LIFE URBANPROOF
toolkit

User Manual

«CLIMATE PROOFING URBAN MUNICIPALITIES»

LIFE Ref. No: LIFE15 CCA/CY/000086

Acknowledgements

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About the Urban Proof toolkit

The LIFE Urban Proof toolkit (hence called the Toolkit) is a powerful decision support system aimed to enable better informed decision making for climate change adaptation planning.

In specific, the user is guided though the different stages of the tool in order to gain insight into the climate change impacts to the urban environment, to explore and evaluate the available adaptation options and to investigate the effect of adaptation interventions in increasing climate change resilience. The climate change impacts assessed are those relevant to the urban context as shown in Figure 1.

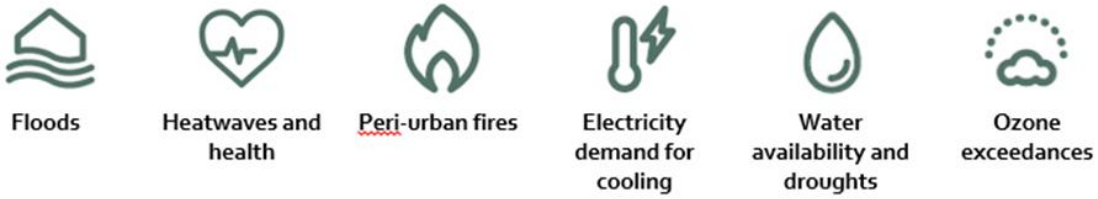


Figure 1: Climate change impacts assessed within the UrbanProof toolkit

The Toolkit provides information on climate change impacts and adaptation at geospatial level for all urban municipalities (Local Administrative Units level 2 – LAU2) of Italy, Greece and Cyprus (Figure 2), while higher resolution data are provided for the municipalities of Reggio Emilia (Italy), Peristeri (Greece) and Strovolos and Lakatamia (Cyprus) which are partners of the LIFE URBANPROOF project (Figure 2).

Figure 2:Urban municipalities of Greece, Italy and Cyprus

The Urban Proof Toolkit was designed and implemented in the framework of the project LIFE UrbanProof "Climate Proofing Urban Municipalities" which is co-financed by the LIFE program for the Environment and Climate Action (2014-2020).

The toolkit consists of 5 interdependent stages which altogether comprise the adaptation process (Figure 3).

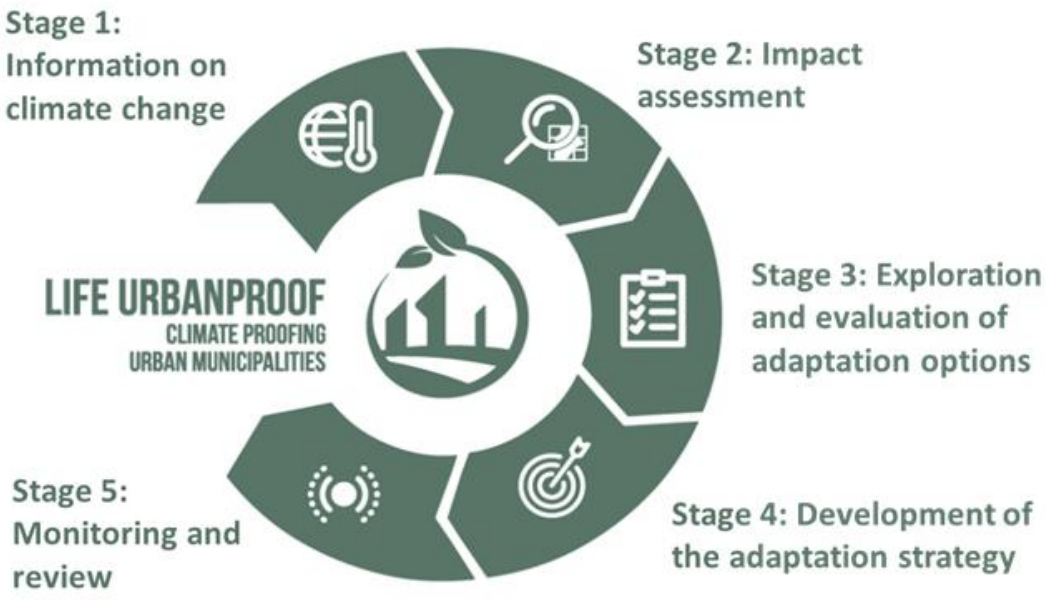


Figure 3: Stages of UrbanProof toolkit

Homepage

In order to enter the tool's homepage, type https://tool.urbanproof.eu/ in your browser's address bar.

At the homepage of the Toolkit, the user may obtain useful information on the main aims and scope of the Toolkit, as well as to navigate to the different stages of the tool. The Toolkit is available in three languages i.e. English, Greek and Italian.

The stages of the Toolkit may be accessed either through the main menu at the top of the page under the "UrbanProof toolkit" tab or by scrolling down the homepage, after the introductory text.

In the main menu, the user may also find useful material related to the Toolkit, under the respective tab. The useful material includes (i) information on the methodology used for the development of the Toolkit, the input data used and its applicability ("Methodology"), (ii) the User manual (current document) and (iii) a video on the demonstration of the Toolkit with step-by-step guidelines on its use ("Demonstration video") (Figure 4).

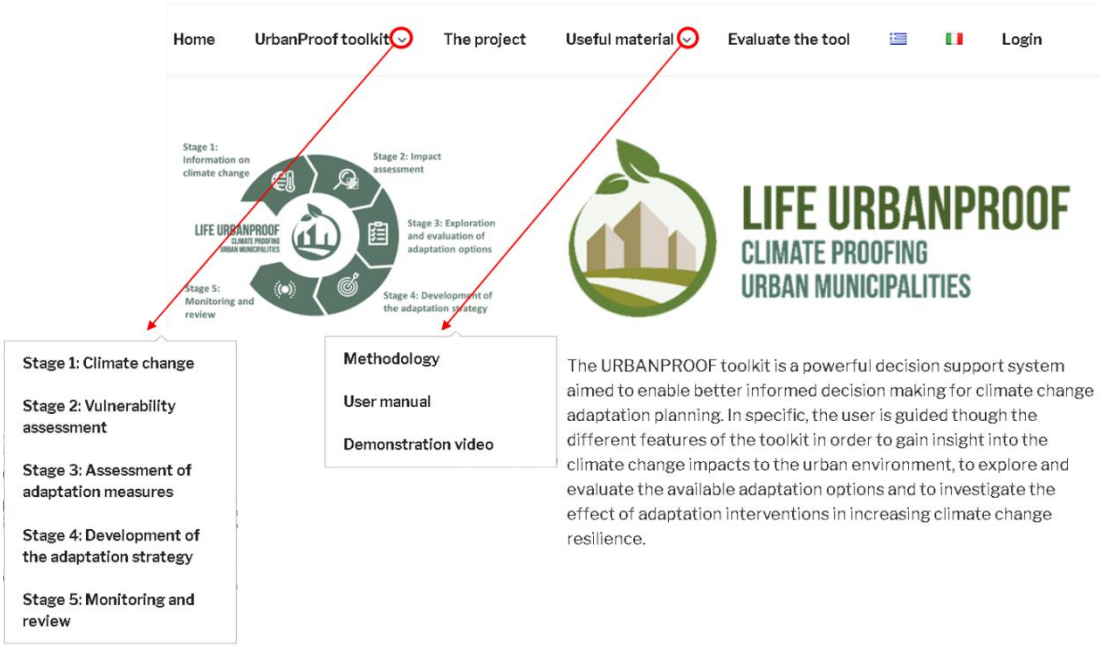


Figure 4: Home Page of the Urban Proof Tool

More information on each stage of the Toolkit is presented below

STAGE 1:Climate Change Information

By entering Stage 1, the user may explore through interactive charts, information on climatic indicators trends for the continuous period 1971-2100. Future projections based on two future emission scenarios namely RCP4.5 and RCP8.5 (Representative Concentration Pathways-RCP).

The user may enter Stage 1, by clicking at the relevant link, as shown at Figure 5.

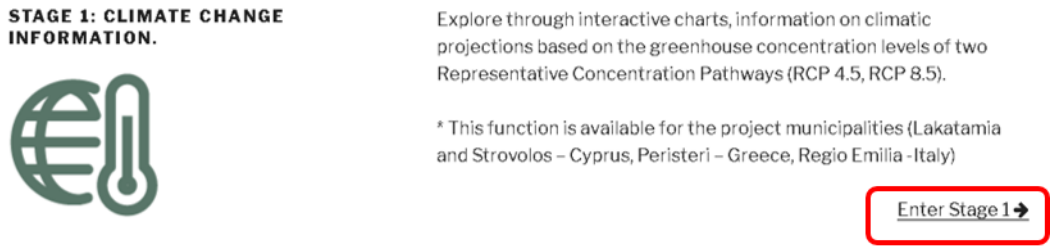


Figure 5:Enter Stage 1

To explore the climatic information available through Stage 1, the user should select area, climatic indicator and climatic scenario, as presented in Figure 6 that follows.

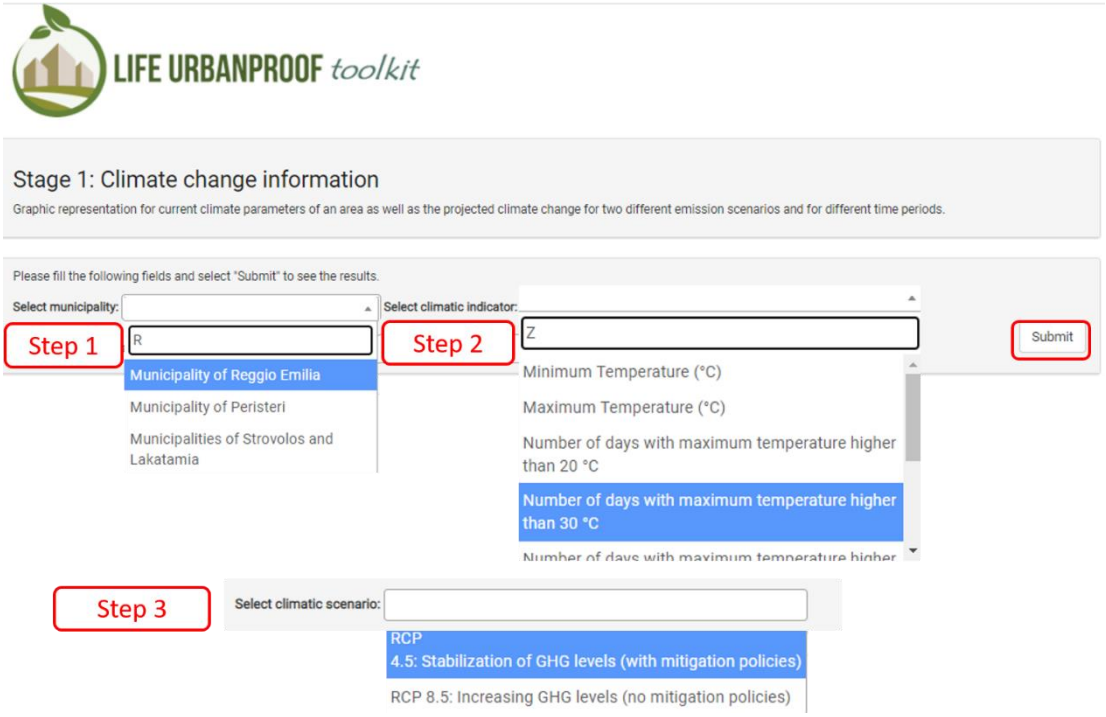


Figure 6: Steps 1,2 and 3 in Stage 1

After completing the aforementioned steps, the user selects “Submit”. Then, the requested information is presented in both graphical and tabular forms, as shown in Figure 7 that follows.

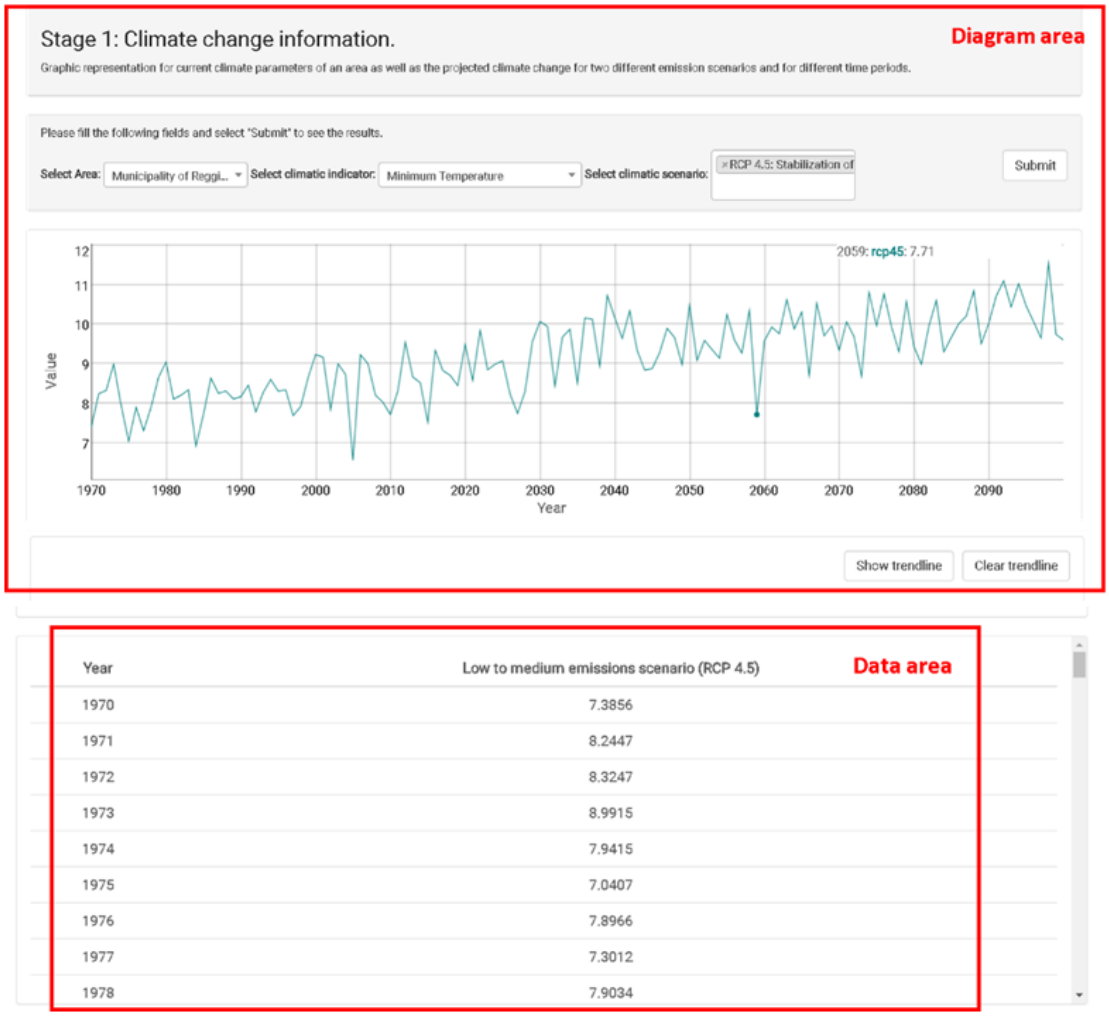


Figure 7: Selected climatic indicators for graph series

By pressing the "Show trendline" button, the trendline is shown on the chart, as follows in Figure 8.

