



DELIVERABLE D.T1.3.3

Tutorial development for user friendly
transfer of the WebGIS tool.

Version 04
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1. Introduction

This document is placed within the framework of the activities performed in the Thematic Work Package T 1 - Integrated WebGIS tool for decision making in the management of heritage at risk - and represents the final step to reach the objective of the output O.T1.3 - WebGIS tool for multi-risk assessment on cultural heritage in Central Europe.

The finalization of the WebGIS tool - “Risk mapping tool for cultural heritage protection” illustrated in D.T1.3.2 has been based on the outputs of the following Deliverables from Interreg CE ProteCHt2save and STRENCH projects:

The present deliverable aims to guide the end user to navigation within the WebGIS Tool explaining how to access and use its main tools.

Note:

Vers. 05 - Updates have been made compared to the previous version mainly in the page addressed to explain the methodology for vulnerability assessment - Changes and improvement follow the feedback of the users after the testing activities of the Web GIS Tool foreseen in D.T2.2.1 and D.T.2.2.2.

Vers. 04 - Updates have been made compared to the previous version in the section dedicated to the description of the case studies

Vers. 03 - Updates have been made compared to the previous version in the section dedicated to the description of the open search tool - 2.6.3. Open search and in the section related to Vulnerability page. Other changes has been made in figures of the session 2.1.

Vers. 02 - Updates have been made compared to the previous version in the section dedicated to the description of the open search tool - 2.6.3. Open search



2. How to explore and use the WebGIS Tool for Risk Mapping

2.1. General view

The WebGIS tool “Risk mapping tool for cultural heritage protection” is available at the website <https://www.protecht2save-wgt.eu/>.

The web page of Web GIS Tool (WGT) for risk mapping is composed of 6 pages. The Home page is immediately available for all users, while a registration is required to access the further contents and pages.



Figure 1. Part of the Home page of the Risk Mapping Tool for Cultural Heritage Protection showing the Header of the web page with project logos, pages, registration and sign in buttons.

2.1.1. Registration

Click on the **Register** button in the home page and subsequently filling the form in all its parts and clicking on ‘Register’ (Fig. 2).

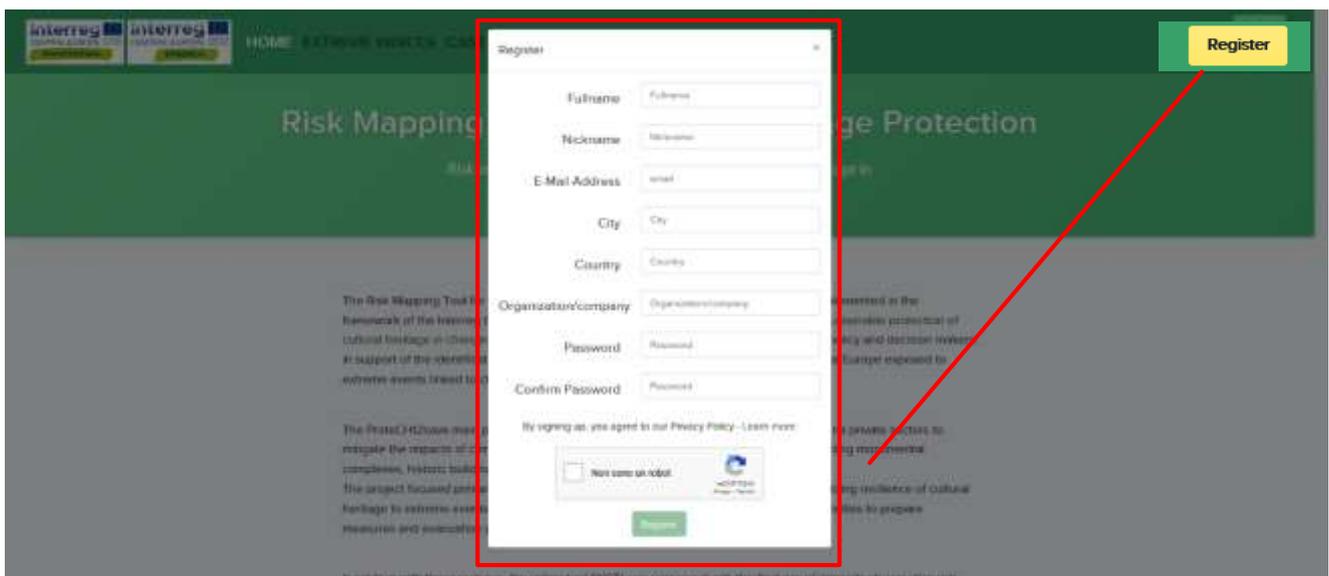


Figure 2. WGT Home page: registration form.

At this stage, the web page administration service will send an automatic notification to the provided e-mail address. Registration e-mails are usually received within few minutes after the registration procedure and it is necessary to click on the link provided in the e-mail to validate the registration.



Once the registration is confirmed, the new account will be automatically validated and enabled to the navigation on the WGT.

2.1.2. Access

Once registered, users can access the WGT home page by entering the username and password they have set up during the registration procedure and they proceed by clicking on the **Sign in** button and inserting the username and password in the relevant fields. Finally click on the 'Login' button.

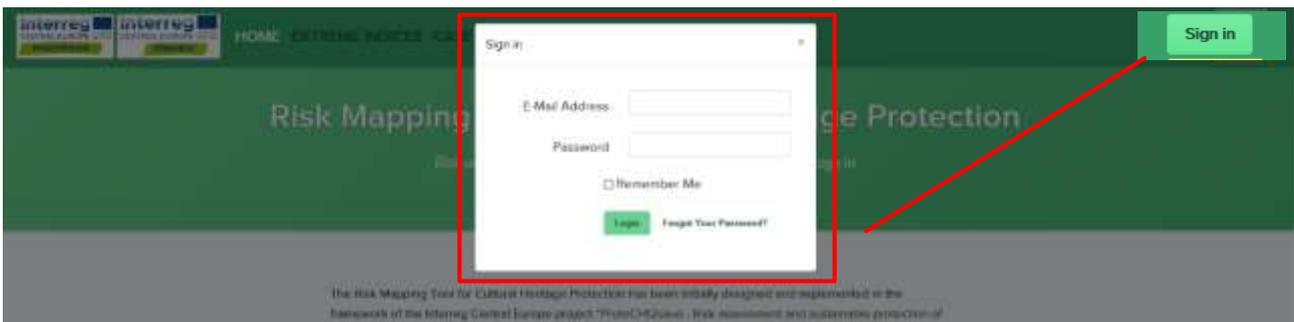


Figure 3. WGT : login procedure

2.2. Home Page

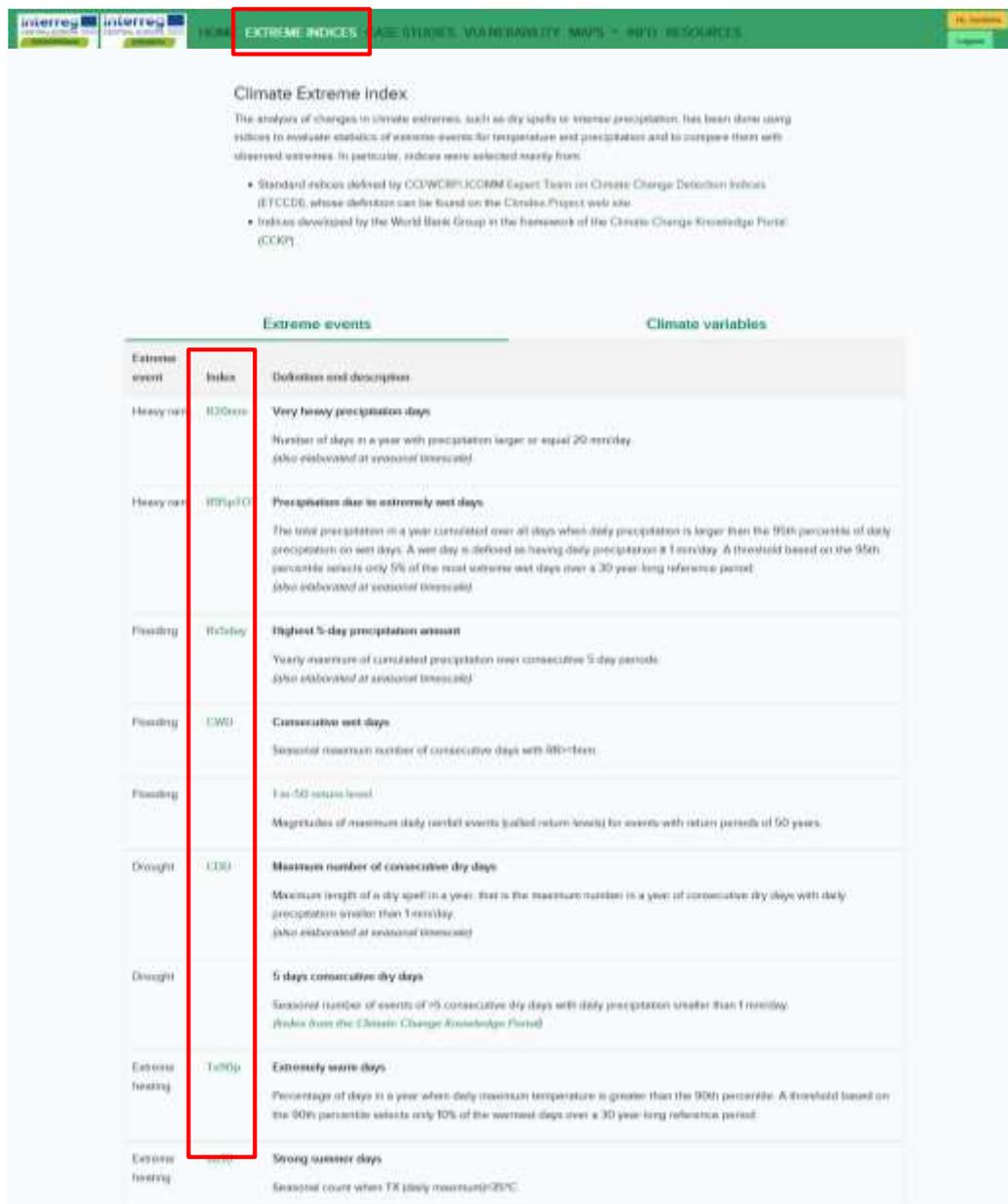
On the Home page a brief general information of the project and the introduction to the Web GIS Tool for risk mapping is provided. Furthermore, a first overview of the project pilot sites is also available.



