
€ 3.745.312,50/ Area TOT 62500 mq; € 59,93/mq

B. Bioswale (16%), Small trees (10%), Permeable concrete (30%), Cool flooring-HIGH (10%), Fixed canopies (10%), Basins and fountains (9%), Gutters (5%)
€ 4.863.281,25/ Area TOT 62500 mq; € 77,81/mq

C. Medium trees (10%), Grassy joint flooring (10%), Permeable concrete (15%), Fixed canopies (10%), Water square (50%), Gutters (5%)
€ 35.142.187,50/ Area TOT 62500 mq; € 562,28,84/mq

Buildings example

A. Green roof (extensive vegetated/semi-vegetated), ventilated facades, fixtures with selective glasses, rainwater harvesting and reuse system
€ 227.070,00/ Area TOT 1050 mq; € 216,26/mq

B. Green roof (intensive vegetated/semi-vegetated), coat insulation, blinds, rainwater harvesting and reuse system
€ 248.662,50/ Area TOT 1050 mq; € 236,82/mq

C. Cool roof (medium, mineral membrane reflex white), green walls, blinds, rainwater harvesting and reuse system
€ 471.397,50/ Area TOT 1050 mq; € 448,95/mq

Figure 11: Example of alternative adaptation for specific land use classes (in brackets the percentage of application on the existing land use).

Adaptation strategies in CLARITY online tools are defined in a way that a-priory eliminates the possibility of common mistakes. E.g., it is not possible to choose two conflicting adaptation options for the same type

of elements at risk. Moreover, the combination of adaptation options in each adaptation strategy has been pre-selected by experts to provide optimal cost/benefit effects mitigating the heat hazard impacts, pluvial flooding impacts or both for one of the four land use (meta-)categories: vegetated areas, buildings, built open spaces and transport infrastructure (roads and railways).

By assigning an adaptation strategy to at least one of these land use categories, users can define an "adaptation project" and re-start the screening calculation. This results in a new estimate of heat and pluvial flooding impacts taking into account the beneficial effects of the chosen adaptation options.

2.7 Implementation/Integration of Adaptation Action Plans

Final step in the EU-GL methodology is integration of adaptation options in the project.

In the advanced urban screening workflow, this is interpreted as inspecting the costs and benefits of different adaptation projects and deciding which one to implement (Figure 21). This can be carried out through the collaboration between local end-users and experts from the CLARITY team.

3 The Marketplace

The overall goal of a marketplace is to promote goods and services and to match offer and demand accordingly; myclimateservices.eu intends to serve the emerging market of climate services. Additionally, it aims to foster collaborations along the value chain increasing co-creation, co-development and innovation in various stages of service and project development.

3.1 Concept of the Marketplace

The concept of the Marketplace can be envisaged as follows:

1. The Marketplace gathers and presents climate services like data, digital tools, expert studies as well as tangible solutions for climate adaptation. Not only offers are presented, but also requests and best practices – these will be infrastructure related projects from cities, regions and enterprises searching for solutions or showcasing the successful utilization climat services.
2. Offers and requests will be matched and possible collaborations ignited.
3. The usefulness is increased by community features like the webZine that reinforces promotional content as well as event organization and management.

The **content is global** to enable technology and know how transfer beyond regions or states. However, there will be a strong regional focus on end user level oganized in "regional hubs" featuring local language, culture and regulatory framework conditions, simultaniously having access to the global marketplace database. The hubs will be curated by local partners and the webZine is crucial as display for the respective regional end user communities and their achievements.

The service allows for detailed describing individual climate services offerings on the marketplace site, finding collaboration partners or climate adaptation demands from other users' projects. Experts can promote their solutions, references and projects on the webZine; the editorial scope on different launched climate related topics provide a relevant framework for their contributions.