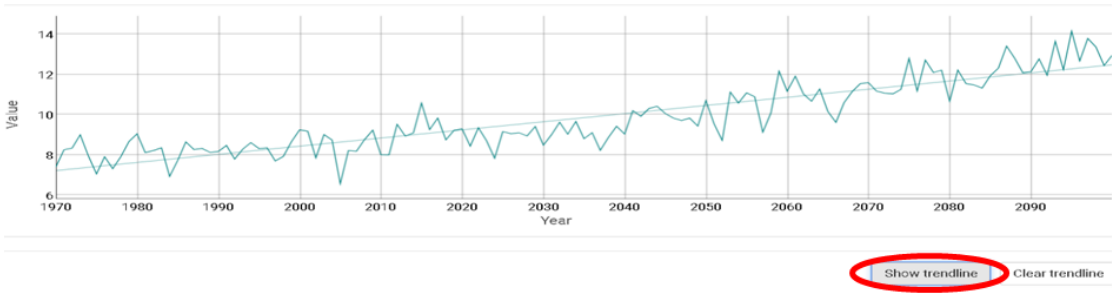
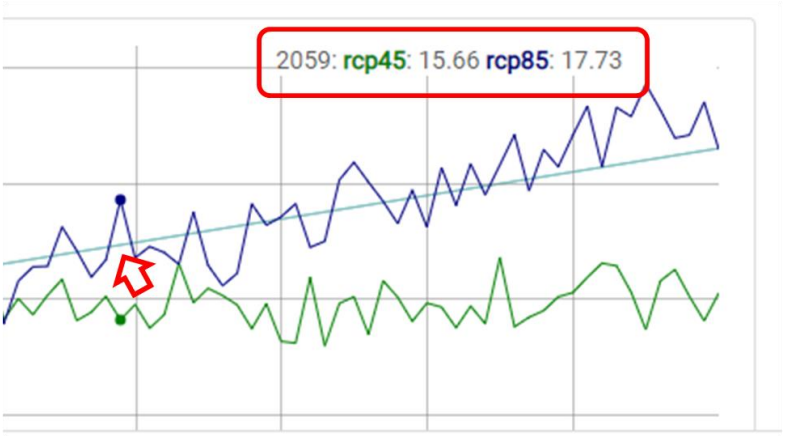


Figure 8: Graph series trendline

Area 1: The values of the selected climate parameters of Stage 1 also appear when the mouse cursor hovers across the lines in the Diagram area (Figure 9)

Area 2: The values of the selected climate parameter can be copied for any further use (Figure 9 bottom)



Year	Low to medium emissions scenario (RCP 4.5)	High emissions scenario (RCP 8.5)
1970	7.3856	7.3856
1971	8.2447	8.2447
1972	8.3247	8.3247
1973	8.9915	8.9915
1974	7.9415	7.9415
1975	7.0407	7.0407
1976	7.8966	7.8966
1977	7.3012	7.3012
1978	7.9034	7.9034

Ctrl + C

Figure 9: Top: View the values of the selected climate parameter on the diagram's line with the mouse cursor. Bottom: Copy table values to be used for other purposes

STAGE 2: Impact Assessment

In this stage, the results of the impact assessment at urban level are provided presented either geospatially through a GIS environment or through graphs (**Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**). It is noted that water availability and drought data, as well as ozone exceedance data are available only for the selected project municipalities, in contrast with the other parameters, that are applicable to all urban municipalities of Greece, Italy and Cyprus.

Urban municipalities, as defined in the UrbanProof tool, include all Level 2 Local Administrative Units (LAU2) classified as: Cities (densely populated areas) and Towns and suburbs (medium population density) (Dijkstra & Poelman 2014[1]).

To enter Stage 2, the user selects the respective impact icon that he or she wishes to examine, as shown below in Figure 10.

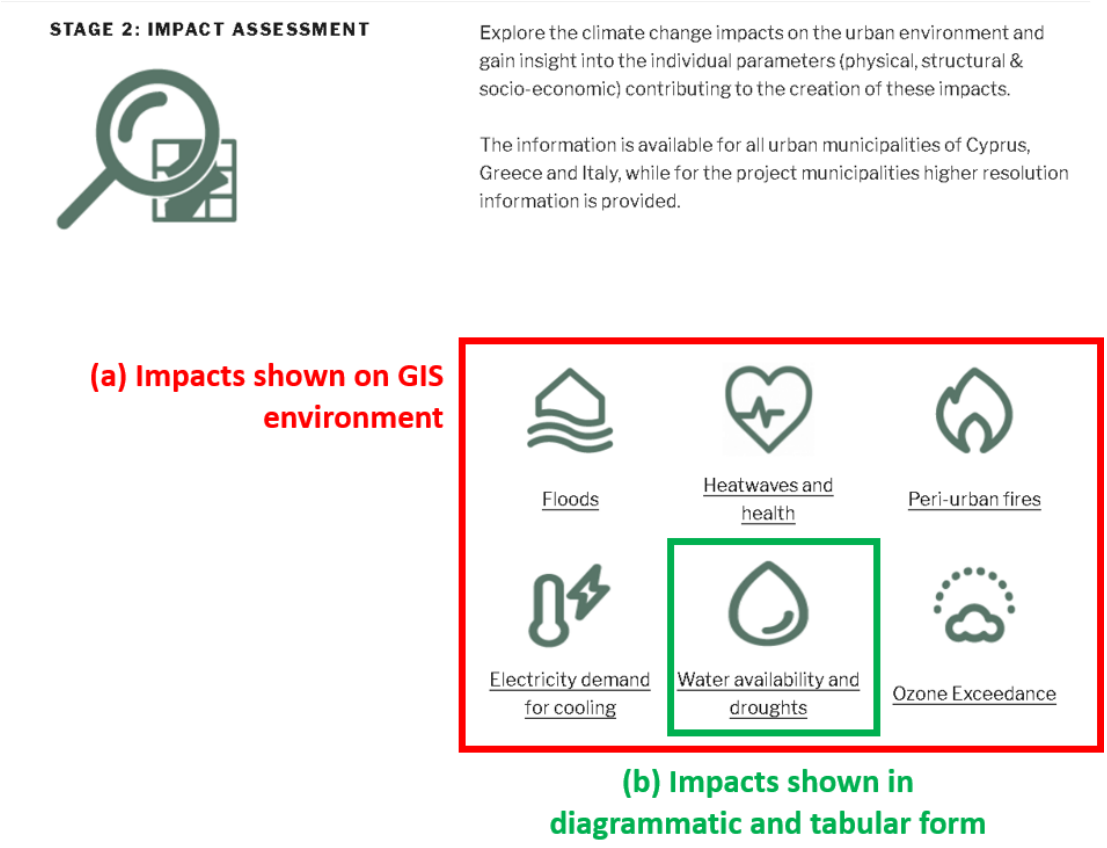


Figure 10: Stage 2, Impact Selection

[1] *Dijkstra, L., & Poelman, H. (2014). A harmonised definition of cities and rural areas: the new degree of urbanisation. Regional Working Paper 2014. Working Papers A series of short papers on regional research and indicators produced by the Directorate-General for Regional and Urban Policy. European Commission.*

a. Floods, electricity demand for cooling, ozone exceedances, peri-urban fires and heat waves and health data

By selecting one of the GIS environment displayed impact, the user is directed to the map view (Figure 11):

Left panel: on its upper part, climate change scenarios are available and below them the layer tree is shown

Center panel: the results of the users' choices are visualised on the interactive map. The interactive map section also includes a number of navigation, exploration and comparison GIS tools.

Right panel: "Search tools panel" which enables the user to view information regarding specific thematic layers, to impose topological queries, or to export data to be further used in external applications.

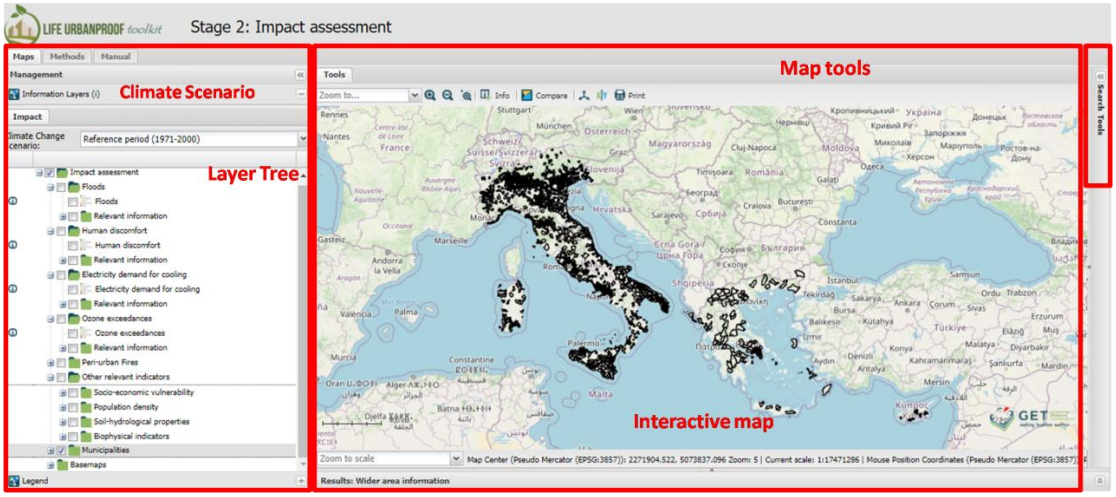


Figure 11: Map view of GIS environment

The results of the impact assessment are provided at two levels of spatial analysis:

- At urban block level, for the case of the project municipalities (Reggio Emilia, Peristeri, Strovolos, Lakatamia)
- At a resolution of 500x500m grid cells, for the case of all urban municipalities (LAU2) of Italy, Greece and Cyprus.

Steps for exploring impacts on map view

STEP 1 **Select climate change scenario from drop down menu:** the Reference period (1971-2000) represents the current climatic conditions, and the Future period (2031-2060) is based on two different Representative Concentration Pathways (RCPs):

- RCP4.5- Stabilization of GHG levels (with mitigation policies)
- RCP8.5- Increasing GHG levels (no mitigation policies)

STEP 2

Selection of impact. Tick √ the preferred impact assessment (layer) from the five main sections, (i.e. impact relevant to Floods, Human discomfort, Electricity demand for cooling, Ozone exceedances, Peri-urban fires) to make it visible on the map (Figure 14). Each section comprises of a "Relevant data" subsection which opens by pressing the **+** sign next to the folder, where particular information related to each section is shown (Figure 12).

Moreover, "Other relevant indicators" section is available at the bottom part of the layer tree, depicting socio-economic vulnerability, population density, soil-hydrological properties, as well as biophysical indicators of the examined municipalities of the LIFE UrbanProof project (Figure 13).