2.3. Climate extreme indices.

In the EXTREME INDICES page detailed information about the climate extreme indices selected for the project are available (Fig. 3). These indices, selected among the 27 climate index defined by the ETCCDD, are internationally accepted by the scientific community for representing change in climate extreme, such dry spell or intense precipitation. They are based on change of temperature and precipitation and relate to heavy rain, flooding, drought and extreme heating.

After a brief introduction, the climate indices and variables elaborated are listed in two separate windows: **Extreme events** and **Climate variables**.



The screenshot shows the 'EXTREME INDICES' page with a table of climate indices. The table is divided into two sections: 'Extreme events' and 'Climate variables'. A red box highlights the 'Index' column in the table.

Extreme event	Index	Definition and description
Heavy rain	HDGens	Very heavy precipitation days Number of days in a year with precipitation larger or equal 20 mm/day. (Also elaborated at seasonal timescale)
Heavy rain	HDp10	Precipitation due to extremely wet days The total precipitation in a year calculated over all days when daily precipitation is larger than the 95th percentile of daily precipitation on wet days. A wet day is defined as having daily precipitation ≥ 1 mm/day. A threshold based on the 95th percentile selects only 5% of the most extreme wet days over a 30 year long reference period. (Also elaborated at seasonal timescale)
Flooding	HD5day	Highest 5-day precipitation amount Yearly maximum of cumulated precipitation over consecutive 5-day periods. (Also elaborated at seasonal timescale)
Flooding	CDW	Consecutive wet days Seasonal maximum number of consecutive days with HD>1mm.
Flooding	I=50 return level	I=50 return level Magnitudes of maximum daily rainfall events (called return levels) for events with return periods of 50 years.
Drought	CDI	Maximum number of consecutive dry days Maximum length of a dry spell in a year, that is the maximum number in a year of consecutive dry days with daily precipitation smaller than 1mm/day. (Also elaborated at seasonal timescale)
Drought	5 days consecutive dry days	5 days consecutive dry days Seasonal number of events of 5 consecutive dry days with daily precipitation smaller than 1 mm/day. (Index from the Climate Change Knowledge Portal)
Extreme heating	TR50p	Extremely warm days Percentage of days in a year when daily maximum temperature is greater than the 90th percentile. A threshold based on the 90th percentile selects only 10% of the warmest days over a 30 year long reference period.
Extreme heating	TR	Strong summer days Seasonal count when TR (daily maximum)>25°C.

Figure 3. Visualization of the climate indices listed in the EXTREME INDICES page.

Clicking on each short name of the indices included in the “Index” column (red box in Fig. 3) it is possible to reach the original web page where deeper information about each climate risk index is available.

In the same page we can also visualize the climate variables elaborated (Fig. 4).

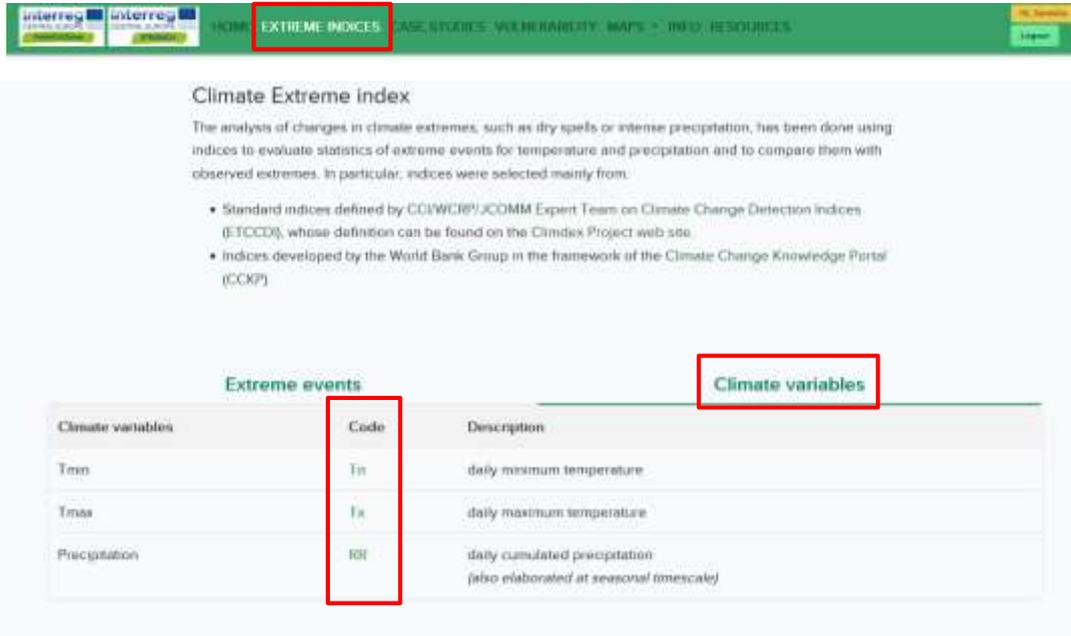


Figure 4. Visualization of the climate variable listed in the EXTREME INDICES page.

2.4. Case studies

This section of the WGT hosts the presentation of the pilot sites participating in both the projects Interreg CE ProteCHt2save and STRENCH (Fig. 5). Here is provided an in deep knowledge of the case studies involved in the projects by showcasing their geographical context with a focus on their unique cultural and natural heritage also highlighting main climate hazards impacting the sites. A survey on the past calamitous events recorded at the site and subsequent prevention, mitigation and adaptation measures put in place. Finally, a series of additional information useful to understand what tools and data can be available at local level for the protection of cultural heritage at risk are also available for an in deep knowledge of the site and a correct analysis of the still existing gaps.

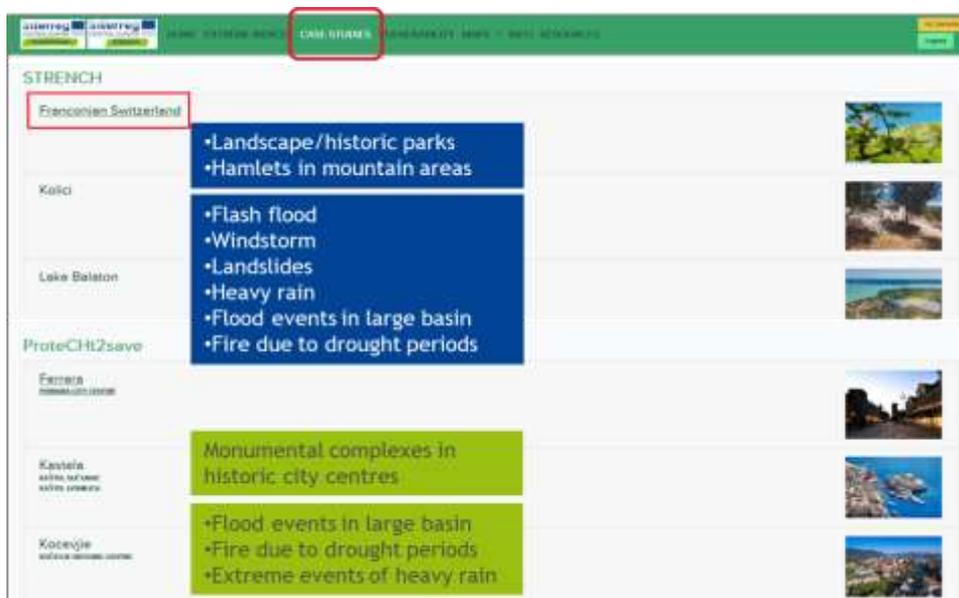


Figure 5. Visualization of the preview of the case studies



Clicking on each of the listed case study in the preview it is possible to visualize a first overview of each site (Fig. 6). In addition, for each case study, there is the possibility to download the detailed and log version of the description in pdf format.