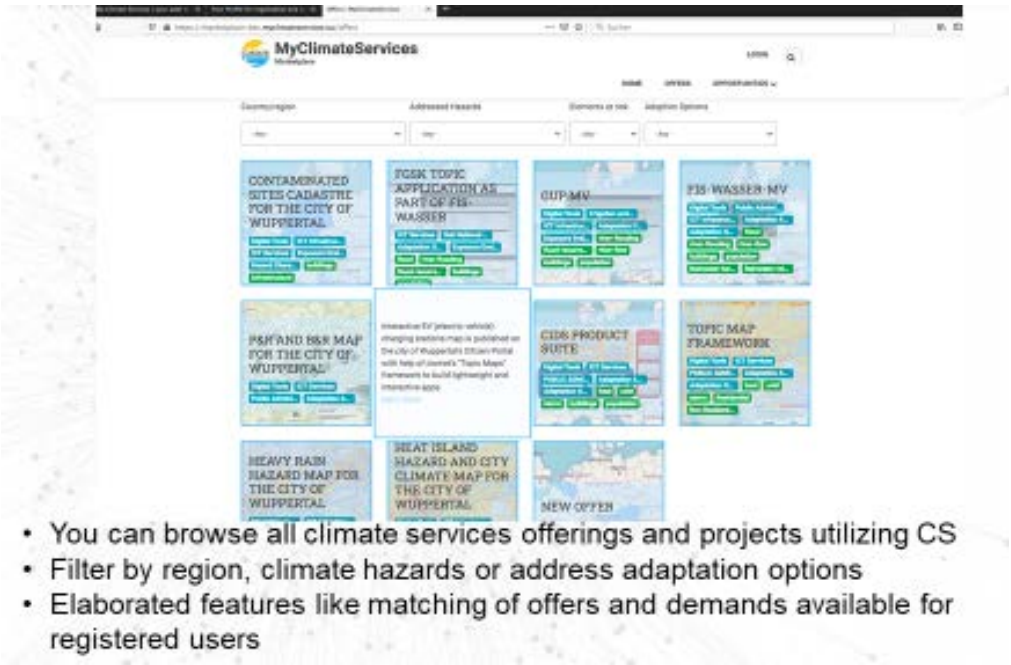


Figure 12: Climate services- make-up and offers

3.1 Solution Offers and Projects

A Solution Offer is data, service or a product that can be introduced and advertised on the Marketplace and contributes to appraisal and/or implementation of Adaptation Action Plans in the CSIS and thus gives Solution Providers the possibility to promote their offerings. A Solution Offer can apply to one or more sectors, EU-GL step/modules and (e.g. in case of data) regions.

Solution Offers can consist of different Climate Services (advice, data, software) or represent a distinct Climate Service on their own. The screening tool part of the CSIS is an example of a Solution Offer. Another example would be a service for creating tailored Data Packages.

Additionally, Solution Offers also represent physical products and services like novel reflective materials, CO2-absorbant paint, climate-change-aware construction services, etc. Interestingly, such a physical Solution Offer could be used as Adaptation Option.

Solution Offers can build on one another (e.g. indices on data, localized services on more generic models) and a single Solution Offer can be provided by different organizations thus encouraging collaborations along the value chain.

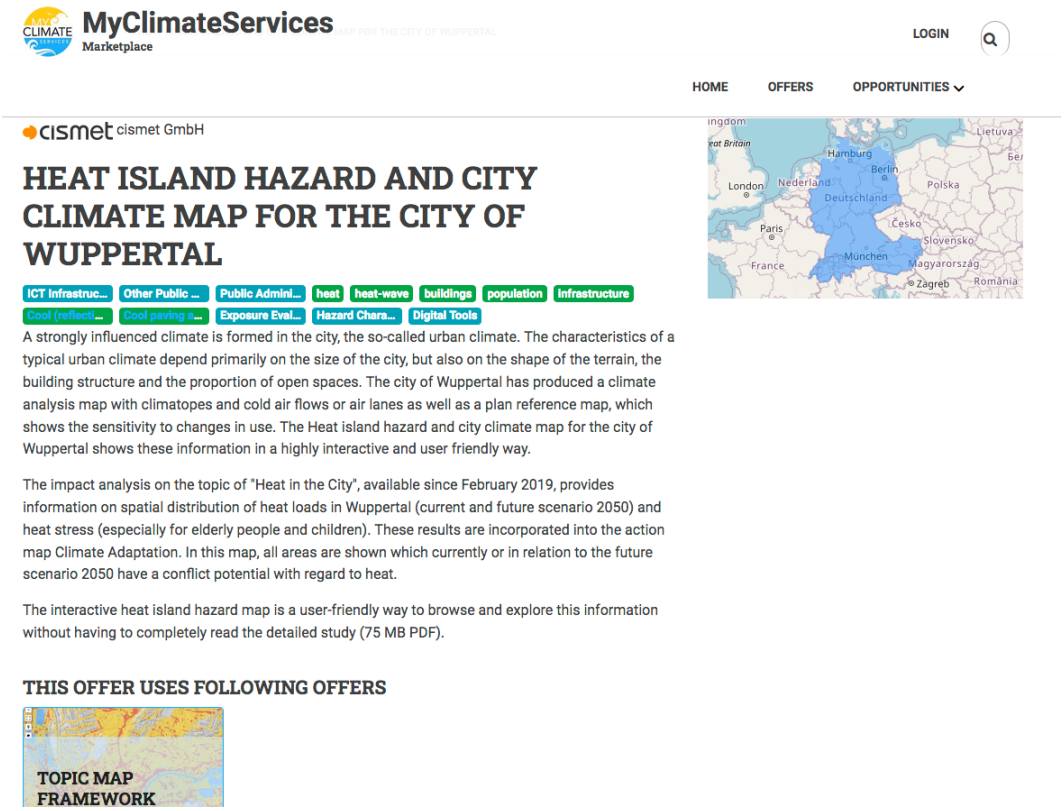


Figure 13: Marketplace - solution offer

The following video provides guidance for creating a solution offer:

- **Create an offer in the MyClimateServices Marketplace:** https://youtu.be/M7UzC3OHiiw (6:37)

A Project describes either a finished (urban) infrastructure measure as a reference for the implementation of one or multiple solution offers or is a drafted or on-going infrastructure project in demand of climate services or provision of specific adaptation options.