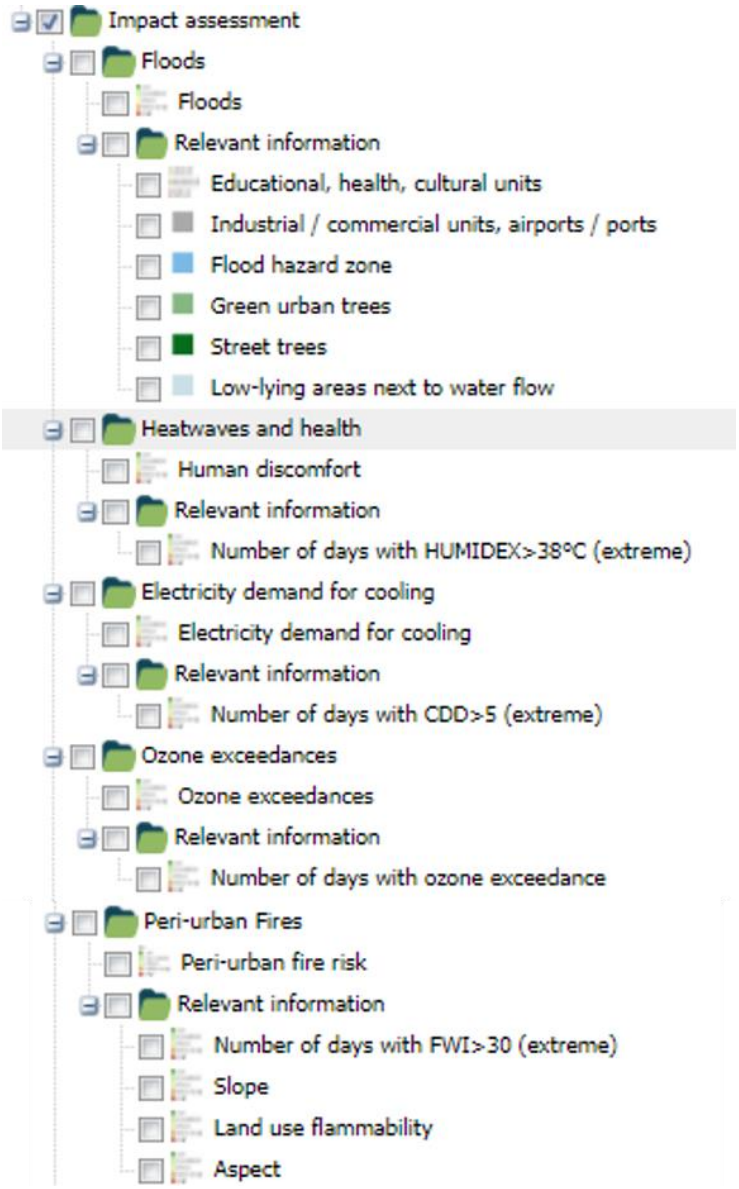


Figure 12: Relevant Impact Data

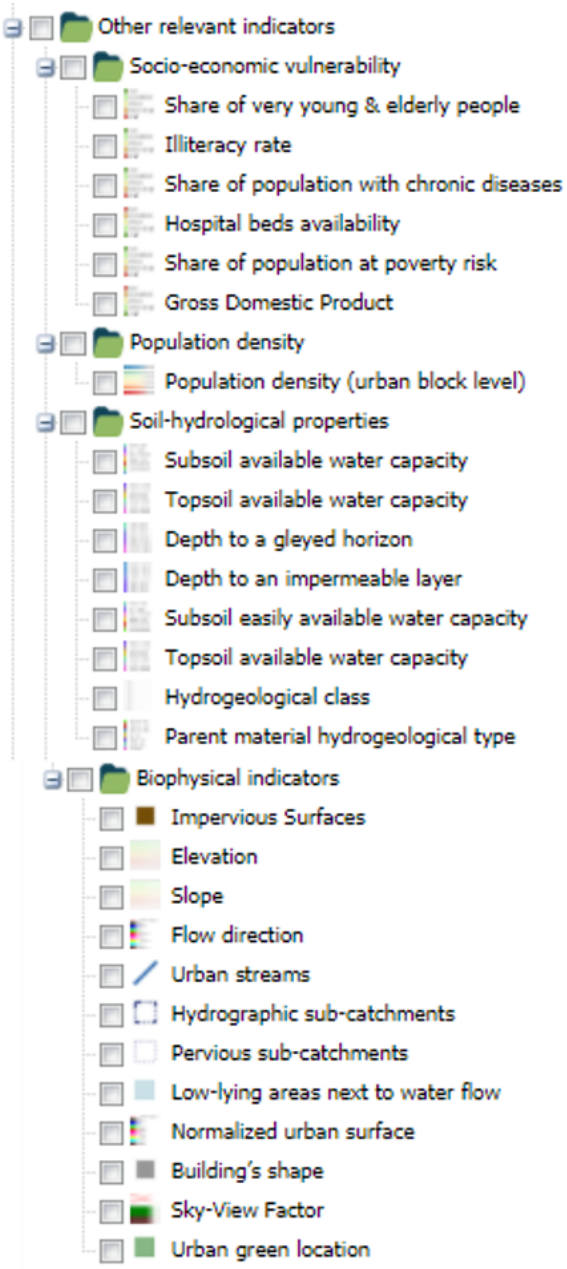


Figure 13:Other relevant indicators

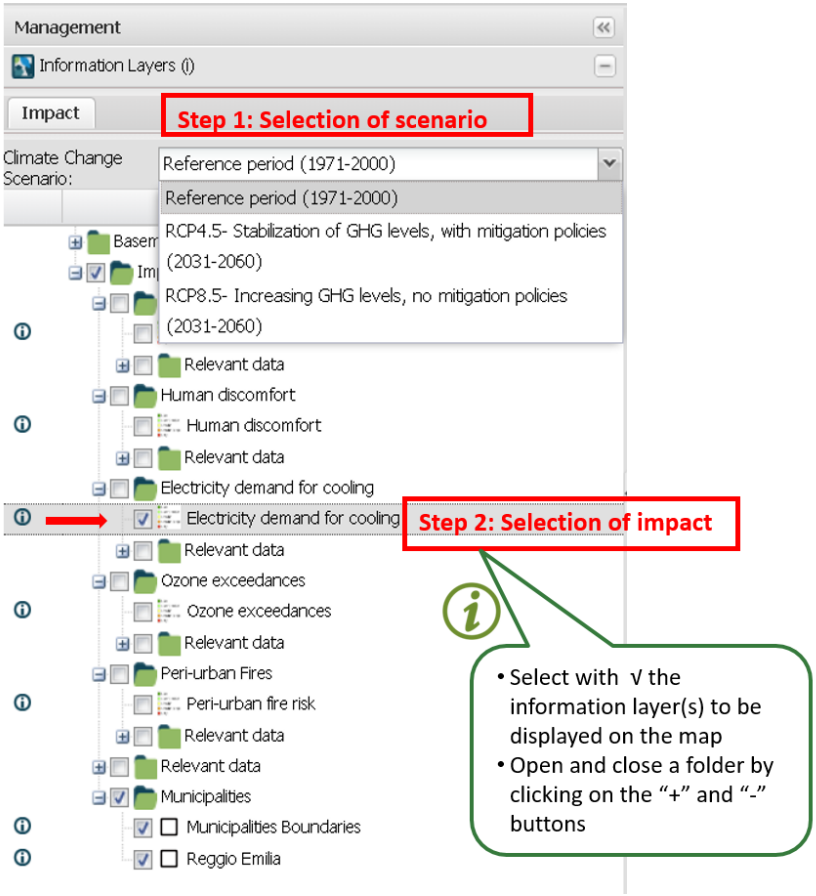


Figure 14: Steps for selecting and displaying a climatic impact

In order to see the **legend** of the layer, you can either press the "Legend" button at the bottom of the left panel, or by moving the cursor over the desired indicator. The values of the indicators shown in the Legend are displayed in 5 colour classes with 5 representing the highest impact and 1 the lowest. (Figure 15).

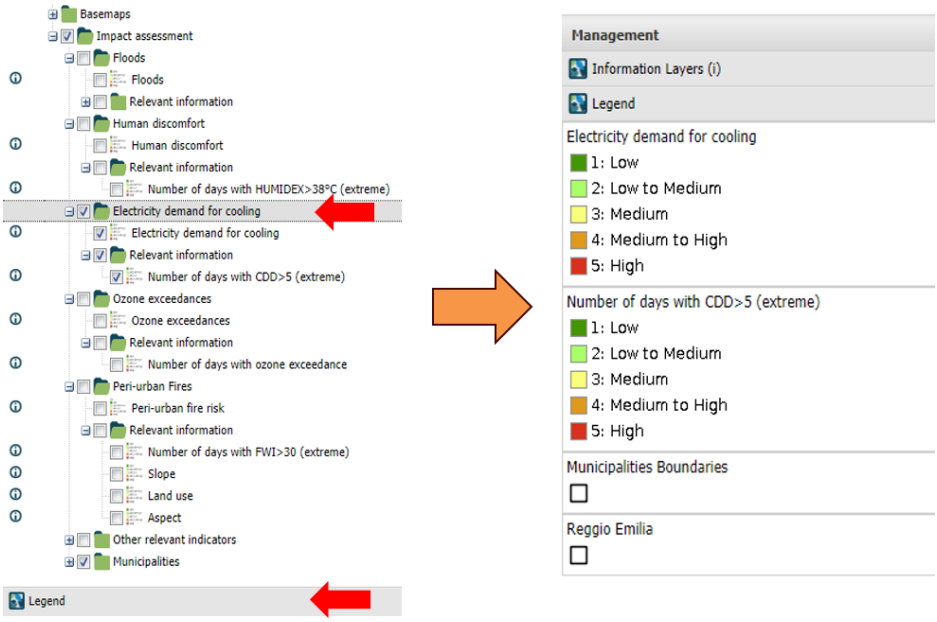


Figure 15:Layer Legend

If more than one information layers are selected, then the one that is located higher on the list is shown to the map.
If you want, you can change the **order**, of the indicators in the left panel, by clicking on the indicator and dragging it to the desired position (Figure 16).

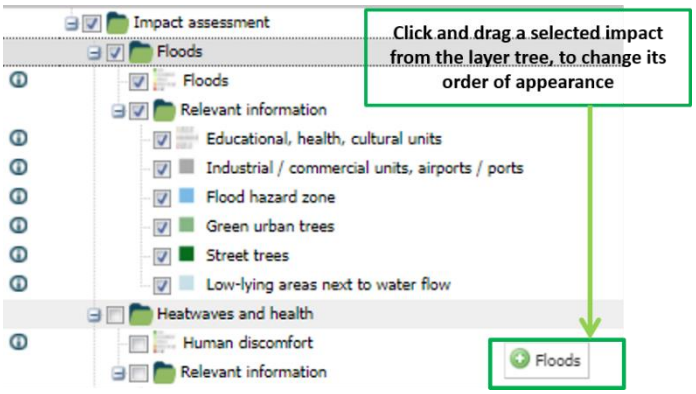


Figure 16:Change layer's order of appearance

More than one information layers may be visible on the map by adjusting the **transparency** of the selected layers (right click on each layer) and moving the cursor of the transparency bar. Moreover, by right clicking on an impact, the user may access several **layer management options** such as to zoom to the three examined countries, select the scale at which an impact will be visible on the map and to download the map in pdf or shapefile format. (Figure 17).

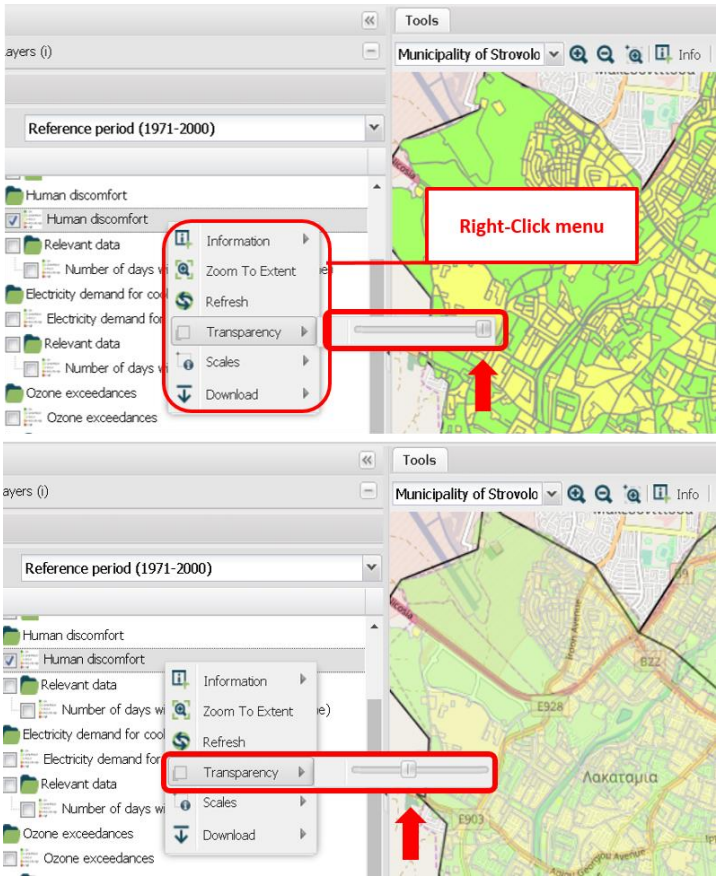


Figure 17:Change layer transparency and right click options

Map tools: Explore (Area 1) and Search (Area 2)

UrbanProof toolkit has very elegant and straightforward GIS tools, which can be used to navigate, explore, identify and compare (explore tools – Area 1), as well as to search and select elements on the map by applying specific criteria (search tools – Area 2) – (Figure 18).

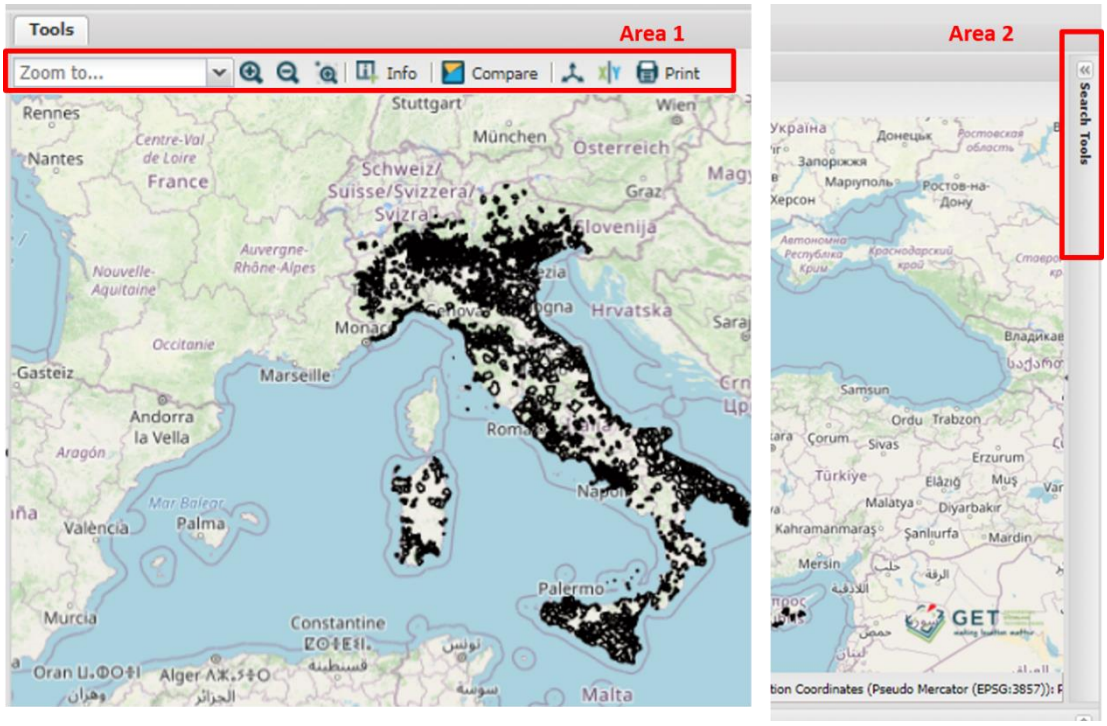


Figure 18: GIS tools provided for the better exploration of results

The elements of the toolbar

Figure 19 presents the elements of the tool bar. More information, as well as examples of the "**Info**" and the "**Compare**" functions are given below.

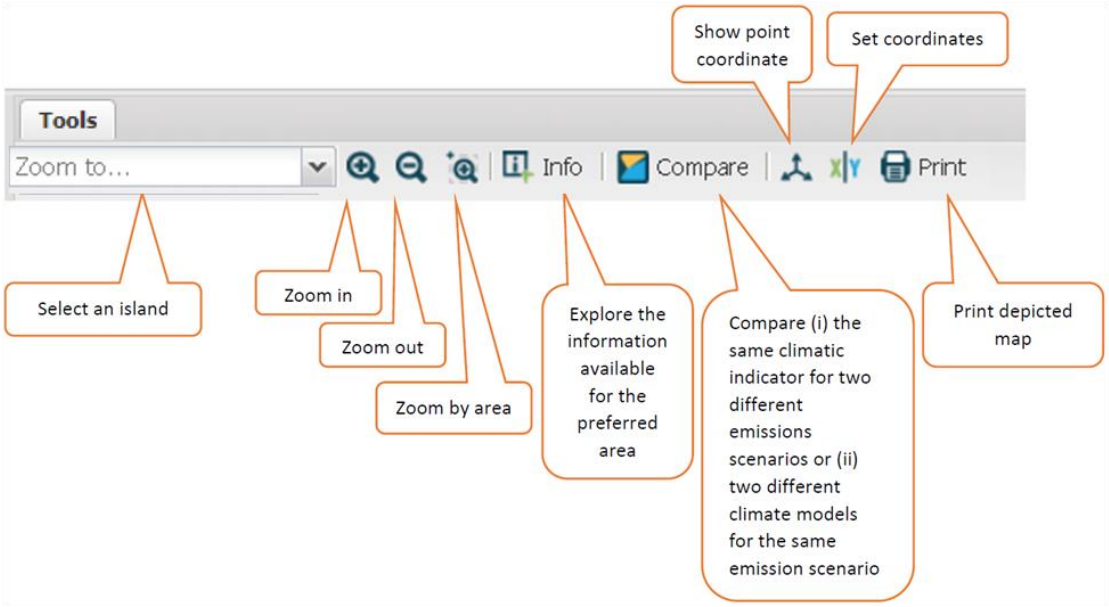


Figure 19: Navigate, explore, identify and compare tools

"Info" tool

Info is a very useful tool to explore the available information for a specific area. In the following example, which is schematically depicted in Figure 20, the user is able to find the flood impact value at any point on the map.

Case study 1: Explore the current ozone exceedance impact in the municipality of Peristeri in Greece

STEP 1: Select Scenario: Reference period (1971-2000)

STEP 2: Select with a √ impact Assessment: Ozone exceedances

STEP 3: Zoom to Municipality of Peristeri (Greece)

STEP 4: Click on "Info" button

STEP 5: Click on the point of interest in the municipality of Peristeri

Tip: In order for the selected information to be displayed, the layer Municipalities has to be deselected (Bottom folder in the layer tree panel) (Figure 20).