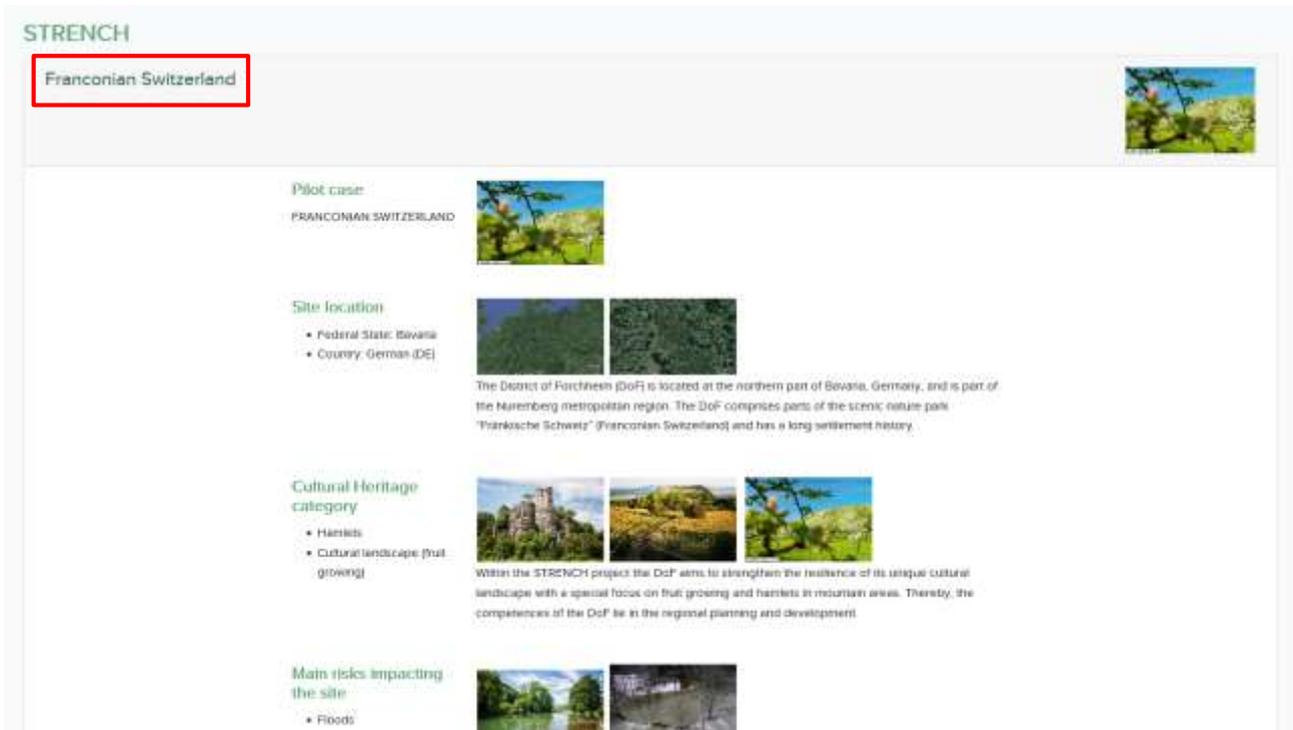


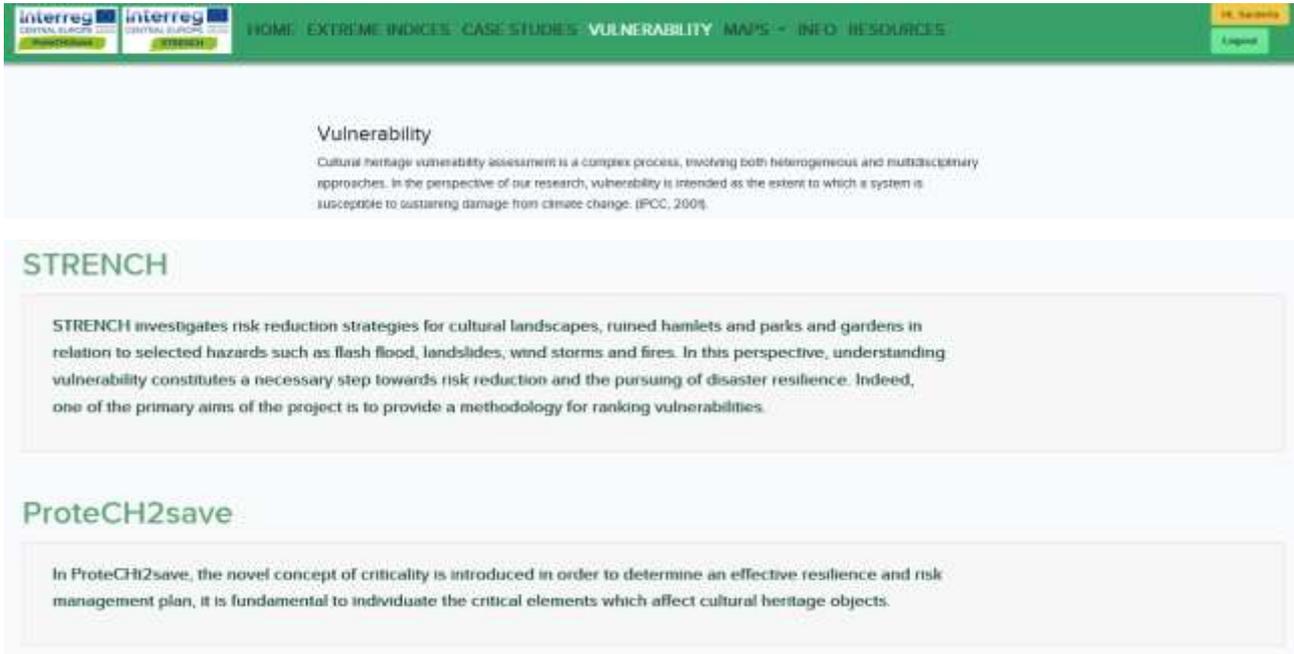
Figure 6. An example of detailed card opened for the German case study.

2.5. Vulnerability

The vulnerability section contains the methodology developed for vulnerability ranking of cultural heritage categories exposed to extreme climate events and the rate of vulnerability of all pilot sites investigated in ProtetCht2save and STRENCH projects.

In this page, after a brief general introduction, the methodology of vulnerability assessment implemented in both projects ProteCht2save and STRENCH is presented and accessible to the users clicking on each box respectively (Fig. 7).

In addition, for each case study where the vulnerability assessment has been carried out at local level, there is the possibility to visualize on line the preliminary result of the vulnerability assessment and also to download the related document in pdf format.

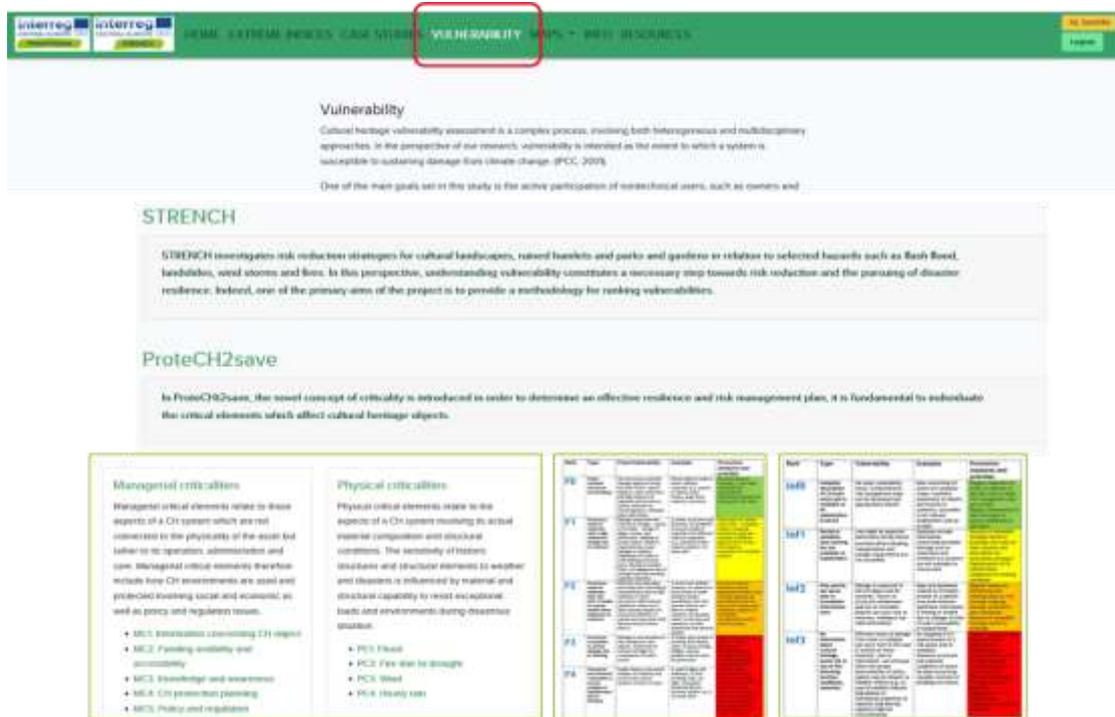



Vulnerability
 Cultural heritage vulnerability assessment is a complex process, involving both heterogeneous and multidisciplinary approaches. In the perspective of our research, vulnerability is intended as the extent to which a system is susceptible to sustaining damage from climate change. (IPCC, 2001).

STRENCH
 STRENCH investigates risk reduction strategies for cultural landscapes, ruined hamlets and parks and gardens in relation to selected hazards such as flash flood, landslides, wind storms and fires. In this perspective, understanding vulnerability constitutes a necessary step towards risk reduction and the pursuing of disaster resilience. Indeed, one of the primary aims of the project is to provide a methodology for ranking vulnerabilities.

ProteCH2save
 In ProteCH2save, the novel concept of criticality is introduced in order to determine an effective resilience and risk management plan, it is fundamental to individuate the critical elements which affect cultural heritage objects.

Figure 7. Extract from the Vulnerability page of the website that illustrates the two box related to the two projects.



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 Cultural heritage vulnerability assessment is a complex process, involving both heterogeneous and multidisciplinary approaches. In the perspective of our research, vulnerability is intended as the extent to which a system is susceptible to sustaining damage from climate change. (IPCC, 2001).
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Managerial criticalities
 Managerial critical elements relate to those aspects of a CH system which are not connected to the physicality of the asset but rather to its operators, administration and use. Managerial critical elements therefore include how CH environments are used and protected (tourism, social and economic), as well as policy and regulatory issues.

- MC1: Information concerning CH object
- MC2: Funding availability and accessibility
- MC3: Knowledge and awareness
- MC4: CH protection planning
- MC5: Policy and regulation

Physical criticalities
 Physical critical elements relate to the aspects of a CH system involving its actual material composition and structural conditions. The severity of historic structures and structural elements to weather and disasters is influenced by material and structural capacity to resist exogenous loads and environments during disaster events.