Projects can comprise contributions from more than one organization and have demand for multiple services also depending from the project phase from intelligence gathering for planning to monitoring of implemeted measures.

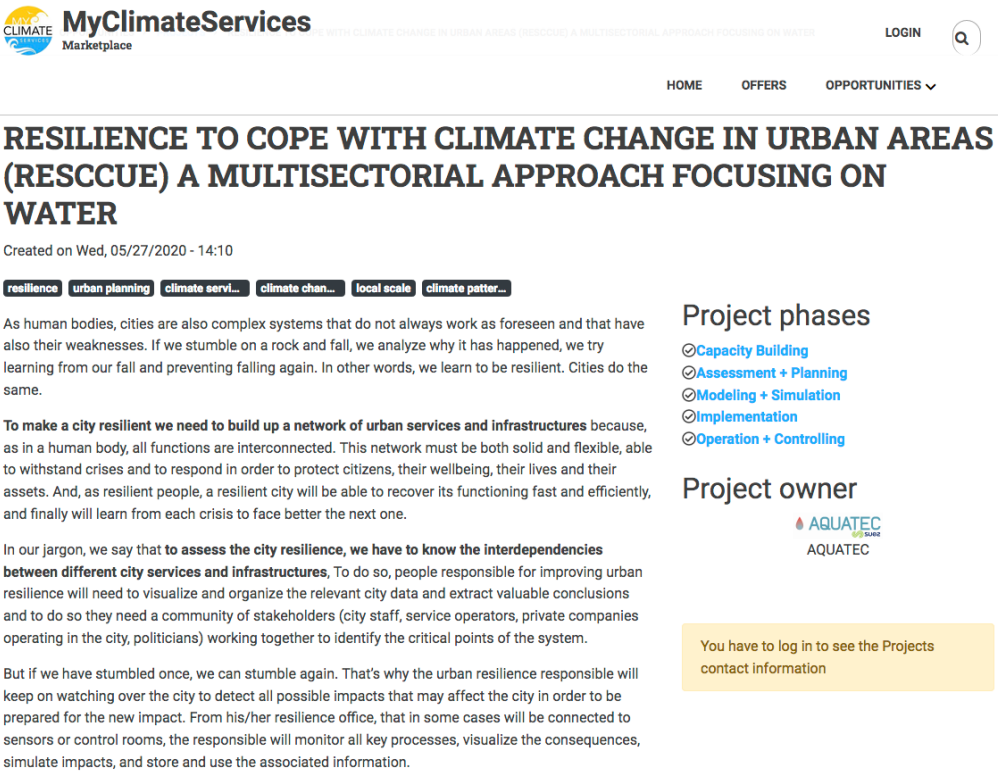


Figure 14: Marketplace - project

The following video provides guidance for creating a project:

- **MyClimateServices marketplace - Create a project:** https://youtu.be/EPJv2053zRU (5:17)

3.2 User account and Organization Profiles

The Marketplace aims to foster new and unusual commercial and R&D collaborations. To achieve this some knowledge about prospective partners and trust between the parties is required. Therefore full functionality of the marketplace is available only for registered users including disclosure of contact data.

B2B contacts are closed between organizations (e.g. legal entities). For activities on the marketplace and matching of Solution Offers and a Project demanding the solutions an organization needs to be linked to the personal account. As a person you can be member of multiple organizations.

Temporary or "virtual" organizations like working groups (e.g. planners and contractors) or project consortia can also be established, set requests and showcase references.

Good practice example of such an organisation is available here:

- **https://marketplace-dev.myclimateservices.eu/opportunities/projects/resilience-cope-climate-change-urban-areas-resccue-multisectorial-approach**

The following video provides guidance for creating and maintaining a user account and organization profiles:

- **CLARITY CSIS: Create a profile:** https://youtu.be/PQOr0diQrPI (2:07)

3.3 The Climate Services Portal and Marketplace

The portal myclimateservices.eu is the single point of entry for the (digital) offerings of the CLARITY project:

Figure 15: The marketplace portal myclimatservices.eu

The portal home page displays latest social media posts and editorial and directly directs to articles featuring the actual editorial focus. Changing editorial foci will deal with diverse topics of climate adaptation in different regions as well as with sectors and direct visitors´ attention to Solution Offers and Projects and their actors.

By accessing the marketplace one can explore and insert solution offers as described above.