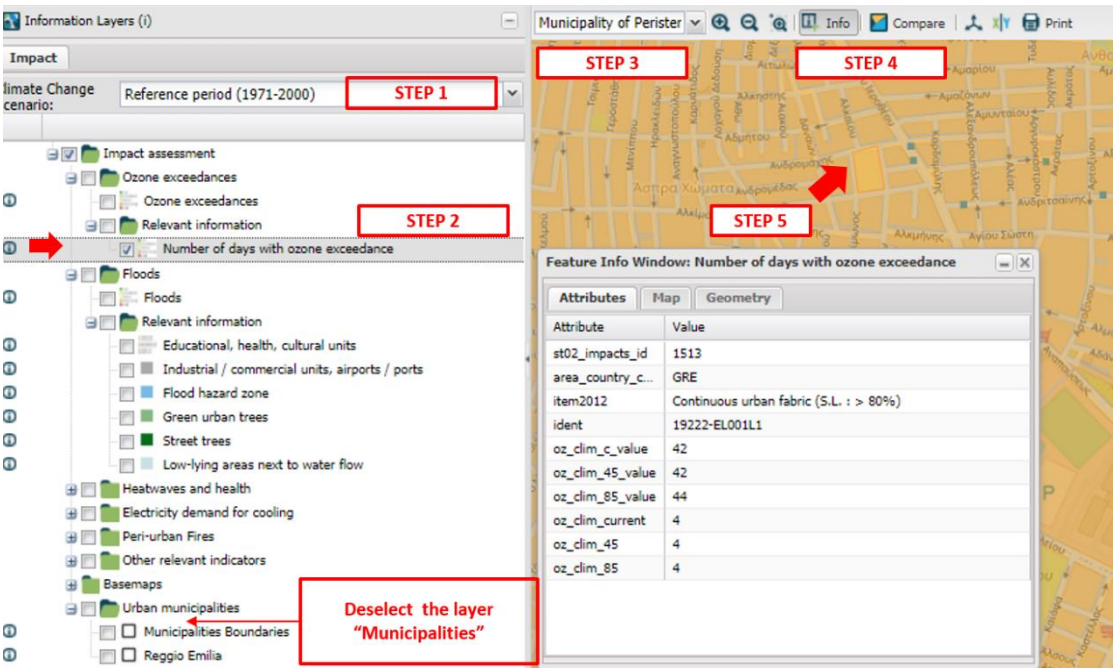


Figure 20: Example of the use of "Info" tool

As shown in Figure 20, the features related to Ozone exceedances at the chosen point are shown in the pop-up window. On the "Search Tools" panel on the right, the user may switch to view the information that is available to the rest of the selected layer's properties. Data can be downloaded in several formats, to be further used in other applications, by selecting the download button (Figure 21).

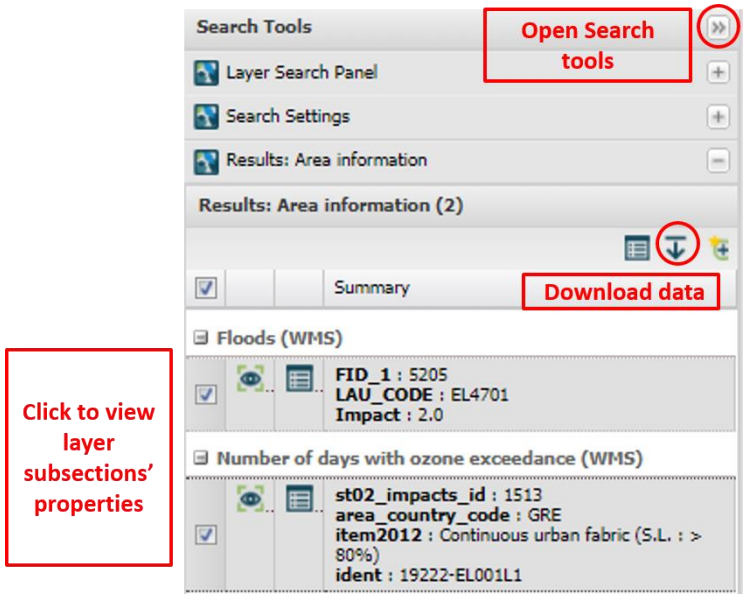


Figure 21: Switch information and download "info" data

«Compare» tool

Compare function is very useful to compare (i) the same impact for two different emissions scenarios or (ii) two different impacts for the same emission scenario. Steps for the first case are following

Case study 2: compare the Electricity demand for cooling of reference period with the respective future demand based on RCP8.5 emission scenario in the municipality of Reggio Emilia in Italy.

STEP 1: Select the preferred region: Municipality of Reggio Emilia (Italy)

STEP 2: Click the Compare button. The "Compare Layers" window appears

STEPS 3a & 3b: Select the impact: in both Steps select the "Electricity demand for cooling"

STEPS 4a & 4b: Select the scenario: In Step 4a select "Reference period" while in Step 4b select "RCP 8.5-Increasing GHG levels (no mitigation policies)"

STEP 5: Press **Compare** button

After Step 5 a red line appears in the middle of Compare window together with spatial distribution of the selected impact. Left side presents the Reference period while right side the Future period based on RCP 8.5 emissions scenario (Figure 22)

By moving the red line left and right on the map, the user may compare the two different cases for the municipality of Reggio Emilia, as shown in (Figure 23).

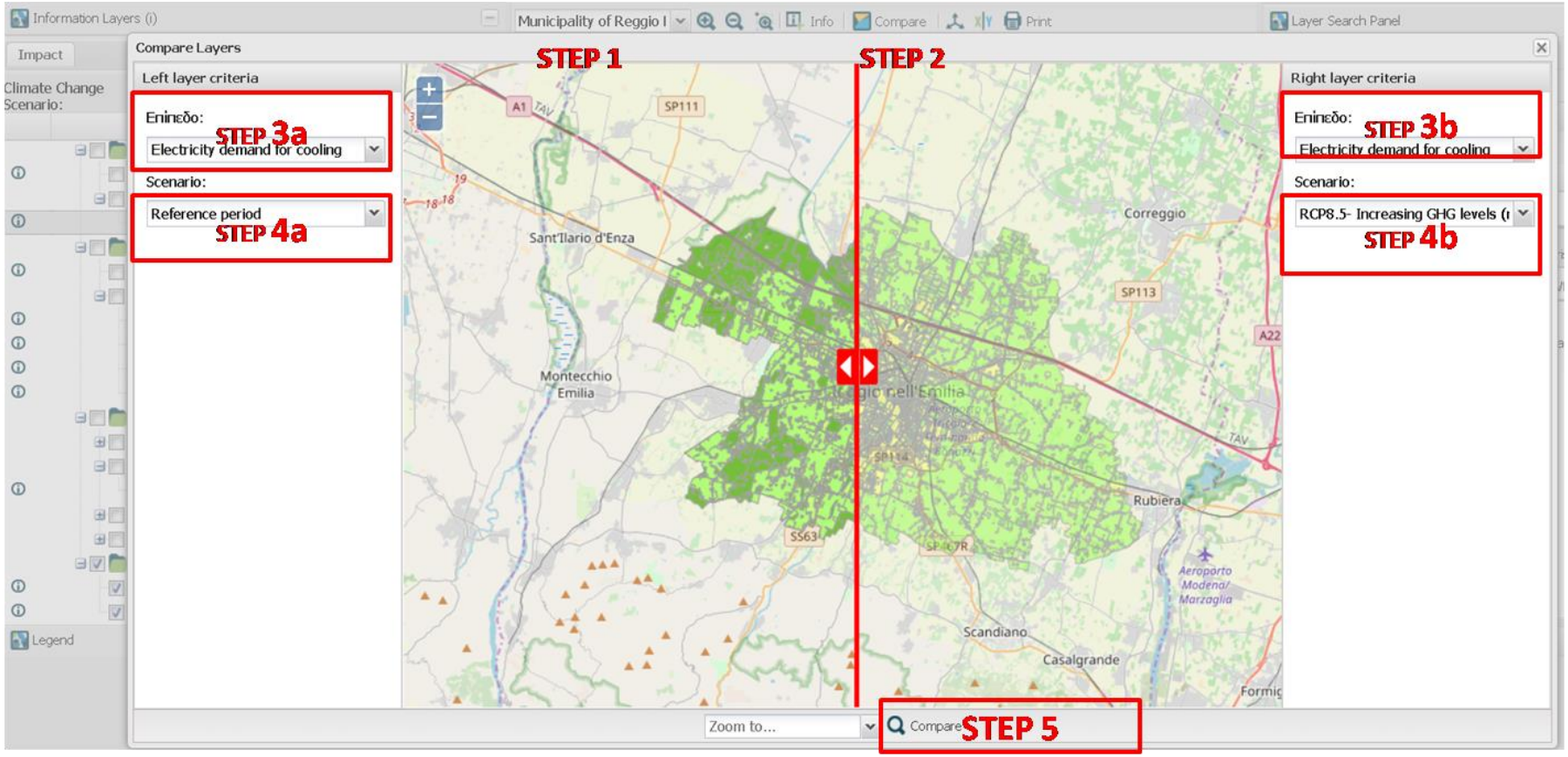


Figure 22: Steps applying the Compare function

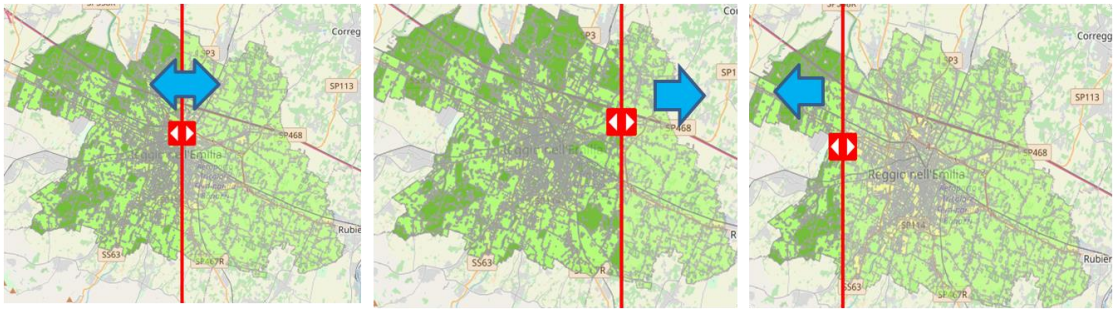


Figure 23: Comparison of electricity demand for cooling between the reference and future period under RCP8.5 in the municipality of Reggio Emilia

As “Compare” window does not have the option to show the legend of the selected impact before Step 1, the user may select the preferred climatic indicator on Layer Tree and then click on Legend button before proceeding to the aforementioned Steps

Display data on the map (Figure 24)

STEP 1: : Select area from toolbar

STEP 2: : Select climate change scenario

STEP 3: Select Layer from the left panel

If more than one information layers are selected, then the one located higher on the list is shown on the map. More than one information layers may be visible on the map by adjusting the transparency of the visible layers (right click on each layer)

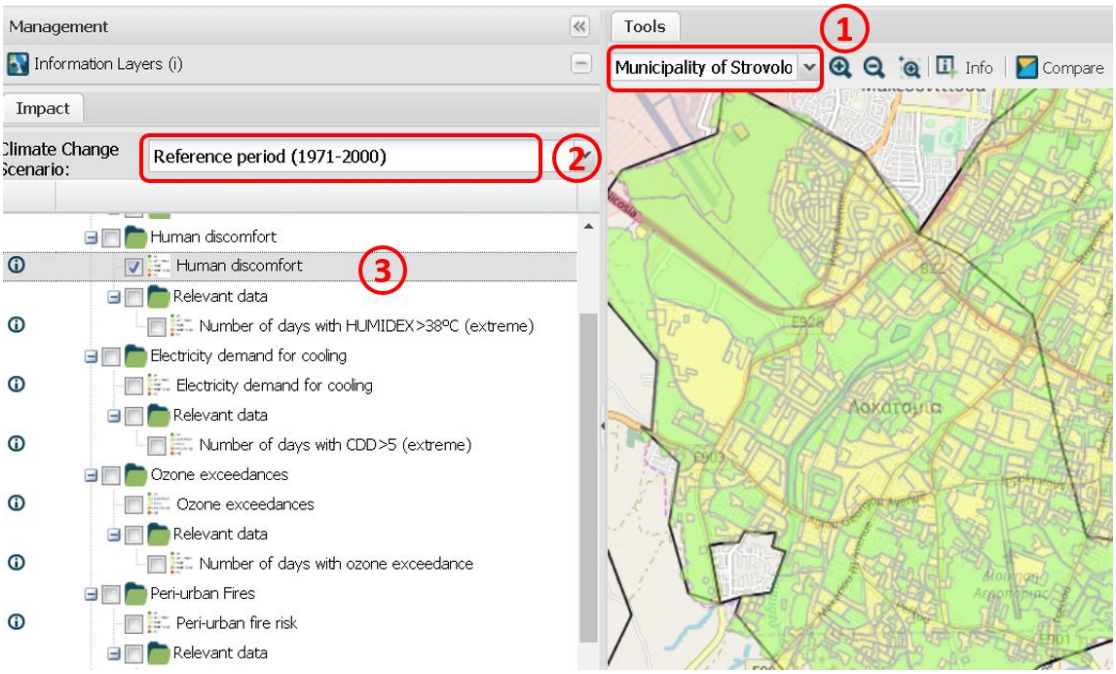


Figure 24:Steps to display data on the map

Search tools (advanced options)

Using the "Search tools" panel on the right side of the screen, the user may access information on manually defined areas on the map using a number of design tools, impose topological queries and filter data. The user starts by selecting an area on the map, as well as one or more layers from the left panel, and then the proceeds to the following steps (Figure 25).

STEP 1: The user selects on the "Layer search panel", the layer that wishes to examine

STEP 2: The user chooses the shape that wishes to draw on the map, among the available designing tools, such as a polygon, a rectangle, a cycle or even a line

STEP 3: Having selected the drawing tool that will be used, the user draws a shape on the map

STEP 4: The user defines either the urban blocks **within** the drawn area, or those **intersecting** it, will be examined, by filling the corresponding field on the "Layer search panel".

STEP 5: Click the Search button

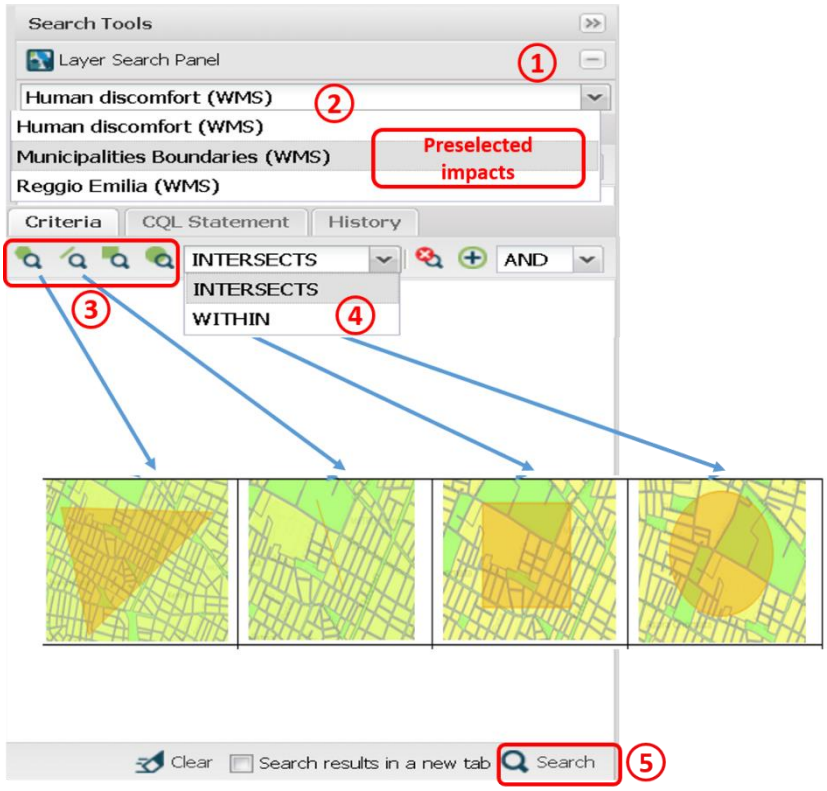
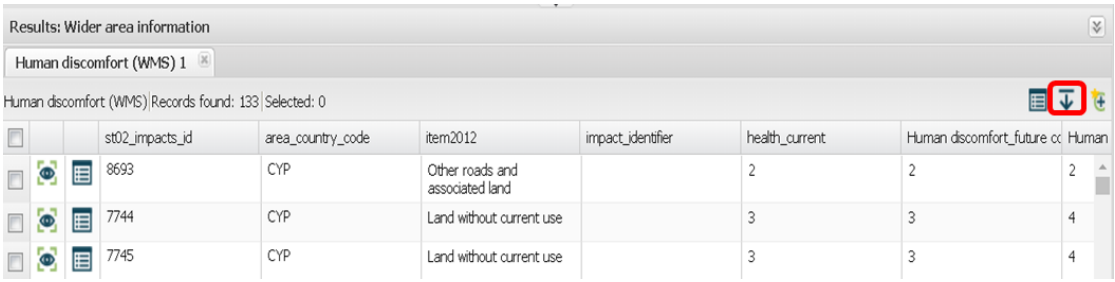


Figure 25:Manual selection of area

A table appears at the bottom of the screen, where the features and their descriptive data are displayed. By pressing the "Download" button, the user may download the data deriving from the search that was executed, to be further used in other applications (Figure 26).



st02_impacts_id	area_country_code	item2012	impact_identifier	health_current	Human discomfort_future cc	Human
8693	CYP	Other roads and associated land		2	2	2
7744	CYP	Land without current use		3	3	4
7745	CYP	Land without current use		3	3	4

Figure 26: Attribute table and download of data retrieved by manual search

Filter Data

The “Layers search panel” also allows the user to reduce the amount of data that wants to be displayed, by imposing filters. To insert a filter, the following steps need to be followed.