- PC1: Flood
- PC2: Fire risk to be thought
- PC3: Wind
- PC4: Heavy rain

ID	Type	Vulnerability	Criticality	Resilience
01
02
03
04
05
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Figure 8. Extract from the ProteCH2save methodology for the ranking of vulnerability

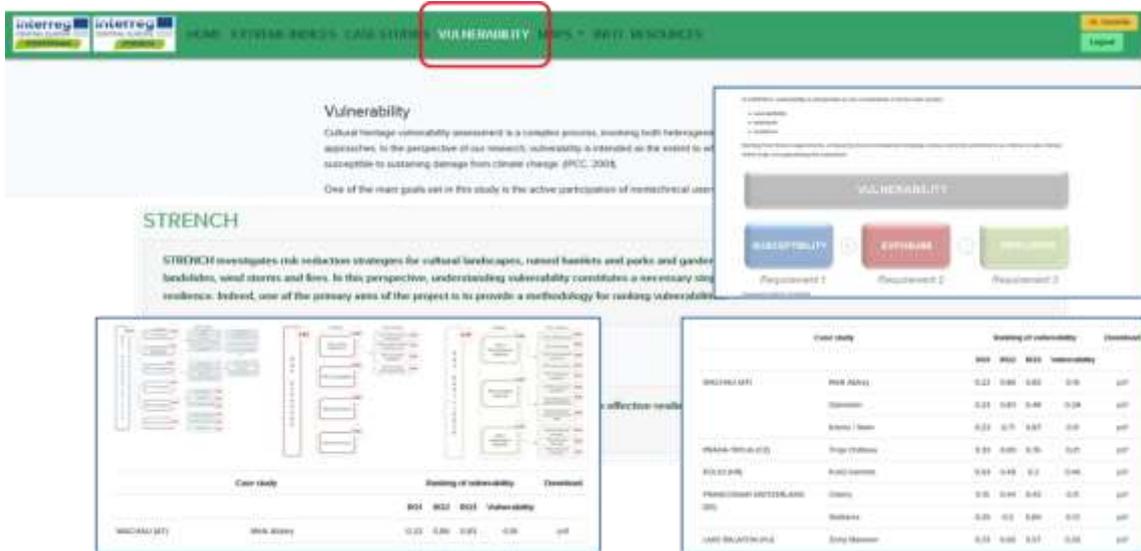
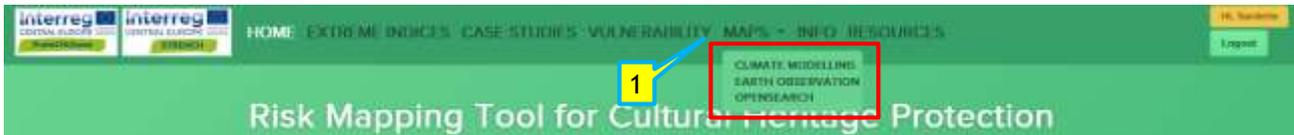


Figure 8. Extract from the STRENCH methodology for the ranking of vulnerability

2.6. Maps

The tools created to visualize and download climate maps, time series and data, are included in the “MAPS” page **1**.

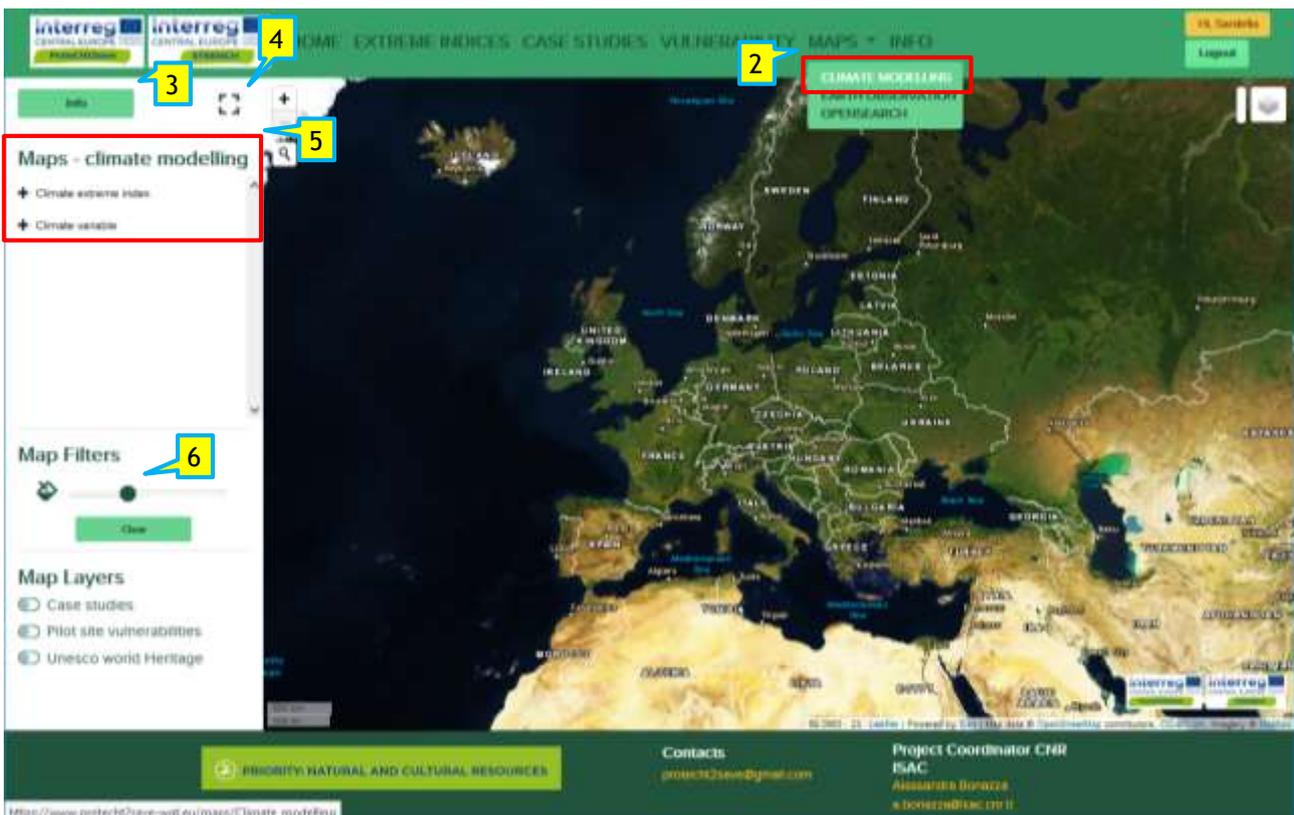


1 Tab for the selection the tool in the “MAPS” menu: Climate modelling, Earth observation and Open search.

2.6.1. Climate modelling

Map setting box

2 Select CLIMATE MODELLING in the MAPS menu in order to open the corresponding maps tool.



3 First. Click the “ Info ” button for more detail about Methodology applied. This step is mandatory before to continue to set the option for the creation of the climate maps.



MAPS PRODUCTION BY CLIMATE MODELLING

3 Hazard maps referring to heavy rain, flooding, drought, and extreme heat were elaborated covering the European and Mediterranean areas calculating climate extreme precipitation and temperature indices using data from the selected combination of models.

Methodology

Numerical climate model simulations have been analyzed to study the possible future evolution of the climate system. In particular, an ensemble of global climate models (GCMs) driving an ensemble of regional climate models (RCMs) was used to provide regional projections for the European continent.

Multi-model ensembles of regional climate projections are based on the [WCRP Coordinated Regional Downscaling Experiment \(CORDEX\)](#), an internationally coordinated effort aiming to harmonize the evaluation of state-of-the-art regional climate models (RCMs) and to generate multi-model ensembles of regional climate projections worldwide.

A sub-ensemble of the CORDEX framework is the [EURO-CORDEX](#) initiative, which provides regional climate projections for Europe at two different spatial resolutions, namely the "standard" resolution of 0.44 degrees (EUR-44, ~50 km) and a finer resolution of 0.11 degrees (EUR-11, ~12 km).

Within ProteCH2saveProject the Euro-CORDEX simulations at 0.11° resolution have been selected among those available and 12 different combinations of 6 global models driving 5 regional models were taken into account to elaborate the maps related to the future projections (Tab.1)

Table 1 numerical models applied in ProteCH2save

Combination	G5	GCM	R5	RCM
1	CNRM-CERFACS	CNRM-CM5	CLMcom	CCLM4-8-17
2	CNRM-CERFACS	CNRM-CM5	SMHI	RCA4
3	ICHEC	EC-EARTH	CLMcom	CCLM4-8-17
4	ICHEC	EC-EARTH	DMI	HIRHAM5

4 Click to enlarge or narrow the width of the setting box.

5 Climate index/variable setting option for maps - climate modelling. Click on + at the left to open and visualize the list of the Climate extreme indices and Climate variables present in this map tool.

List of the 5 climate extreme indices elaborated:



Maps - climate modelling

- Climate extreme index**
- + Highest 5-day precipitation amount - Rx5day
- + Maximum number of consecutive dry days - CDD
- + Percentage of extremely warm days - Tx90p
- + Precipitation due to extremely wet days - R95pTOT
- + Very heavy precipitation days - R20mm
- + Climate variable

List of the 3 climate variables elaborated:

Maps - climate modelling

- + Climate extreme index
- Climate variable**
- + Daily cumulated precipitation - RR
- + Daily maximum temperature - Tx
- + Daily minimum temperature - Tn

Climate extreme index includes 5 indices. Clicking on **+** of a climate extreme index or variable of interest and listed in this box (index in green in this example) further setting option will be available. First of all the “Time coverage”: “Future projections” and “Historical observations”.