"Events" directs to the MyClimateServices event management site and offers the possibility to look for interesting events to attend and advertize and organize own events including direct connection with third party platforms for operating webinars and digital conferences. Also "event restrospect" like summary and conclusions, videos, presentations etc. can be managed via the website of the respective event. For organizers especially of small events like project presentations and workshops (virtual and analogue) there are two main benefits:

- embedding in the climate services environment and communities
- a single website to maintain planning announcing and reporting of a specific event

Adjustments to the agenda, speakers, even venue and time slot need to be taken care of only at one site. Organizers can assign event teams whose members can maintain the site as well and events can be fully public or only for members.

This link directs to an event website featuring the retrospect of a past event:

- **https://events.myclimateservices.eu/2020/july/webinar-climate-services-emerging-market-latest-trends**

The portal also directs to the CLARITY Climate Screening Tool which is described in the next section.

Figure 16: events.myclimateservices.eu

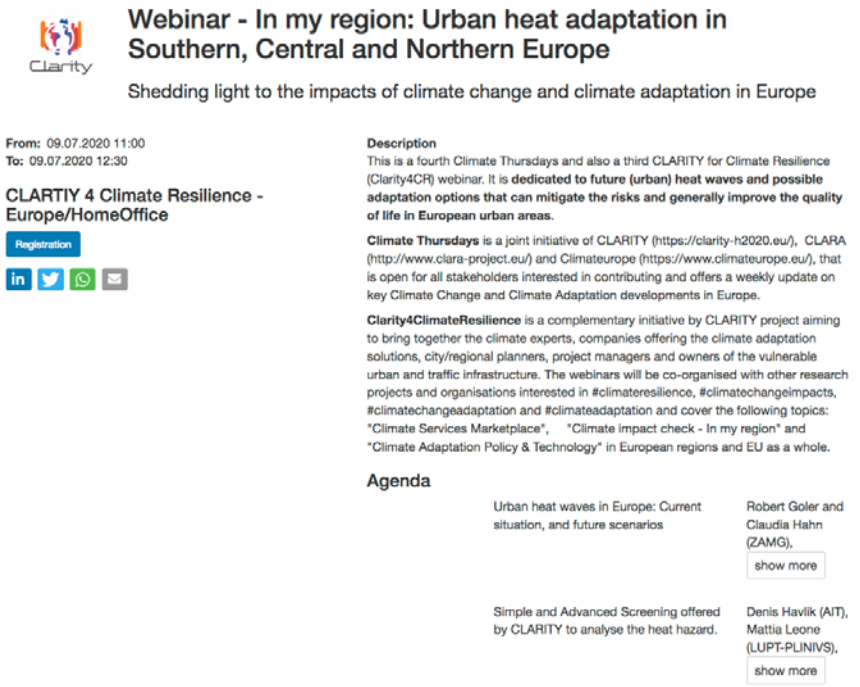


Figure 17: screenshot of an event website (partial)

4 CLARITY Online Services

The CLARITY provides services at several levels of detail: online basic and advanced screening studies, online traffic screening studies and the offline expert studies.