STEP 1 Apply the steps from 1 to 5, as presented above, and click on button “**+**” as shown in Figure 27.

STEP 2 For the fields presented after clicking “+” button, select an attribute of the urban block (e.g. area_country_code, layer), apply a condition and set the condition’s value. By pressing the “Search button” the features within the drawn area are re-examined and filtered out, in accordance with the selected filter.

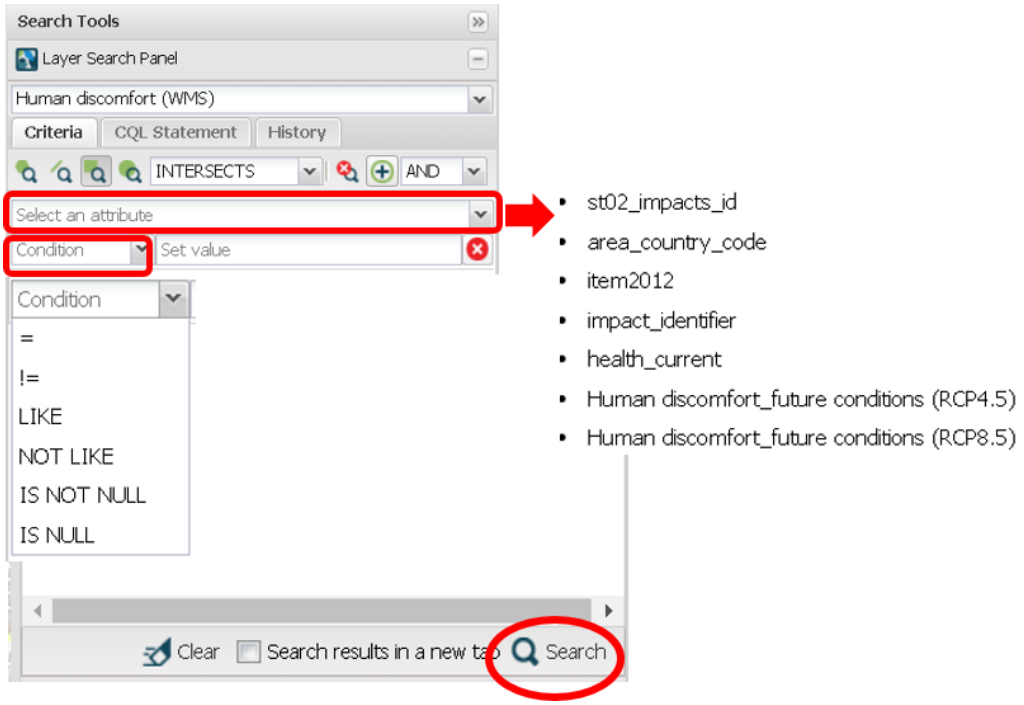


Figure 27: Set filter condition

STEP 3 Multiple filters may be added and set a condition between them (AND και OR) (Figure 28).

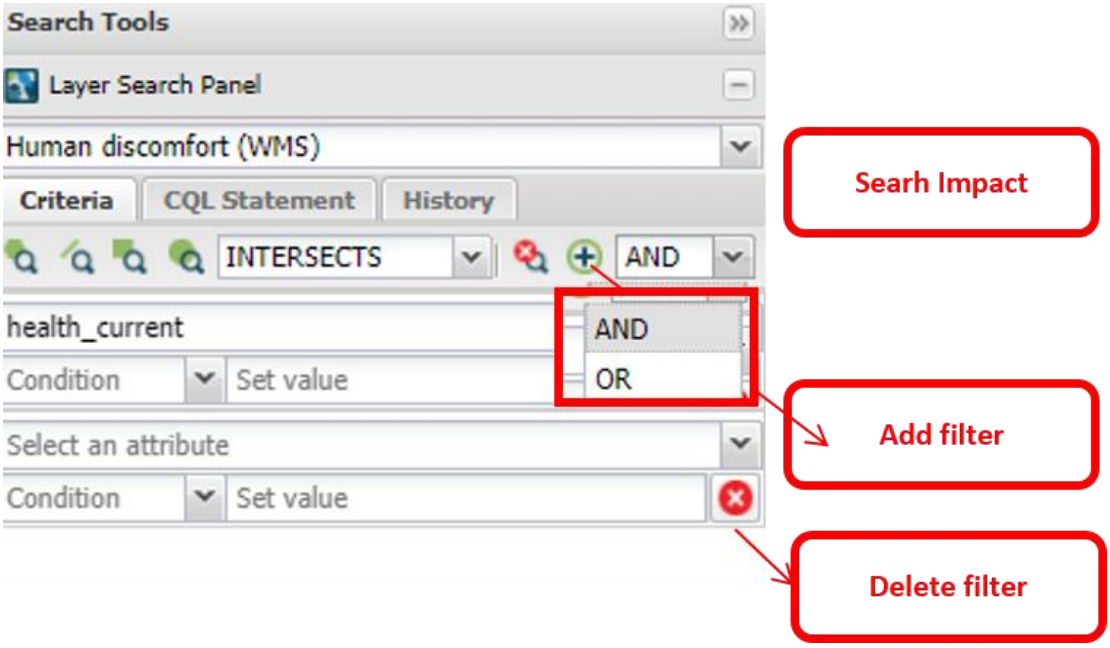


Figure 28; Add multiple filters

In the following example, the user will view out of the urban blocks with "Health_current" value equal to 2, only the ones that have "Human discomfort_future conditions (RCP4.5)" value equal to 3 (Figure 29).

Data can be downloaded in several formats, by pressing the "Download" button, to be further used in other applications

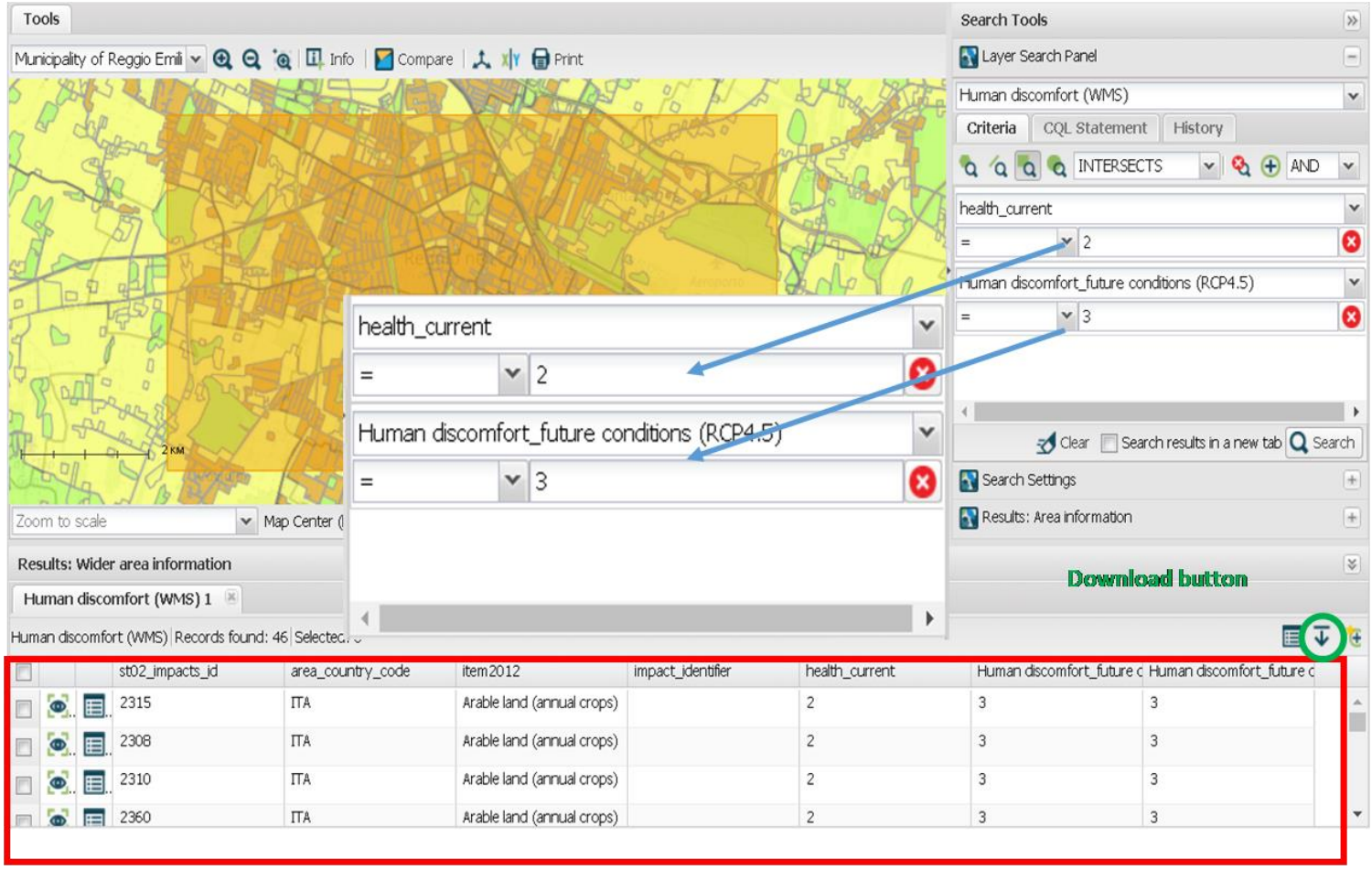


Figure 29: Example of data filtering

b. Water availability and droughts

In Stage 2 of the toolkit, the users may also access diagrammatic information on water availability and droughts. For the assessment of this impact, the following indicators are used:

- **Total water impact (a)**: The assessment of overall water impact is based on the following water indicators, while the **social vulnerability index (b)** is also taken into account in order to reflect the social aspect as well.
- **Water Exploitation Index(c)**: This index relates water availability and water use and compares annual water withdrawal/demand from ground and surface waters to the total renewable freshwater resources
- **Standardized Precipitation Evapotranspiration Index (SPEI) (d)**: This index uses precipitation and potential evapotranspiration to calculate the impact of drought on the availability of water resources.
- **Drought risk (e)**: This indicator reflects drought risk based on the SPEI results with respect to drought intensity and frequency.

The indicators (a), (b), (c) and (e) are presented in bar charts while indicator (d) is presented in time series graph.

Diagrammatic information includes the assessment of the overall water impact, or the Standardized Precipitation Evapotranspiration Index (SPEI).

Water availability and droughts data, is available only for the project's municipalities. The users just need to select the period, as well as the climate scenario that wish to examine in the respective fields, and press the "Submit" button, as shown in Figure 30. After finalising selection, a graph is displayed on the screen, where the Water exploitation index, the Drought risk, the Social vulnerability and the total water impact are shown, for each of the project's municipalities.

By hovering the cursor over each of the diagram bars, appears the value of each indicator.

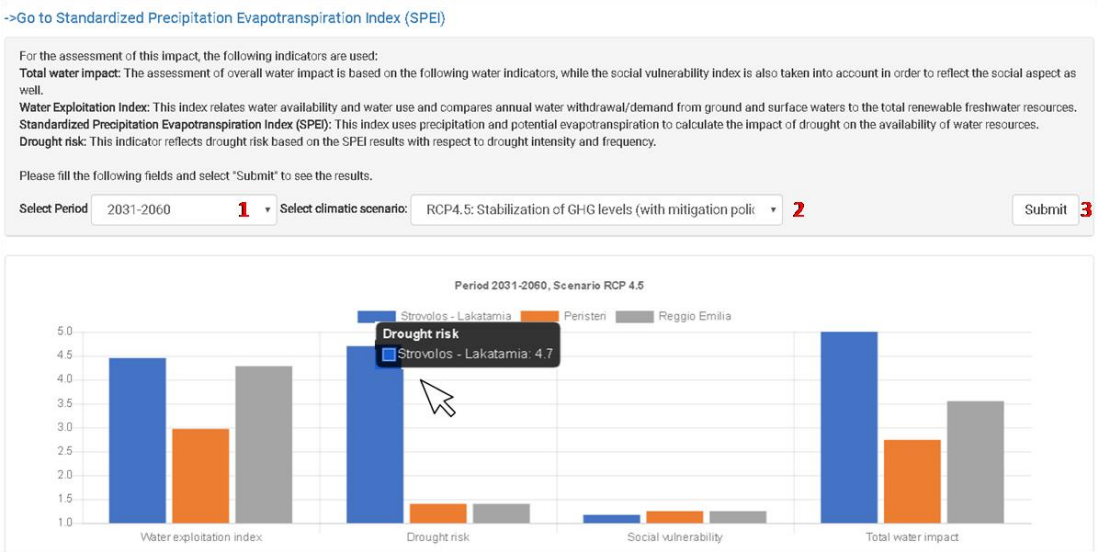


Figure 30: Total water impact assessment

In order to view the impact of drought on the availability of water sources in project's selected areas, the users may select the "Go to SPEI" link on the "Water availability and droughts" stage, to be directed to the total water impact window.

In this window, select the municipality to be examined as well as the climatic scenario, by clicking on the respected fields and press the "Submit" button (Figure 31). Then, the availability of water resources for the period from 1980 to 2100 is presented on the screen, in graphical and in tabular form. The users may view or hide the regression line of the diagram, by pressing the "Show regressions" and "Clear regressions" buttons respectively. By hovering the cursor over the diagram, the water availability values for each year is shown, while tabular data can be copied to be further used in other applications (Figure 32).