Map for Historical observation is immediately available clicking on  **Historical observations** :

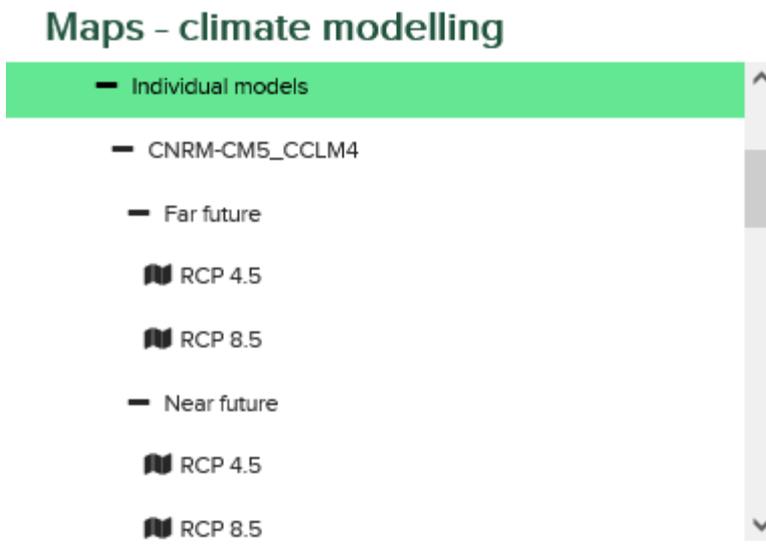
Maps - climate modelling

- Climate extreme index
- Highest 5-day precipitation amount - Rx5day**
- Time coverage
- Future projections
- + Individual models
- + Model ensemble statistics
-  **Historical observations**

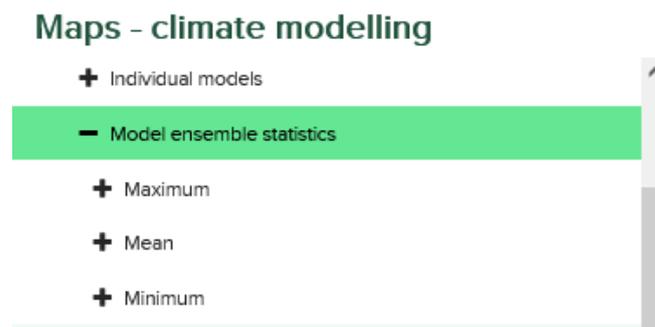


Considering the “Future projections” it is possible to select between “Individual models” and “Model ensemble statistics” (click “INFO” button [3](#) for detailed information on both the combination of the individual models elaborated and the model ensemble statistics).

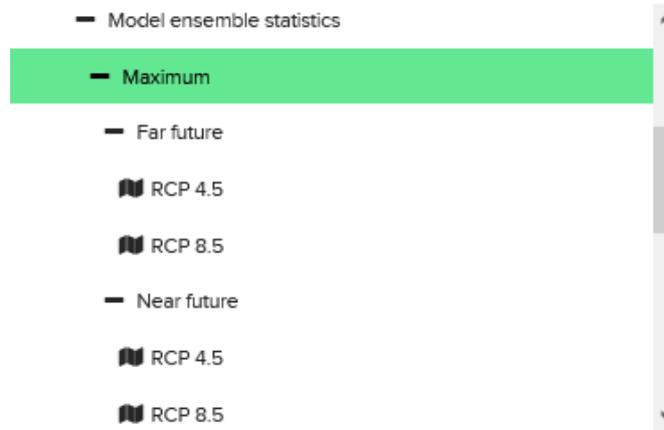
Clicking on + of “Individual models” a list of the 12 model combination is provided. Selecting only one of them and clicking on + at the left of the name (e.g. CNRM-CM5_CCLM4) other two option are available: “Near future” and “Far future”. For each of them two maps are plotted and immediately available clicking respectively on  RCP 4.5 and  RCP 8.5 .



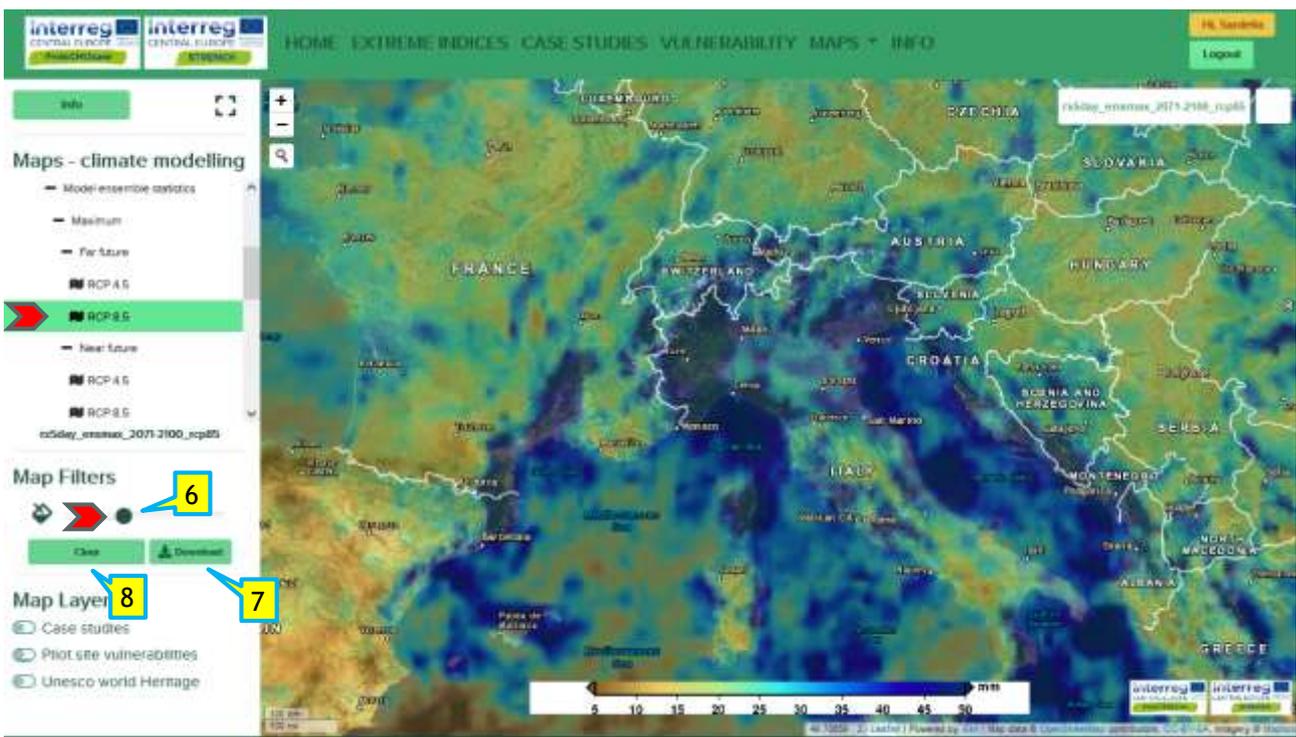
Also in the case of “Model ensemble statistics”, maps for “Near future” and “Far future” under two RCPs scenario (4.5 and 8.5) are available and elaborated for 3 different ensemble statistics: “Maximum”, “Mean” and “Minimum”.



Maps - climate modelling



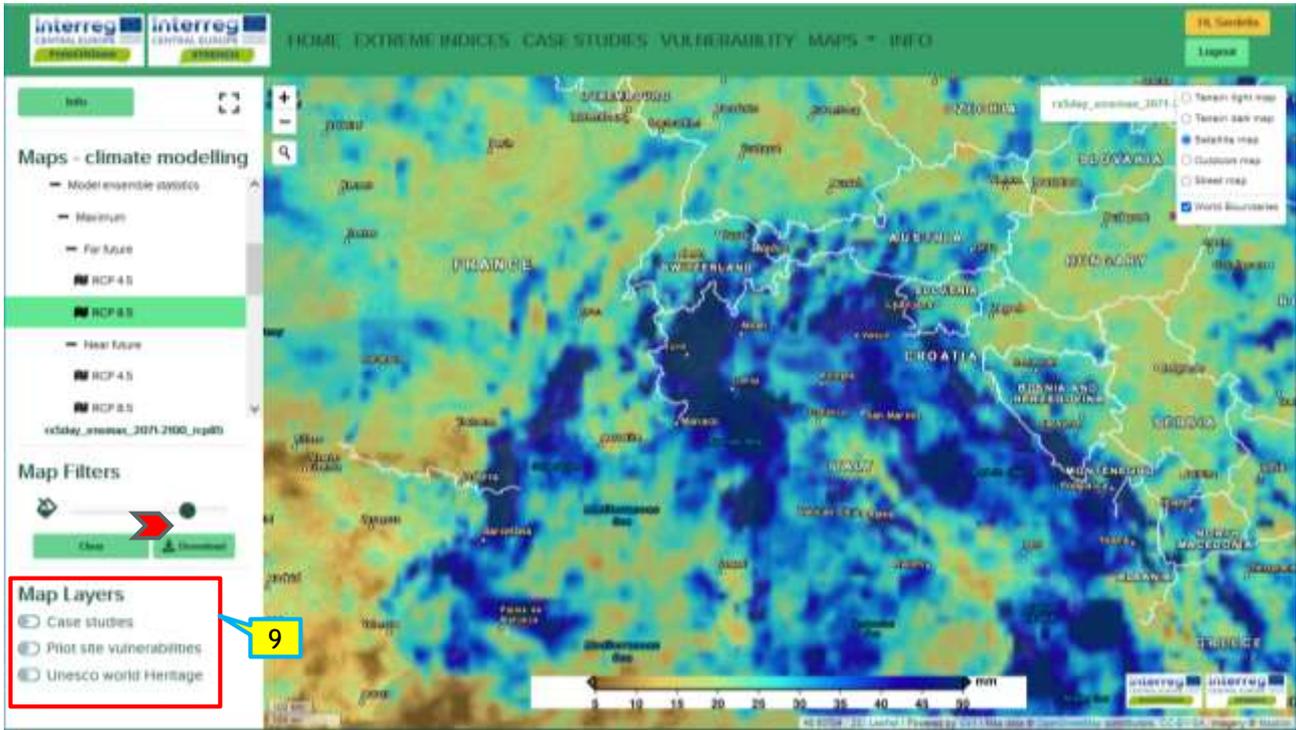
As the final step of the selection, for both climate extreme index and variable, clicking on each RCPs with the symbol RCP it is possible to create the related map, as follows:



The figure represents an example of a map created by selecting RCP 8.5 in the “Far future” for “Maximum” of “Model ensemble statistics” related to “Rx5day” extreme index.