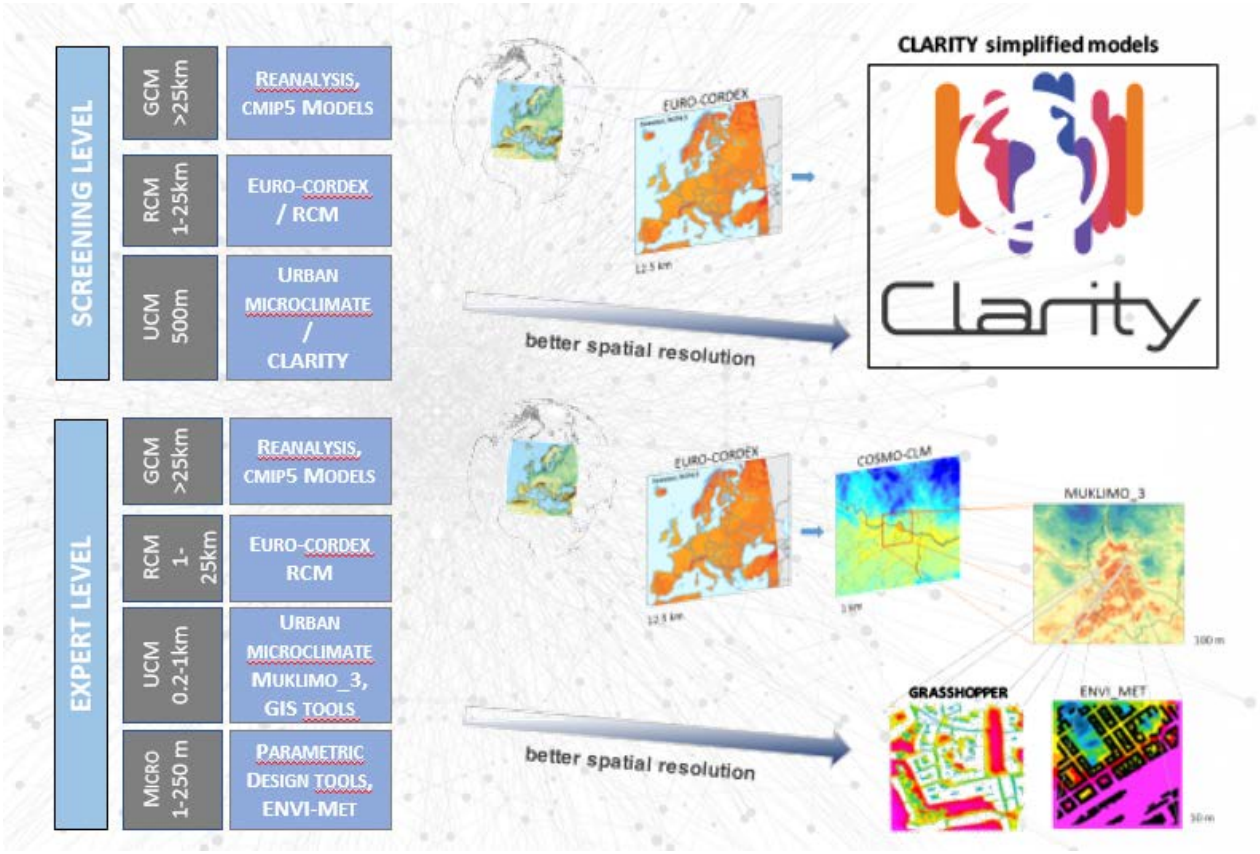


Figure 18: The CLARITY Screening levels

4.1 Basic Screening

The Basic Screening study type enables the users to compare the existing hazard and exposure data sets and explore the vulnerabilities and adaptation options anywhere in Europe. Over 20 hazard indices are provided for several periods and future climate scenarios. However, the hazard resolution is limited to 12x12 km^2, which is not enough to capture the urban climate variations. Additionally, this type of screening does not encompass impact calculations, but the comparison of the hazard intensity with positions of the elements at risk can be used as a proxy for risk/impact assessments.

Following video presents a general introduction to clarity online services and the basic screening study:

- **CLARITY Basic Urban Screening for climate resilience: https://youtu.be/WdiUfq2-jUw (9:11)**

Basic screening is a simplified version of the Advanced Urban Screening (see tutorial in the next section), with all the "advanced" functionality removed. That is, it does not offer any on-demand downscaling or indicator calculation. Basic screening is meant as fallback solution in the areas where Advanced Urban Screening is not available and likely to be more useful for experts seeking an easy way to get a first impression about a region they aren't familiar with than for the end users.

4.2 Advanced Screening: Urban Infrastructure

The "Advanced Screening: Urban Infrastructure" study type permits the user to perform on the fly calculation of local hazards, exposure and impact for a selection of European cities and regions where the relevant input data is available. This type of screening can capture the urban climate variations, as its resolution reaches 500x500m2. However, the calculations are limited to "urban heat islands" and "pluvial flooding" events. Moreover, the advanced screening is not available in whole Europe. Service coverage in October 2020 is illustrated in Figure 19.