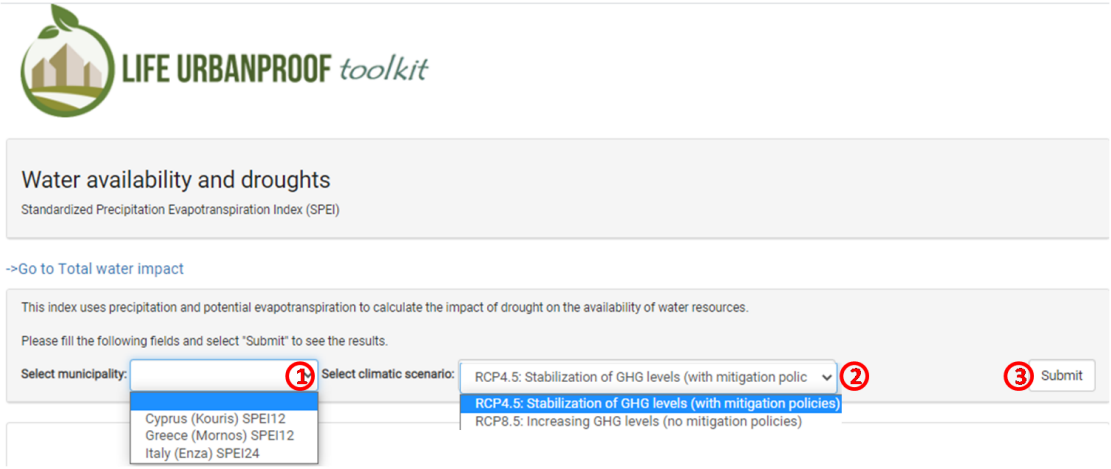
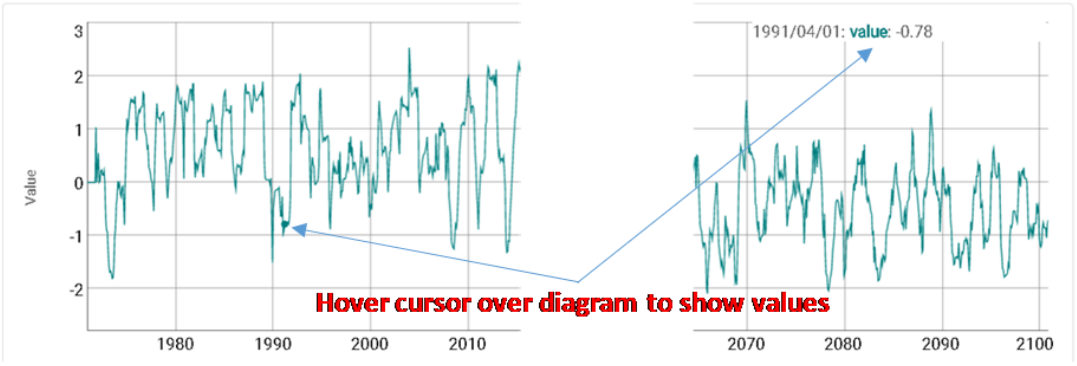


Figure 31: Definition of area and scenario for the calculation of SPEI index



SPEI scale

Class	Value
Extreme wet	SPEI ≥ 2
Severe wet	1.5 ≤ SPEI < 2
Moderate wet	1 ≤ SPEI < 1.5
Moderate drought	-1.5 < SPEI ≤ -1
Severe drought	-2 < SPEI ≤ -1.5
Extreme drought	SPEI ≤ -2

Show Regressions | Clear Regressions

#	Date	SPEI
0	2100-12-01	-0.70435
1	2100-11-01	-0.78685
2	2100-10-01	-1.04368

Ctrl + C

Figure 32: Presentation of SPEI calculation data

STAGE 3: Exploration and Evaluation of Adaptation Options

In Stage 3, the user may either explore the available adaptation measures and their evaluation scores provided by a "pool of experts" of the UrbanProof project, or to "ask" for an evaluation of the adaptation measures by setting his or her own values.

The first option is available to all users, while the second requires user authentication via login (Figure 33) In order to gain access to editing, press Sign Up, enter your preferred username, password, and email. Your subscription is completed upon approval of the terms.

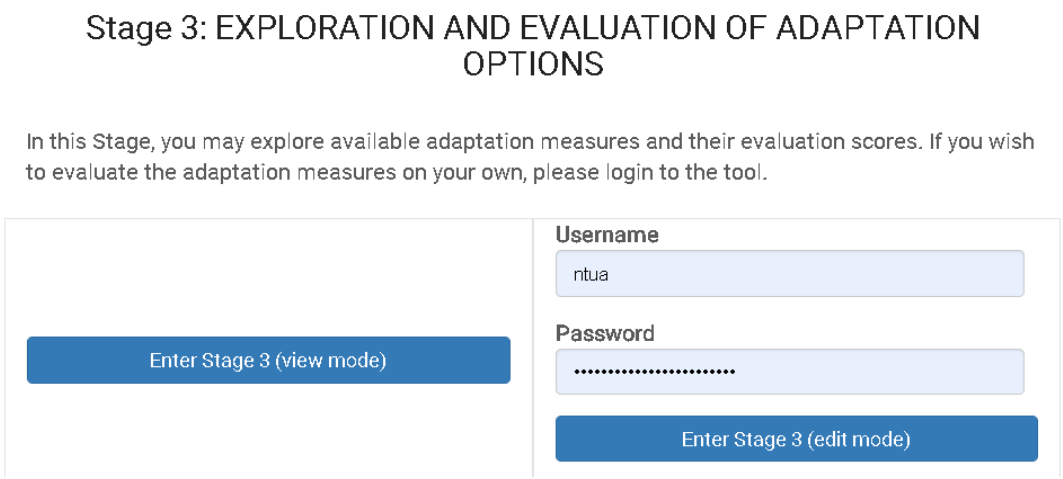


Figure 33: Enter Stage 3 in view mode or via authentication

In the first step of evaluating adaptation measures, the Multi Criteria Analysis Method is used, setting the weight of four criteria:

- the efficiency in addressing the impact
- the environmental friendliness
- the economic viability
- and the job growth

For each one of the criteria, a value needs to be set, expressing their weight. The weight value may range from 0 to 100, and the sum of all four weights must be equal to 100. Within the custom evaluation of adaptation measures mode, users can set weights to the criteria according to their perception of their relevant importance in the evaluation of the adaptation measures (Figure 34).

Otherwise, weight values within the "Pool of experts" evaluation are, by default, equally set.

In the rest of the tabs of "Stage 3" section, the user may access different tables showing the impact for which he or she wishes to explore adaptation measures.

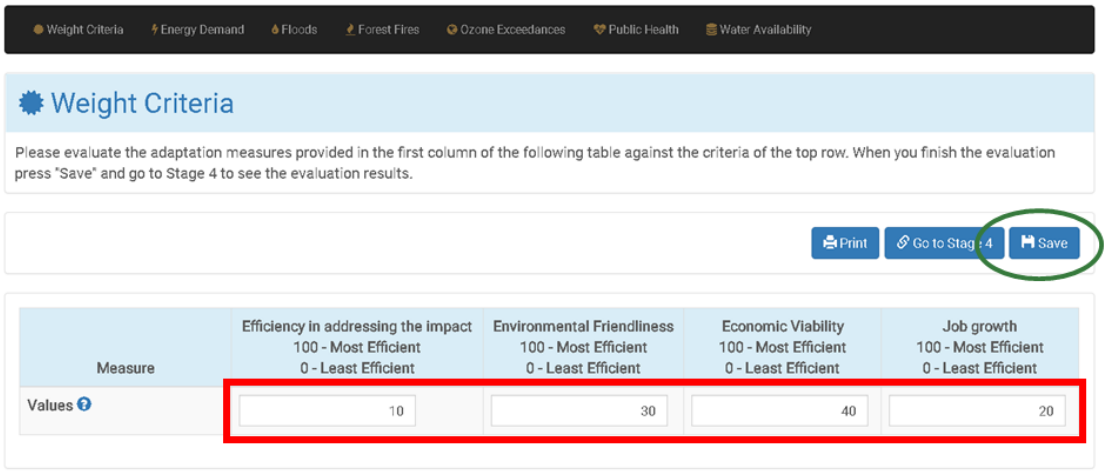


Figure 34: Evaluation of adaptation measures according to user defined weights

The user is also able to view or set evaluation for these adaptation measures. In the example below (Figure 35) the table of evaluation of adaptation measures related to energy demand are shown.

In this table, the evaluation of the adaptation measures in the first column, against the criteria in the top row, as provided by the UrbanProof "pool of experts" is presented. You can see more information for each measure by pressing the info **(?)** button

After inserting the values of the user's preference and pressing "Save", the user may proceed to Stage 4 to see the evaluation results.

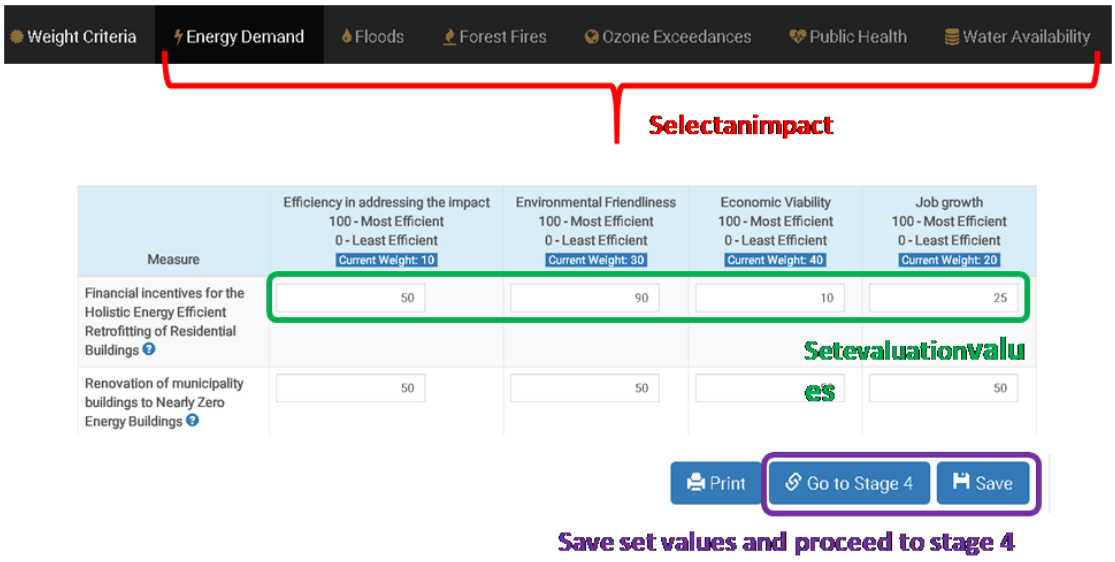


Figure 35: Energy demand adaptation measures

STAGE 4: Development of the adaptation strategy

In stage 4, prioritization of the adaptation measures based on the score they attained at Stage 3, takes place. The adaptation measures are prioritized based on the ratings provided in Stage 3 for the multi-criteria analysis (MCA). The measures gathering the higher ratings may be included in the Local Adaptation Plan of the municipality. The corresponding scores are presented on 1-100 scale, where 1 reflects the worst performance against a criterion and 100 the best. The scores presented throughout the table reflect the average of all scores provided by the expert pool while, in the last column, the total score is provided. The latter is calculated as the weighted average of the scores given for each criterion and adaptation measure

In Figure 36, the prioritization of adaptation measures addressing flood risk is presented. More explicit information on each measure is available by clicking on the icon in the adaptation measures column.

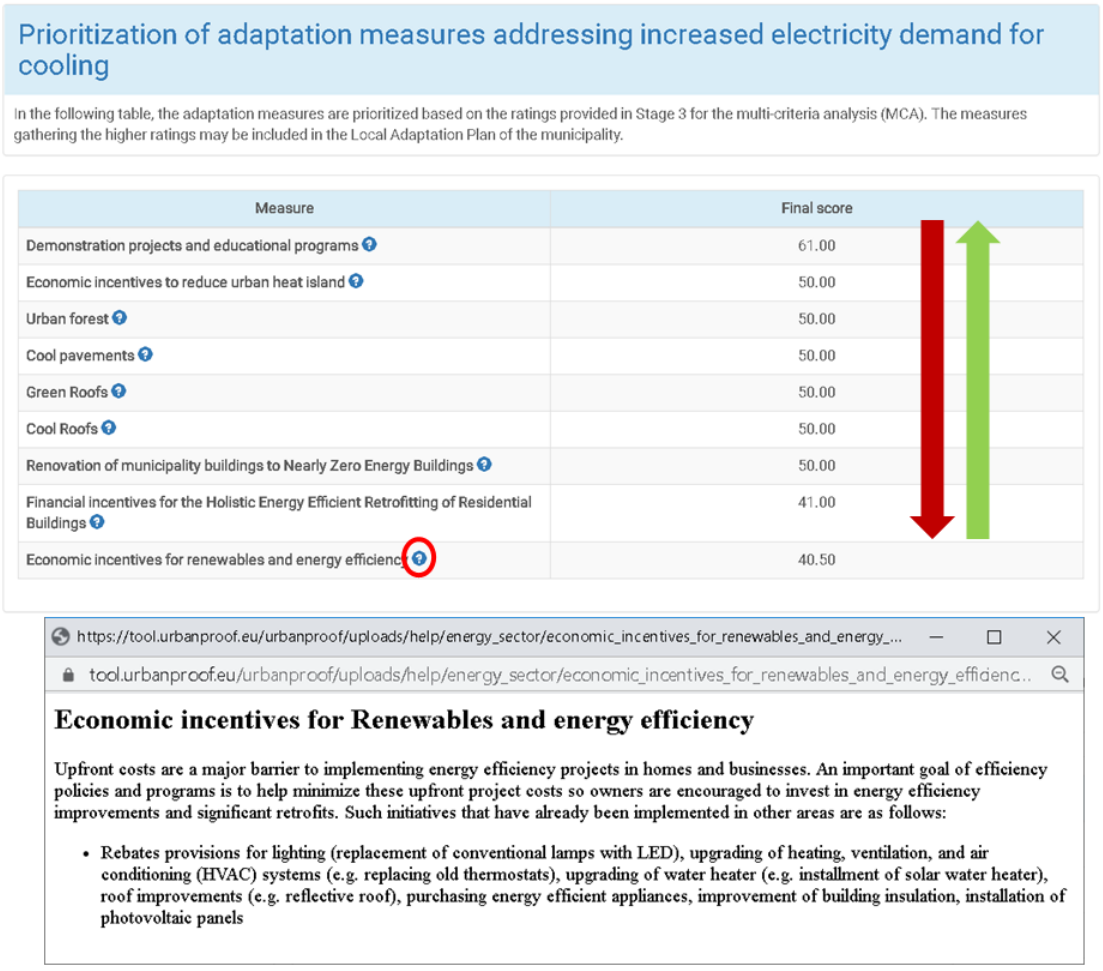


Figure 36: Development of adaptation strategy and display of detailed information for each adaptation measure

STAGE 5: Monitoring and Review

In the Monitoring and Review Stage (Stage 5), the user is able to investigate the effect of the implementation of adaptation measures in increasing the resilience of a municipality to the examined impacts and it can be applied to all urban municipalities (LAU2) of the examined countries. Stage 5 impacts include floods, heatwaves and health, peri-urban fires and energy demand. The process is similar for all cases, with some differences described in the following sections.

Floods

In order to exploit the capabilities of the Monitoring and review stage, the user first selects the "floods" impact by clicking to its respective icon on the toolkit's homepage. After that, the user is directed to the home page of the Monitoring and review stage of the selected impact. When entering the floods' section of Stage 5 the user sees a new screen shown in which he or she, may select the country and the municipality that wishes to examine, at the top of the screen and press the "Go" button.

The selected municipality appears on the screen, separated in smaller areas, called cells, of different colour, depending on the value of the examined impact on each cell. The impact indicator is scaled from [0(low) – 5(high] and presented with different colours, with the relevant legend seen at the bottom left part of the map. The user can see the average municipality impact of the selected area by pressing the "Show average municipality impact" button above the map (Figure 37).