After that the map has been visualized on the screen:

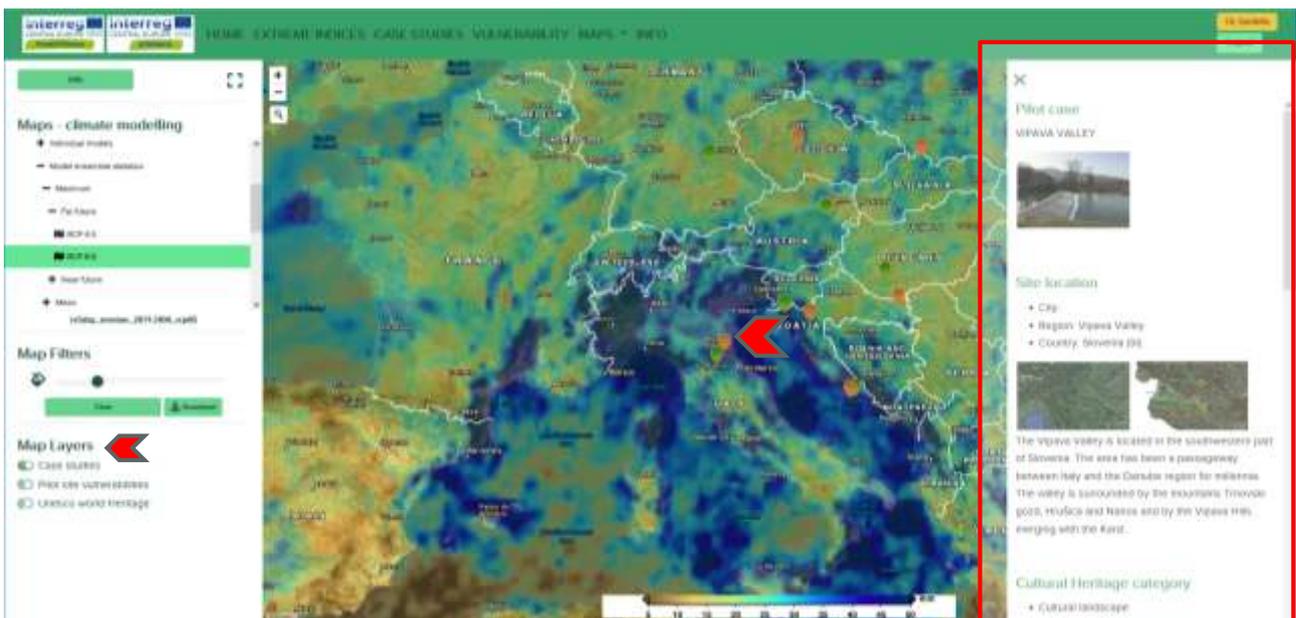
- 6** Move the green dot of the Map filters option in order to change the transparency of the map colours



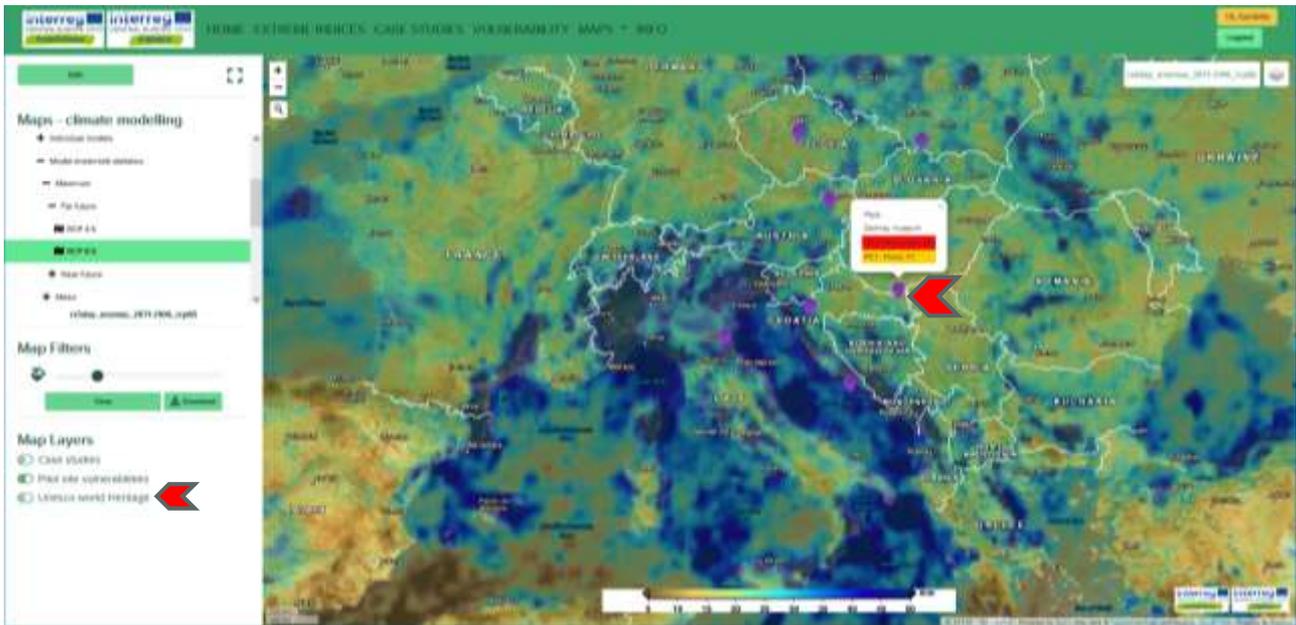
7 Click to download the visualized map.

8 Click “Clear” button to reset both setting box and map window.

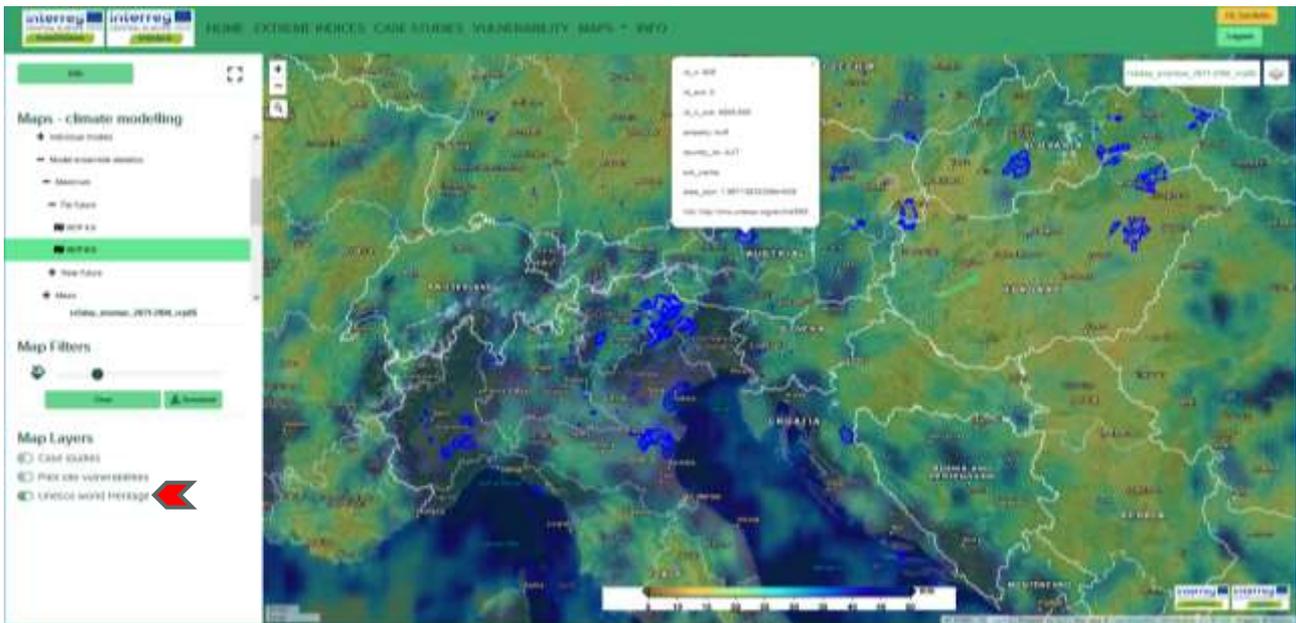
9 In the Map Layers box it is possible to switch on and off supplementary layers containing detailed information on the project case study and their vulnerability and a layer related to the distribution of UNESCO World Heritage Sites (data from JPI-CH PROTHEGO Project).