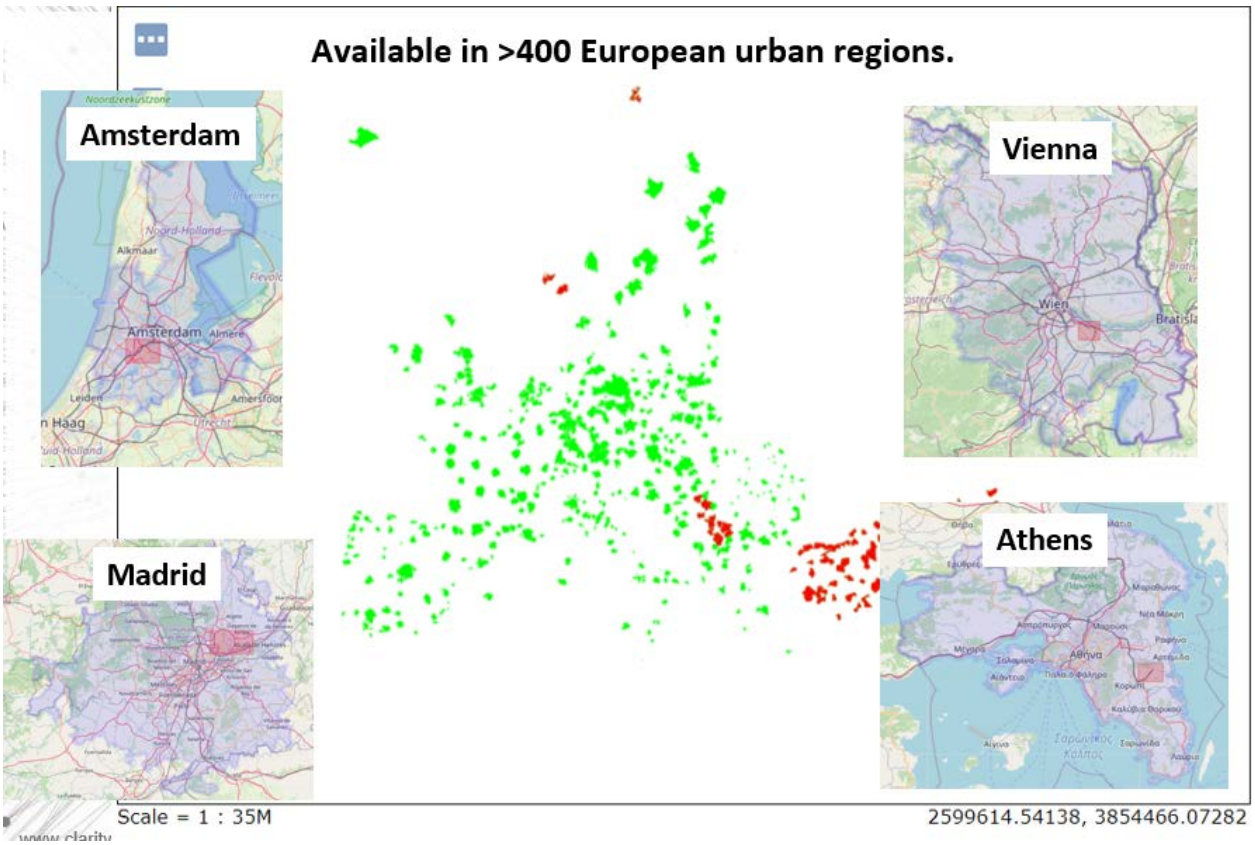


Figure 19: Advanced screening service coverage (10/2020)

Similar to the basic screening study, the advanced screening also offers the possibility to explore the characteristics of the main adaptation options anywhere in Europe. In contrast to the basic screening type this study automatically downscales the hazards, population and infrastructure exposure to 500x500m^2 (Figure 20), calculates various impact indicators and even allows the users to assess the impact of adaptation options (Figure 21).

Following video provides a step by step tutorial explaining how to use the service and explains the limitations of the current service implementation:

- **Advanced Urban Screening for climate resilience tutorial: https://youtu.be/qWyrI3cqY4c (1:11:02)**

A shorter video that only explains what the service is doing and how, is also available:

- **Introduction to CLARITY - Screening Tool and Marketplace: https://youtu.be/KQmvovKCvIo (9:42)**