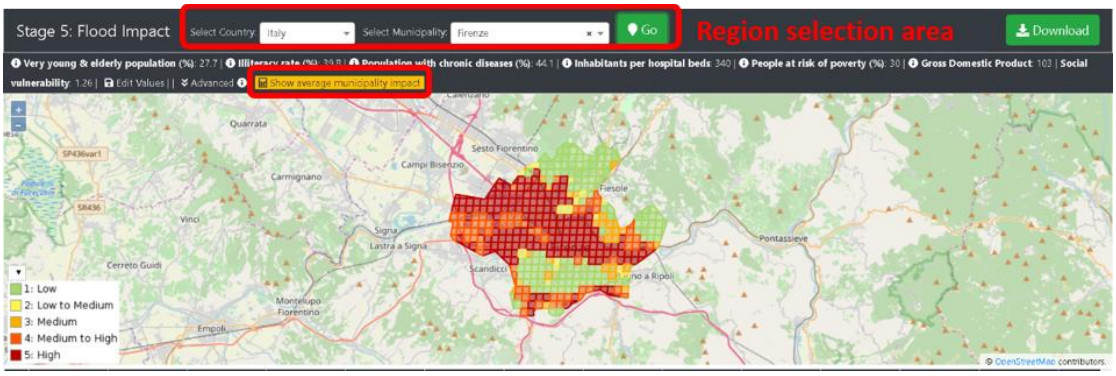


Figure 37: Top: Stage 5, select area, Bottom: Municipality map view separated in cells

Above the map, detailed information on the individual indicators comprising the Social Vulnerability indicator that is used in the assessment, is provided.

The **composite Social vulnerability** index reflects the population groups sensitive to floods (Very young and elderly population, Illiterate, People at risk of poverty, Population with chronic diseases) and the adaptive capacity of the health care system and of the economy (regional level data on the inhabitants per hospital beds ratio and on the Gross Domestic Product). The indicators are normalized in the scale [1(low) – 1.5(high] based on their position with respect to the respective European average value (above/below average EU value), in order to express different scales of social vulnerability.

Table 1 describes in detail the Social Vulnerability Indicators.

Very young & elderly population (%):	Percentage of people over 70 years old plus the percentage of people under 9 years old. The data are available at municipal level.[2]
Illiteracy rate (%)	Percentage of people with educational level lower than primary school, such as illiterate/literate with lack of an official educational level or those who gave up school. The data are available at municipal level.[3]
Population with chronic diseases (%	Percentage of people with chronic diseases (asthma, chronic lower respiratory-excluding asthma, high blood pressure, stroke or chronic stroke disease, diabetes, chronic depression). This information is available from Eurostat (2014) at national level only and therefore the values assigned to each municipality are the respective national ones.[4]
Hospital beds/100,000 inhabitants	Available from Eurostat (2015) at regional (NUTS2) level. Therefore the values assigned to each municipality are the respective regional ones.[5]
Population at risk of poverty (%)	This information is available from Eurostat (2016) at national level only and therefore the values assigned to each municipality are the respective national ones[6].
Gross Domestic Product	This information is available from Eurostat (2016) at regional (NUTS2) level and therefore the values assigned to each partner municipality are the respective regional ones. Unit: Euro per inhabitant in % of EU average.[7]

Table 1:Social vulnerability indicators

[2] ISTAT (2017). ''Resident municipal population by age, sex and marital status'', Dataset: Population and Households, Instituto Nationale di Statistica
ELSTAT (2011a). ''Demographic and social characteristics of the Resident Population of Greece according to the Population – Housing'', Census, 2011, Hellenic Statistical Authority
CYSTAT (2012). ''Population distribution per group at the Municipalities of Cyprus'', Statistical Service of Cyprus
Eurostat (2016). "Population on 1 January by age group and sex"
[3] ISTAT (2011). ''Educational attainment of resident population aged 6 years and over'', Dataset: Education and Training. Instituto Nationale di Statistica
ELSTAT (2011b). ''Table B.06: Population by sex and education/Regional Units-Municipalities, Permanent Population Census''. Hellenic Statistical Authority
CYSTAT (2011). ''Population (equal and over than 15 years old) recorded by literacy level in municipal level'', Statistical Service of Cyprus
Eurostat (2017). "Population by educational attainment level, sex and age (%) - main indicators/ Less than primary, primary and lower secondary education (levels 0-2)"
[4] Data source: Eurostat (2014). ''Persons reporting a chronic disease, by disease, sex, age and income quintile''
[5] Data source: Eurostat (2015). ''Hospital beds by NUTS 2 regions''
[6] Data source: Eurostat (2016). ''People at risk of poverty or social exclusion''
[7] Data source:Eurostat (2016). "Gross domestic product (GDP) at current market prices" by NUTS 2 region

You can edit the values of the social vulnerability indicators if you have updated statistical data, in order to recalculate the indicator. You can do that by pressing "Edit values" and entering the new ones. Press "Edit values" in order to do so, type the new ones and press "Save values" to update them. (Figure 38**Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**).

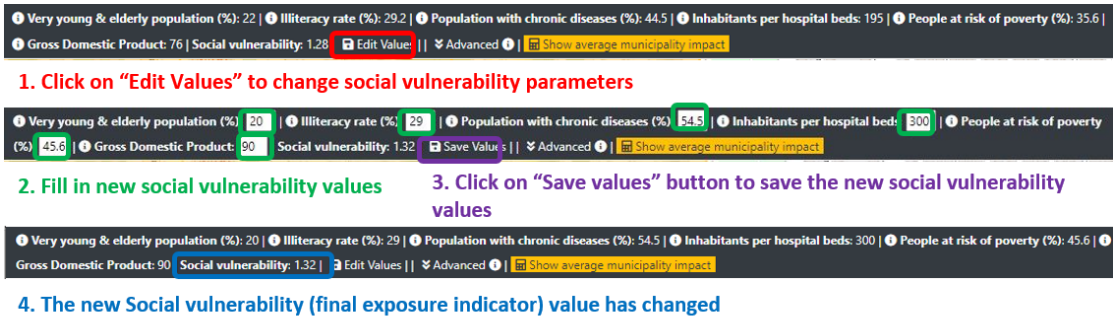


Figure 38:Change values of Social vulnerability indicators

Below the map, a table appears, with each of its rows, corresponding to the municipality's cell values. The parameters displayed on the table below the map are explained in Table 2.

Population density	Density of population, expressed as the number of people per cell (500x500m). Quantity and spatial distribution of population expressed as population density. This indicator serves as a proxy of the expected number of residents exposed to climate change impacts. The information on population is available at the level of building blocks and land use polygons through the Urban Atlas database of the Copernicus Land Monitoring Service..[8]
Critical infrastructure	Critical infrastructure with respect to floods, includes hospitals, schools, commercial and industrial areas, public facilities, cultural units and transport infrastructure. The flood zone areas where critical infrastructure is located may indicate at the same time the exposure of population and of the critical infrastructure to floods. A failure of critical infrastructure means a substantial disturbance of public life which undermine the security of service supply[9].
Social vulnerability	Reflects the population groups sensitive to climate change as well as the adaptive ability of the health system and economy. The social vulnerability indicators are normalized in scale [1(low) – 1.5(high)].
Flood zones	Area potentially affected by flooding (flood hazard zone) under a medium probability scenario at least with a return period of 100 years. The flood hazard maps are produced by the competent national authorities in compliance with the Floods Directive 2007/60/EC. [10].

[8]Data Source: Urban Atlas database - Copernicus Land Monitoring Service, Global Human Settlement (GHS) Population grid (LDS) – Joint Research Centre-*https://ghsl.jrc.ec.europa.eu/ghs_pop.php*

[9] *https://mapcruzin.com/free-europe-arcgis-maps-shapefiles*
http://geodata.gov.gr/maps/?locale=el

[10]Data Source: Eionet Reporting Obligations Database (ROD) – European Environment Agency

Main land use	Main CORINE land cover type in the selected cell and respected runoff index[11]
Adaptation intervention	Type of adaptation intervention to be implemented. And respective runoff index. Press the arrow to select among the available adaptation interventions.
Adaptation area	Set the area (in m2) if the adaptation intervention you intend to do. *The inserted area may not exceed 250,000m2, which is the maximum cell area.
Weighted runoff index/	The weighted runoff index is calculated for the selected area, taking into account the runoff index of the main land use, the selected adaptation intervention and their respective areas.
Flood impact	Conceived as a function of climate change, hazards, exposure and social vulnerability whereas adaptation is considered to reduce flood impact. To estimate hazard, flood hazard maps were used for a 100-year flood return period were used, while exposure to floods was estimated based on both population density and critical infrastructure. The adaptation ability is evaluated through the permeability of the ground, an increase of which reduces the overall runoff and flood risk. The Flood impact indicator is normalised in scale [0(low) – 5(high)].

Table 2:Parameters' description

By selecting a cell on the map, the table goes to the cell's corresponding row, where values can be edited to evaluate the impact of an intervention. (Figure 39).

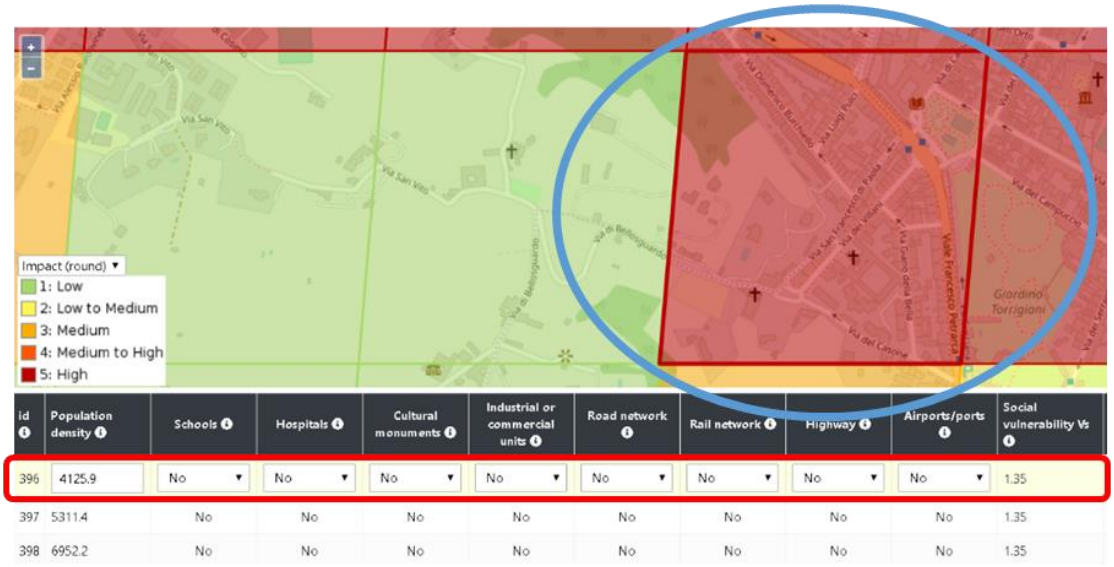


Figure 39: Make intervention to a cell

In this row, the user may define the area of an adaptation measure, by pressing the edit icon, filling the "Adaptation area" field and then selecting among the available measures of the "Runoff index adaptation area" dropdown menu. If the adaptation measure you want to select is not in the available list of the "Adaptation Intervention" column, you can select the

[11] Πηγή Δεδομένων: Corine Land Cover - Copernicus Land Monitoring Service

one whose runoff index value is closest. After setting desired values, press the "Update" button and the impact score is recalculated and shown on the relevant table (Figure 40).

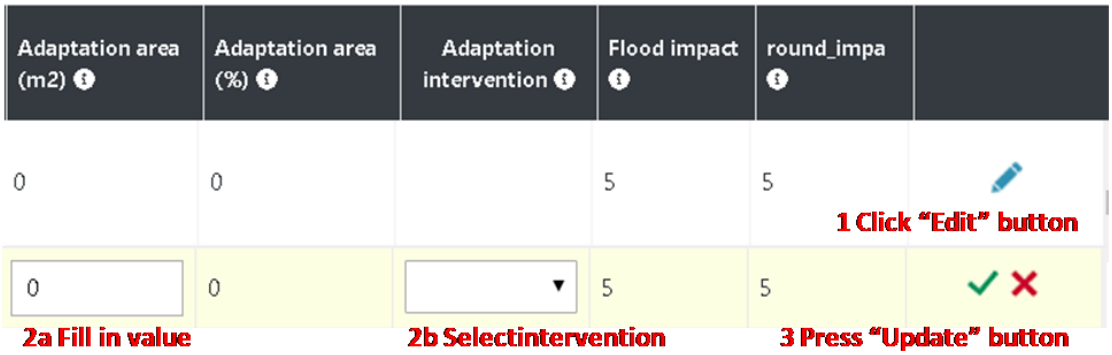


Figure 40: Define adaptation measure on flood impact

To achieve a reduction of the estimated impact which may be observable at municipal level, the user should apply measures at a wider area, that is, to a greater number of cells, especially to those where higher impacts are foreseen. Once the user applies these changes, then he/she may select the " Show average municipality impact" option to see if and how much, the initial impact has been reduced.

This could be particularly helpful when setting targets (e.g. reduction of the overall estimated impact for the municipality by 30%) for the coming periods, in the adaptation and monitoring plan of a municipality.

What is more, the user may change the weights of the main indicators used in the impact assessment, by increasing or decreasing their influence to the formulation of the final impact score. To do this, the user selects the option "Advanced" which is located above the map. Then a new field opens where he may change the contribution of each indicator from 1 which is the current contribution, to No contribution or to double the contribution (Figure 41)

Figure 41: Modify social vulnerability parameters' values

To download the data for the selected country, region and municipality, the user may implement the following Steps:

STEP 1:

Select "Download" at the top-right hand of the screen and then a file named *export.json* will be created containing the data requested.

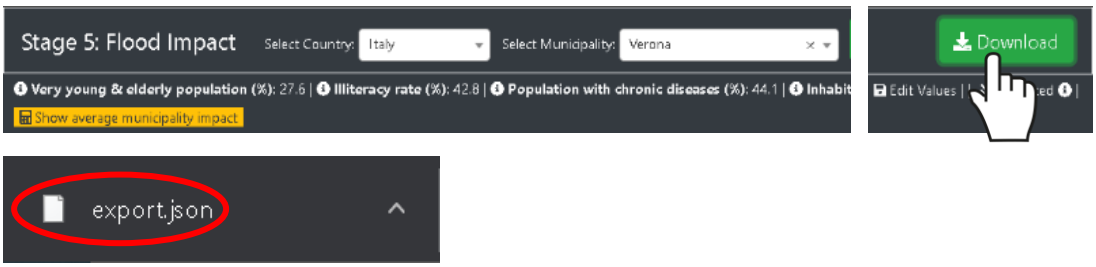


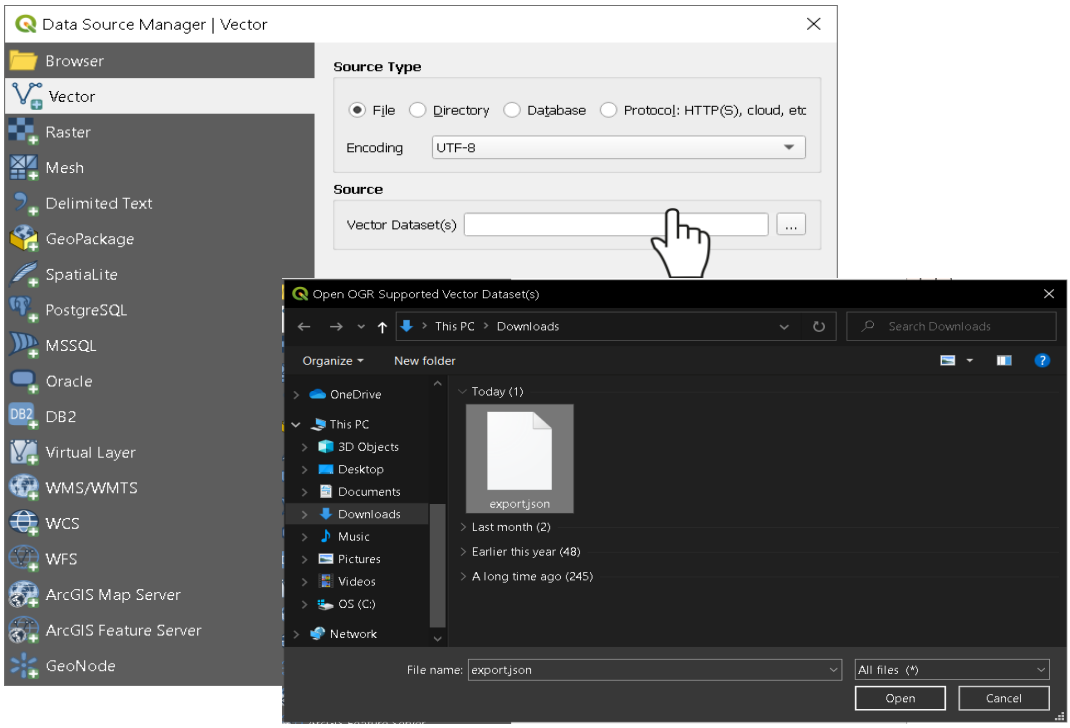
Figure 42: Download data for a selected municipality in Stage 5

STEP 2:

Open a GIS (Geographic Information System) software (in this example the open software QGIS is used). Import the downloaded .json file by selecting *Layer → Add Layer → Add Vector Layer*.