Switch on the Case studies layer. Clicking on the icons in the visualized map a card with detailed information on the case studies selected will be displayed on a new box on the right of the map

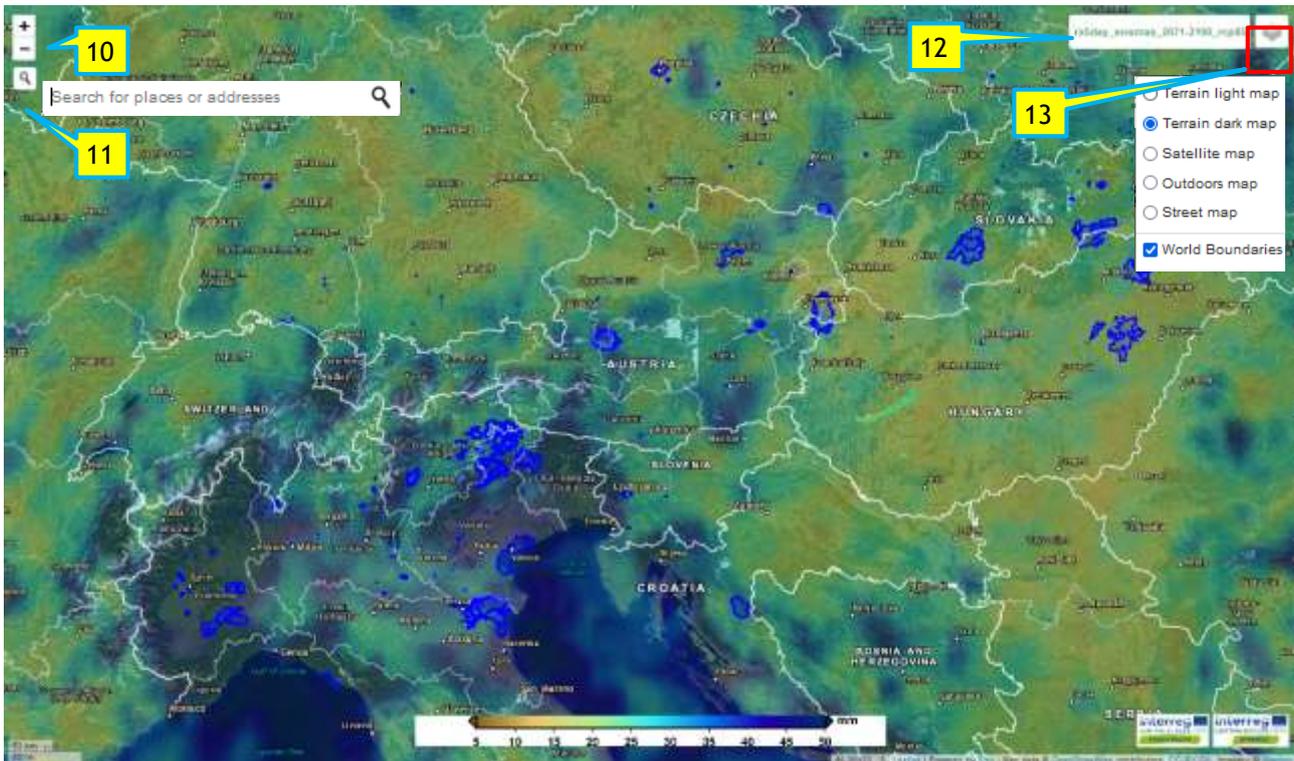


Switch on the Pilot site vulnerabilities layers. Clicking on the icons in the visualized map information related to the vulnerability of the pilot sites will be provided.



Switch on the UNESCO World Heritage layer to visualize on the map the boundaries of the World Heritage Sites.

Map Visualization window

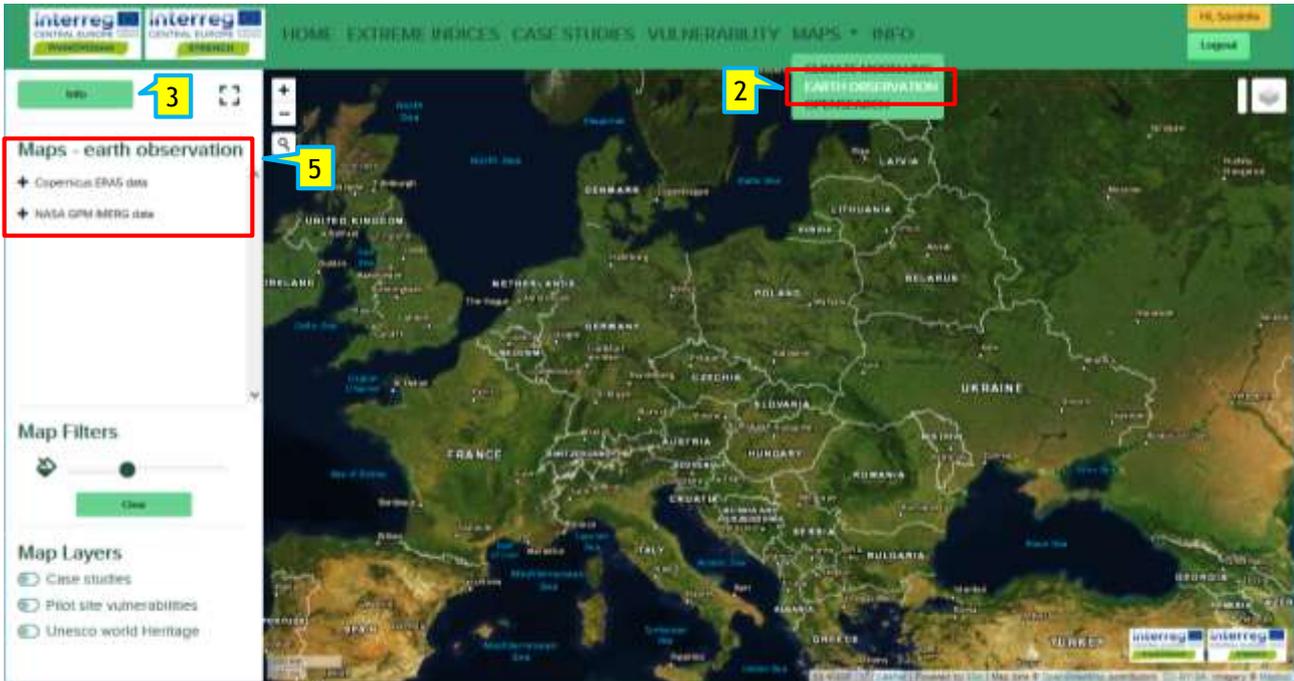


- 10** Zoom in/out.
- 11** Search for place or addresses (search is available only for the map boundary within the window).
- 12** Name of the map produced.
- 13** Visualization option to change the base map.

2.6.2. Earth Observation

Map setting box

2 Select EARTH OBSERVATION in the MAPS menu in order to open the corresponding maps tool.



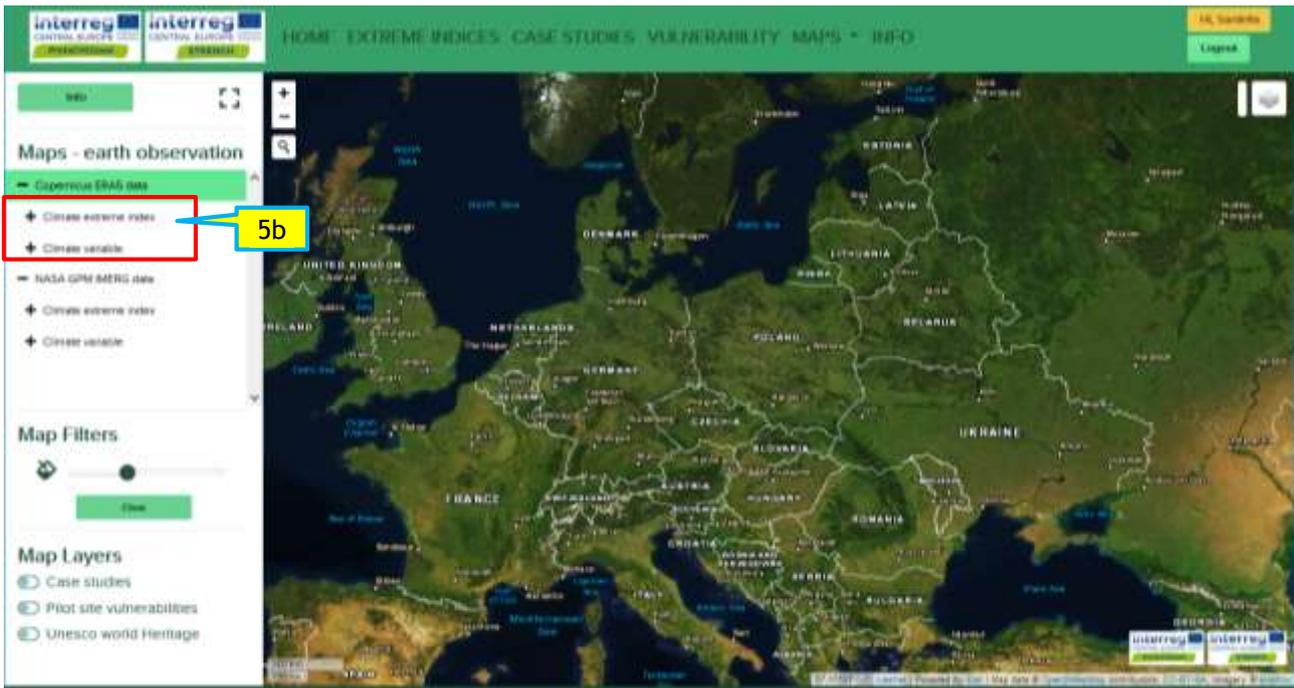
3 First. Click the “ Info ” button for more detail about Methodology applied. This step is mandatory before to continue to set the option for the creation of the climate maps.





5 Setting box related to the selected map tool. In this box it possible to explore and visualize map related to the different earth observation dataset used to climate index calculation selecting between Copernicus ERA5 or NASA GPM IMERG. See more detail clicking on the info button **3**.

5b Click **+** to visualize the list of the Climate extreme indices and Climate variables related to the selected dataset. The procedure for maps visualization is similar to the one explained climate modelling action.