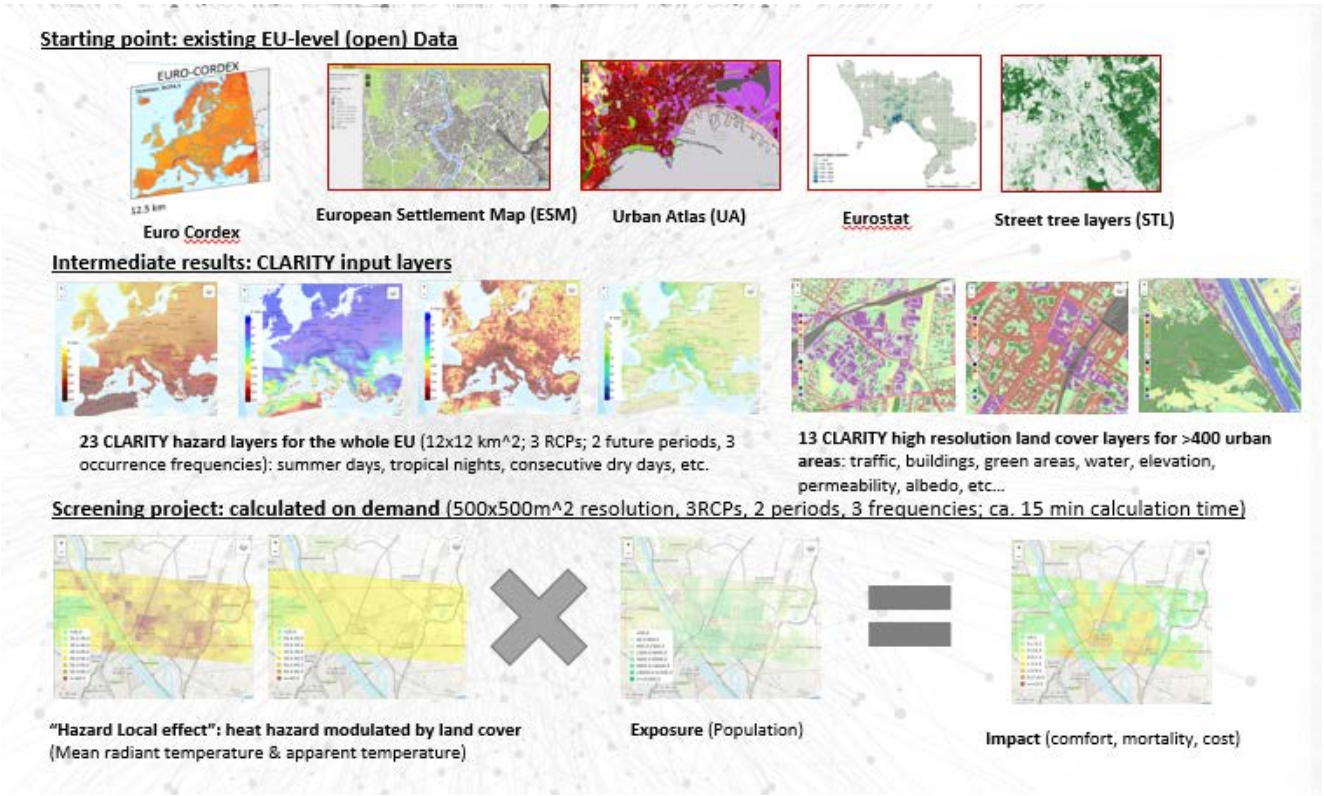


Figure 20: Advanced Urban Screening workflow

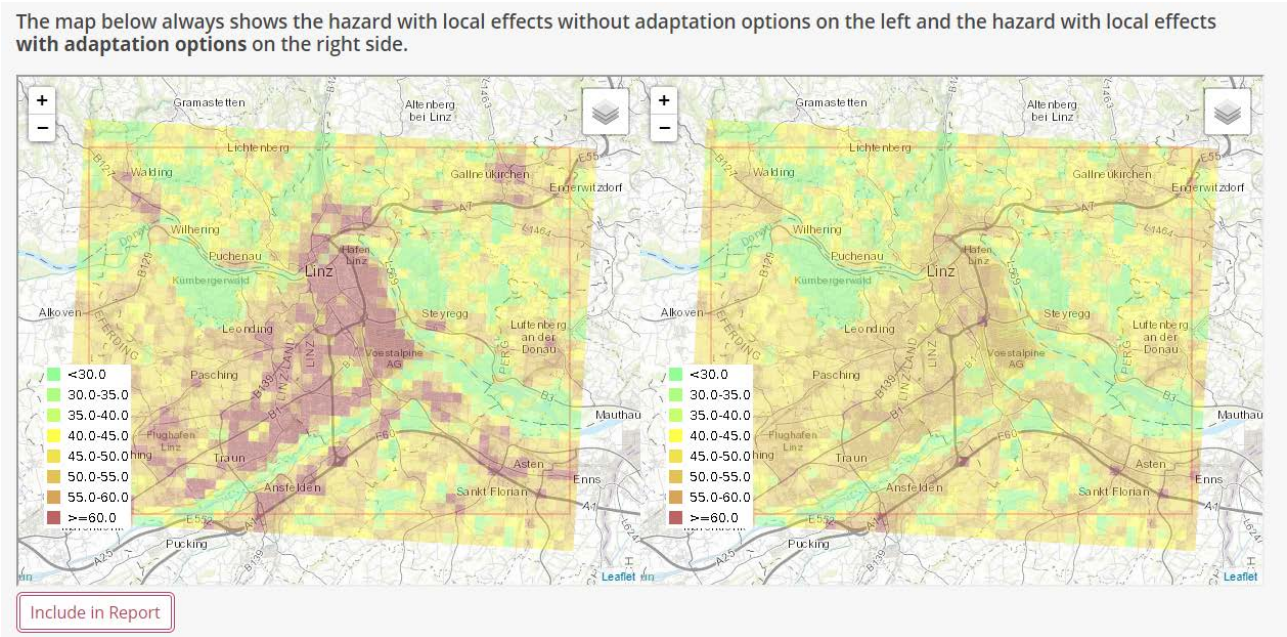


Figure 21: Mean radiant temperature in Linz before (left) and after (right) implementation of the adaptation strategy in the city of Linz (RCP8.5, end of 21-st century, 20y reoccurrence event).

4.3 Advanced Screening: Traffic Infrastructure

The Advanced Screening: Traffic Infrastructure is focused on screenings of traffic infrastructure. Traffic screening is mainly targeting Spain, where better input data is available. A simplified version of the traffic screening is also available for other EU states.

Traffic screening is conceptually similar to the Advanced Screening: Urban Infrastructure but targets a different type of infrastructure and a different group of users. It further differs from the former in terms of the technology used in the background. Since both studies are implemented by embedding external applications in the CSIS workflow, the overall workflows are nevertheless very similar in terms of design and use.