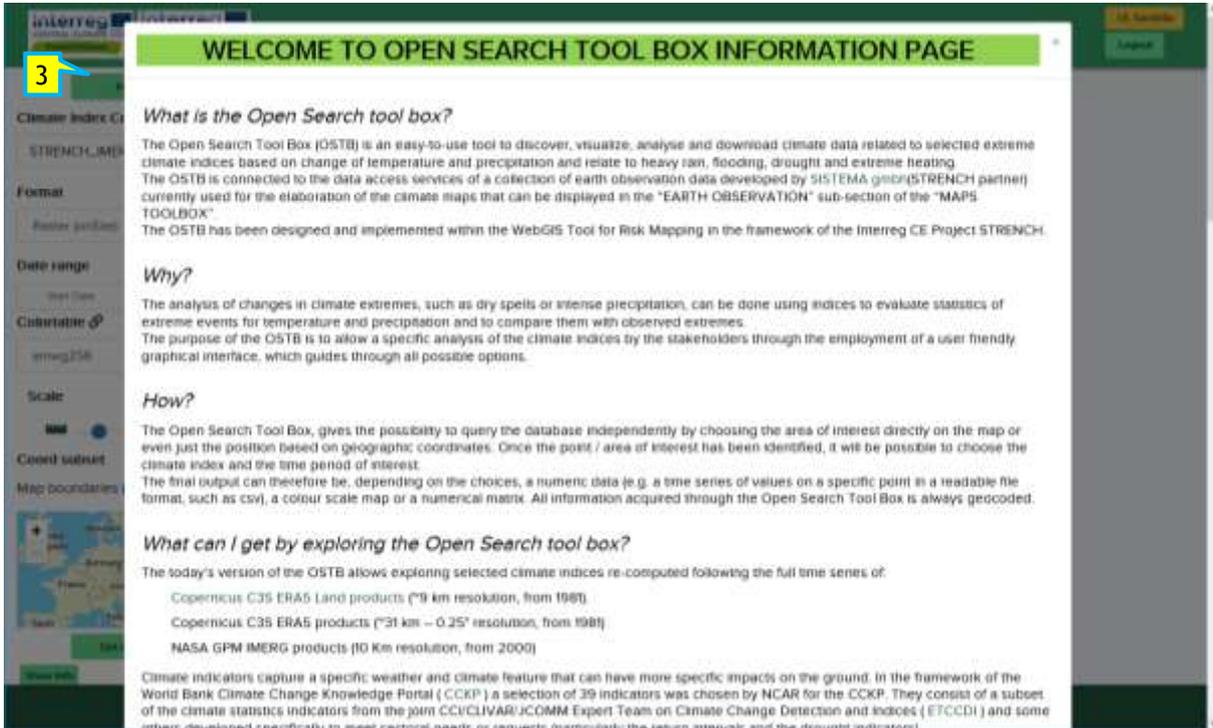
2.6.3. Open search





2 Select OPEN SEARCH in the MAPS menu in order to open the corresponding maps tool.

3 First. Click the “ Info ” button for more detail about Methodology applied. This step is mandatory before to continue to set the option for the creation of the climate maps.



WELCOME TO OPEN SEARCH TOOL BOX INFORMATION PAGE

What is the Open Search tool box?
 The Open Search Tool Box (OSTB) is an easy-to-use tool to discover, visualize, analyse and download climate data related to selected extreme climate indices based on change of temperature and precipitation and relate to heavy rain, flooding, drought and extreme heating. The OSTB is connected to the data access services of a collection of earth observation data developed by SISTEMA gislab(STRENCH partner) currently used for the elaboration of the climate maps that can be displayed in the 'EARTH OBSERVATION' sub-section of the 'MAPS TOOLBOX'. The OSTB has been designed and implemented within the WebGIS Tool for Risk Mapping in the framework of the Interreg CE Project STRENCH.

Why?
 The analysis of changes in climate extremes, such as dry spells or intense precipitation, can be done using indices to evaluate statistics of extreme events for temperature and precipitation and to compare them with observed extremes. The purpose of the OSTB is to allow a specific analysis of the climate indices by the stakeholders through the employment of a user friendly graphical interface, which guides through all possible options.

How?
 The Open Search Tool Box, gives the possibility to query the database independently by choosing the area of interest directly on the map or even just the position based on geographic coordinates. Once the point / area of interest has been identified, it will be possible to choose the climate index and the time period of interest. The final output can therefore be, depending on the choices, a numeric data (e.g. a time series of values on a specific point) in a readable file format, such as csv), a colour scale map or a numerical matrix. All information acquired through the Open Search Tool Box is always geocoded.

What can I get by exploring the Open Search tool box?
 The today's version of the OSTB allows exploring selected climate indices re-computed following the full time series of:
 Copernicus C3S ERA5 Land products (°9 km resolution, from 1980)
 Copernicus C3S ERA5 products (°31 km – 0.25° resolution, from 1980)
 NASA GPM IMERG products (10 Km resolution, from 2000)

Climate indicators capture a specific weather and climate feature that can have more specific impacts on the ground. In the framework of the World Bank Climate Change Knowledge Portal (CCKP) a collection of 39 indicators was chosen by NCAR for the CCKP. They consist of a subset of the climate statistics indicators from the joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI) and some other relevant indicators in more critical needs or subjects particularly the urban atmosphere and the drought indicators.

14 Select to choose the climate index, listed based on earth observation datasets IMERG - ERA5 - ERA5LAND (see INFO button for details).



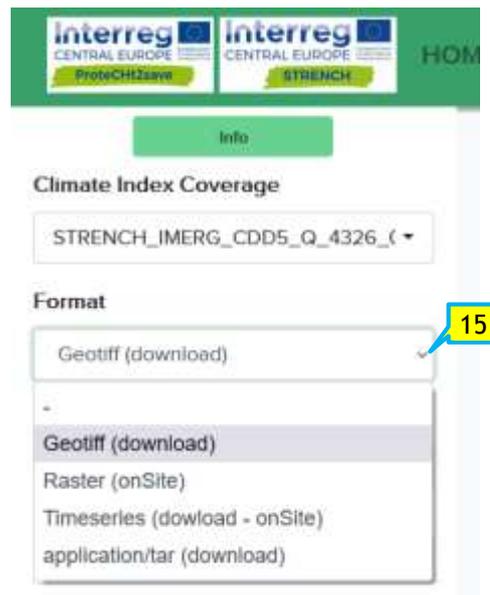
Climate Index Coverage

- STRENCH_ERASLAND_CDO5_X_4326_01
- STRENCH_MERG_CDO5_Q_4326_01
- STRENCH_MERG_995p10T_Q_4326_01
- STRENCH_MERG_RR_Q_4326_01
- STRENCH_MERG_Rx5day_Q_4326_01
- STRENCH_MERG_CDO_Q_4326_01
- STRENCH_MERG_CWD_Q_4326_01
- STRENCH_MERG_IGDmax_Q_4326_01
- STRENCH_ERAS_CDO5_Q_4326_025
- STRENCH_ERAS_HWI_Q_4326_025
- STRENCH_ERAS_995p10T_Q_4326_025
- STRENCH_ERAS_TY99p_Q_4326_025
- STRENCH_ERAS_RR_Q_4326_025
- STRENCH_ERAS_Rx5day_Q_4326_025
- STRENCH_ERAS_CDO_Q_4326_025
- STRENCH_ERAS_CWD_Q_4326_025
- STRENCH_ERAS_HWI_ERAS_Q_4326_025
- STRENCH_ERASLand_CDO5_M_4326_01
- STRENCH_ERASLand_CDO5_Q_4326_01
- STRENCH_ERASLand_CDO5_X_4326_01
- STRENCH_ERASLand_CDO_M_4326_01
- STRENCH_ERASLand_CDO_Q_4326_01
- STRENCH_ERASLand_CDO_Y_4326_01

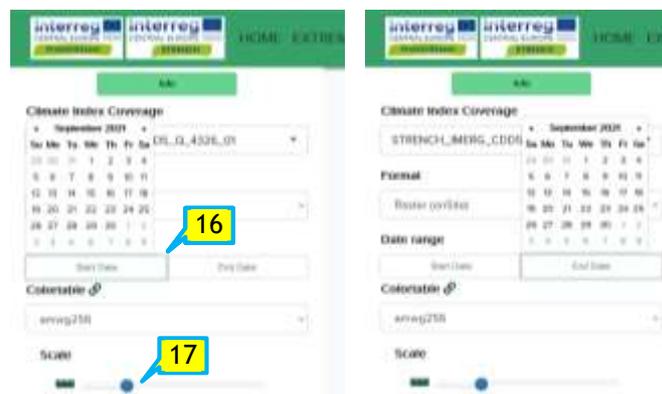


15 Select to choose the format of the outputs:

- **Geotiff** (only download) - This option allows to download the file of the data related to the visualized map in the preview window at the right of the screen. Data are downloaded in geotiff format and can be opened and managed with any GIS application.
- **Raster** (only map view - onSite) - Selecting this option, the map related to selected options done in the points 14, 16, 17, 18, 19 and 20 will be visualized in the preview window at the right of the screen. The width of the map displayed will match with the one present in the map box (once flagging to activate the map boundaries, point 19).
- **Timeseries** (graph - view onsite and download data) - This option allows to visualize and download related data of the timeseries after selecting options in the points 14, 16, and 21. Visualized and downloaded data refer only to the values present in the location defined by the pointer in the map (point 21) or by wrote the name of the location (point 22).
- **Application/tar** (only download) - Selecting this option it will be downloaded the entire set of data related to the visualized map in the preview window at the right of the screen. Data will download in tar format, can be opened and managed with any decompression program and subsequent managed with any GIS application.



16 Select **Start Date** and end **End Date** to identify the data range





17 Moving the dot in the scale bar it is possible to modify the resolution of the visualized map.



18 To change the colour table (only for raster view).

19 Flag to activate the map boundaries in order to ensure visualization/download of map/data relative to the map extension shown in the box. Without flag Map boundaries, global data will be downloaded/visualized.

20 Zoom in, zoom out

21 Centre of the map box. Move the map to place the centre on the point of interest for the Time series elaboration

22 Search tool - select to write the name of the location of interest for the time series production.

23 At the end, click on Get model to visualize

Coord subset

Map boundaries



Coord subset

Map boundaries



Get model

Coord subset

Map boundaries



Get model



Example of time series of the climate index CWD (ERA5 Land, Yearly assemblage, entire dataset) related to the city of Bologna using selection from (14), (15), (16), (22) and finally (23)



3. Methodological Approach to work with the Risk Mapping Tool for Cultural Heritage Protection