Following video provides a step by step tutorial explaining how to use the service:

- **CLARITY Transport Networks application demo: https://youtu.be/LwMVjHS4C-8 (40:48)**

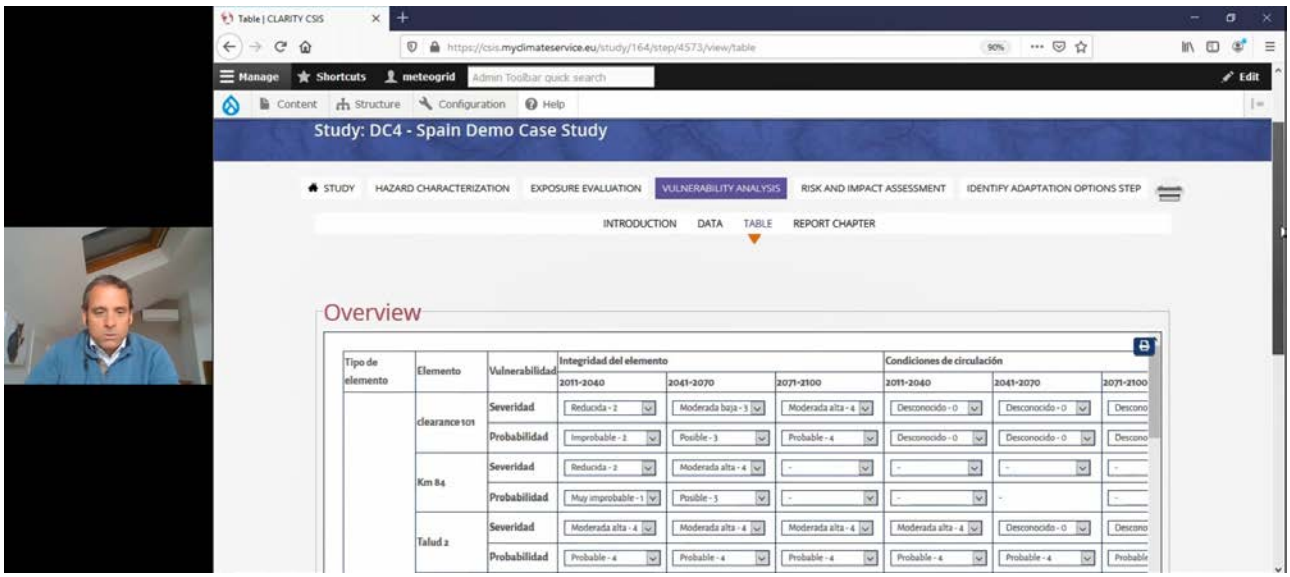


Figure 22: Vulnerability definition step in CLARITY traffic infrastructure screening application

Complete webinar explaining why and how the service is designed and which data it uses in the background is also available:

- **Climate Adaptation in Transport Networks - Roads and Railroads: (https://youtu.be/-cBvYA3ynTQ (1:45:53)**

5 Suggestions for further reading

The main objective of this deliverable is to present the guidelines for using the CLARITY online services, including the marketplace. The document itself is considered just part of the deliverable, with large portion of the actual work being invested in production of the online video tutorials explaining various aspects of the project:

- Methodology
- Marketplace
- Simple and advanced urban screening
- Transport screening

The reason for designing the tutorials and other educational features as videos is that we believe that such videos are easier to digest and will therefore reach more potential users and customers than text documents.

For the readers that have read this document, watched the videos, and wish to learn more, detailed descriptions of the project work and results are available in CLARITY deliverables and can be downloaded from CORDIS server as well as from https://clarity-h2020.eu/content/downloads. Following deliverables are exceptionally valuable in our opinion:

- **D1.4. CLARITY CSIS v2:** describes the CLARITY service implementation and data sets used to implement different workflows.
- **D2.4. CLARITY Demonstrators Implementation and Validation Report v2:** reports on the outcomes of the final round of CLARITY demonstrators' implementation, evaluation and validation process, including feedback from potential end-users external to the consortium.
- **D3.3. Science support report v2:** explains the scientific aspects of the project – methodology, models and data that was used to achieve the project results
- **D4.4 Technology support report v2:** explains the technology related aspects of the project, provides the final overview of all the tools and models that were either inherited from previous projects or developed in CLARITY, and explains how the inherited tools were used and/or extended in CLARITY.
- **D5.6 Social-Innovation Assessment Report:** summarizes the CLARITY project impacts on society in general and on the four pilot regions that participated in the project in particular.
- **D6.7 CLARITY Guideline v2 (this document)**

Furthermore, a large number of CLARITY-related publications and open data sets is available on CLARITY Zenodo channel (https://zenodo.org/communities/clarity/).

Finally, several webinar recordings and other video materials in German, Spanish and Italian are also available on our GotoStage channel (https://www.gotostage.com/).

6 Acknowledgement

According to Article 38.1.2 of the model grant agreement, all the documents related to CLARITY (deliverables, presentations, papers, newsletters, leaflets etc.) shall contain the following statement: ***"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730355."***

7 References

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