STEP 3:

In the popup window, select *File* in the field *Source type* and in the field *Source* select *Browse* in order to locate the "*export.json"* file in your computer.



Note: In case you do not have a GIS software, you may download the data in tabular form with the use of any online free software for the conversion of JSON files to spreadsheet files, such as *.csv* or *.xls*.

Heatwaves and health

Again, the user first selects the required impact, by clicking on the respective icon on the toolkit's homepage, in this case the Heatwaves and health icon, and is directed to the home page of the Monitoring and review stage of the selected impact. On this screen, the user may select the country and the municipality that wishes to examine, at the top of the screen and press the "Go" button.

The selected municipality appears on the screen separated in cells of different colour, depending on the value of the examined impact on each cell. By clicking on "Show average municipality impact" button, a pop-up window appears where the use can examine the initial average value of the impact (before the implementation of adaptation measures) in the selected municipality (Figure 43).

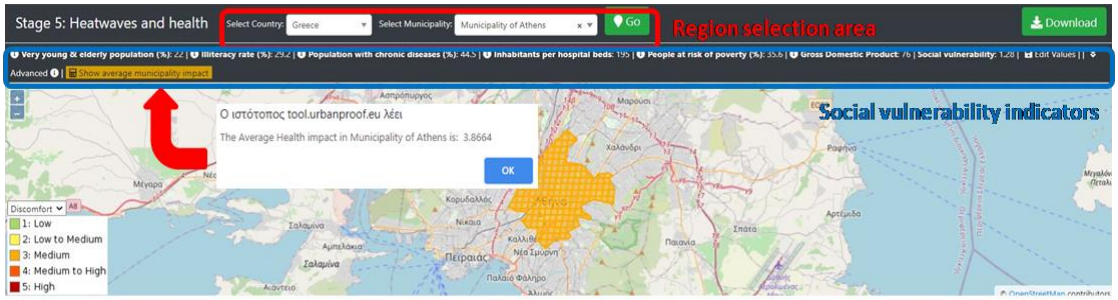


Figure 43: Top: Select Country and Municipality as well as social vulnerability indicators, Bottom: Municipality map view separated in cells

Below the map, a table appears where each row corresponds to a cell of the selected. municipality. The parameters in this table correspond to hazard (HUMIDEX before and after the intervention) and exposure (Population density) as well as parameters referring to the adaptation measures such as the cell area and the adaptation area. The final column ("Human discomfort") corresponds to the estimation of the total vulnerability after the implementation of adaptation measures in the specific Municipality's cell (Figure 44).

Id	Population density (inh/km2)	Cell area(m2)	Mean summer HUMIDEX for present climate	Mean summer HUMIDEX for future climate (RCP4.5)	Mean summer HUMIDEX for future climate (RCP8.5)	Adaptation area	Mean summer HUMIDEX after the intervention	Human discomfort

Figure 44: Parameters for the monitoring of the effect of adaptation measures in human discomfort

The parameters displayed on the table are explained in Table 3

Population Density	Density of population, expressed as the number of people per cell (500x500m) (see. Table 1)
Cell area	Total area of the cell in m2
HUMIDEX indicator	HUMIDEX, is a climatic indicator reflecting the impacts of temperature and humidity on human discomfort, was used to depict hazard. In specific, the number of days with HUMIDEX above 38°C which expresses high discomfort. The vulnerability of the exposed population was estimated based on the composite Social Vulnerability index and the population density. The impact indicator is normalized in the scale [0 (low) – 5 (high)] to express different levels of impact.
Mean summer HUMIDEX for present climate	Mean value of the HUMIDEX during summer for present climate

Mean summer HUMIDEX for future climate (RCP4.5)	Mean value of the HUMIDEX during summer for future climate based on the RCP4.5 emissions scenario
Mean summer HUMIDEX for future climate (RCP8.5)	Mean value of the HUMIDEX during summer for future climate based on the RCP8.5 emissions scenario
Adaptation area	Set the adaptation interventions' area (in m2)
Mean summer HUMIDEX after the intervention	Calculation of the average HUMIDEX during summer after the implementation of adaptation interventions
Human discomfort	Human discomfort assessment (scale 1-5)after the implementation of adaptation interventions

Table 3:Parameters for reviewing adaptation measures in human discomfort

By selecting a cell on the map, the table goes to the cell's corresponding row, where values can be edited to evaluate the impact of an intervention. (Figure 45).

Figure 45:Intervention in a cell

In this row, the user may define the area of an adaptation intervention (in m2), as well as the calculated value of the Mean summer HUMIDEX after the intervention (information about the calculation of this indicator is followed). Additionally, the user is able to change the preexisting value of the population density if new updated data are available (Figure 46).

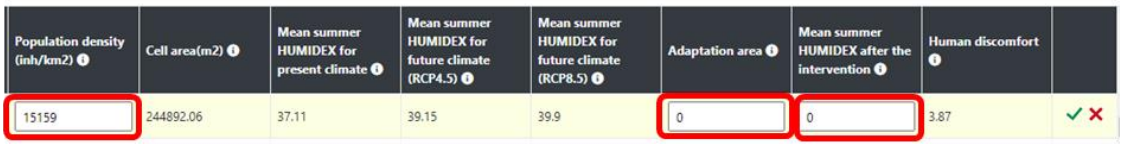


Figure 46: Editing of values monitoring of the effect of an adaptation measure on human discomfort

After setting the desired values, by pressing the "Update" button, the impact score is recalculated and shown on the relevant table field (Figure 47).

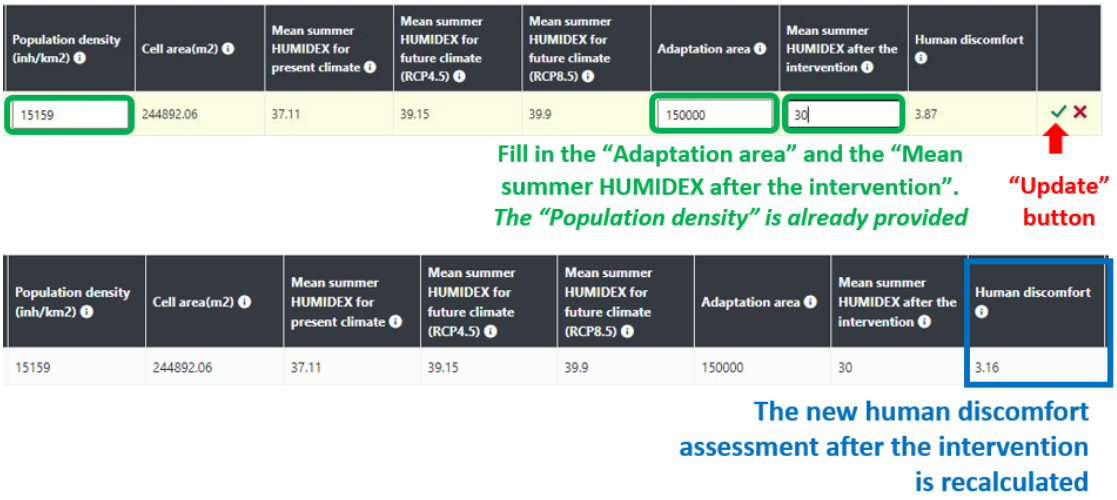


Figure 47: Set the values in the corresponding fields and press "Update" button (top). The new recalculated value of the impact is provided in the final column (bottom)

To calculate mean summer HUMIDEX after the intervention, click on the Heatwaves and health section of Stage 5. On the initial screen with guidelines click on the link for calculating the HUMIDEX index (Figure 48).

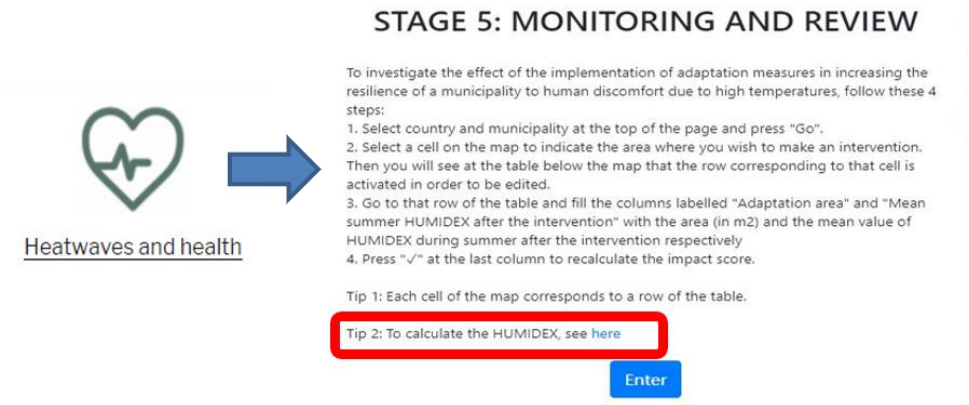


Figure 48: Steps for opening the online HUMIDEX calculator tool

After the above steps the online HUMIDEX Calculator opens where the user is able to calculate the HUMIDEX (in °C) by inserting the respective temperature and relative humidity (Figure 49). More specifically, to calculate the requested mean summer HUMIDEX after the intervention, the user should calculate the HUMIDEX of each summer day inserting to the online tool the maximum temperature as well as the respective relative humidity of that day. After that, the mean value of the HUMIDEX (mean value from all summer days) should be inserted to the Urban Proof toolkit (Figure 49).

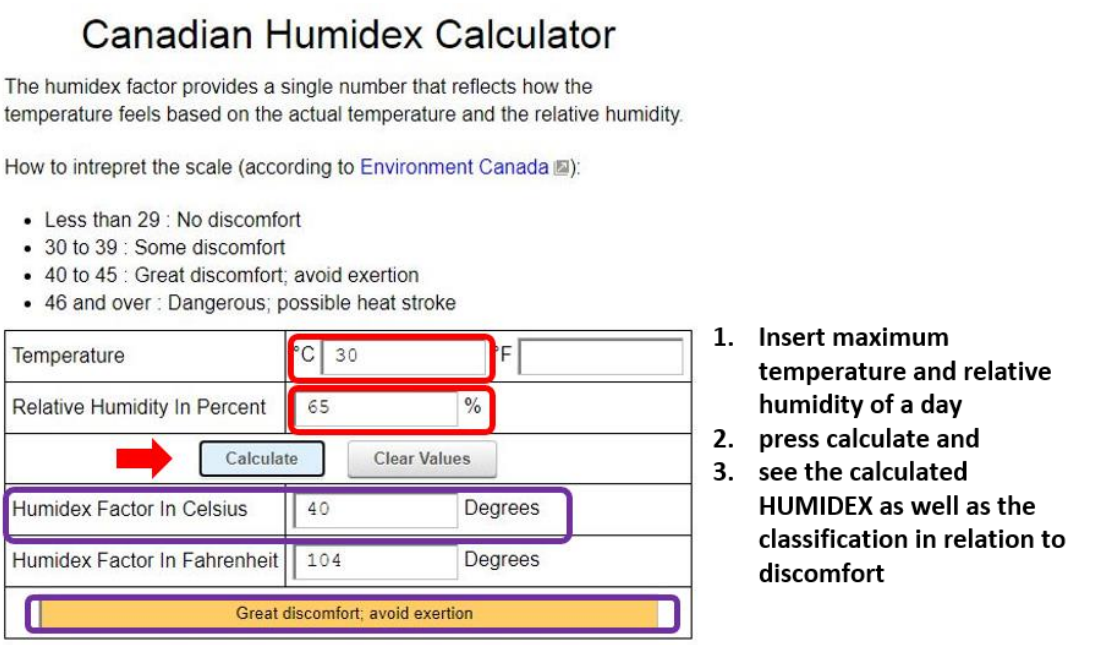


Figure 49: The online tool to calculate the requested "Mean summer HUMIDEX after the intervention

Like in the case of floods, you can edit the given values of the social vulnerability parameters located under the Country/municipality selection menu, in order to alter the result of the impact assessment (see Figure 38).

Although you can update all the fields concerning social vulnerability indicators, you are advised to change the default values only if you have available reliable updated data concerning these fields

The effect of the implementation of the examined adaptation measures to the selected impact can be downloaded to be used in other applications by clicking on the "Download" button on the upper right part of the screen, as shown in Figure 50.

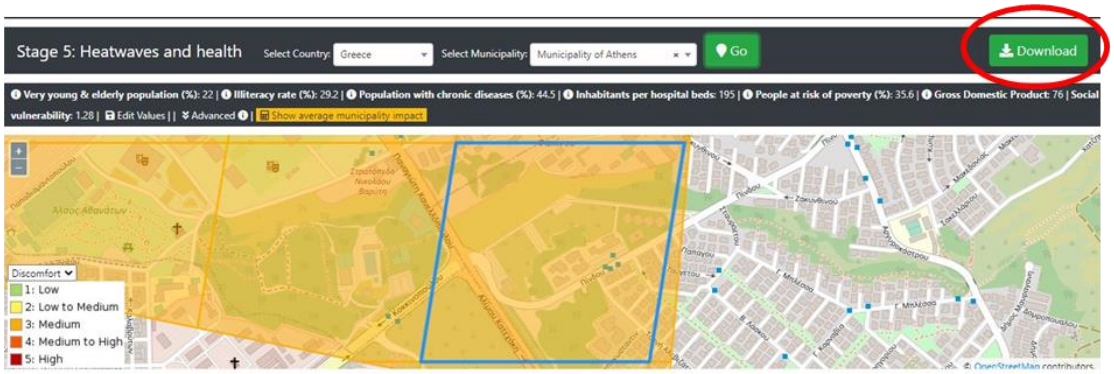


Figure 50:Download the results of the adaptation measures for heatwaves and health

Peri-urban fires

As in previous impacts, the user first selects the required impact, by clicking on the respective icon on the toolkit's homepage, in this case the Peri-urban fires icon, and is directed to the home page of the Monitoring and review stage of the selected impact. On this screen, the user may select the country and the municipality that wishes to examine, at the top of the screen and press the "Go" button. The selected municipality appears on the screen separated in cells of different colour, depending on the value of the examined impact on each cell.

By clicking on "Show average municipality impact" a pop-up window appears where the use can examine the initial average value of the impact (before the implementation of adaptation measures) in the selected municipality (Figure 51).

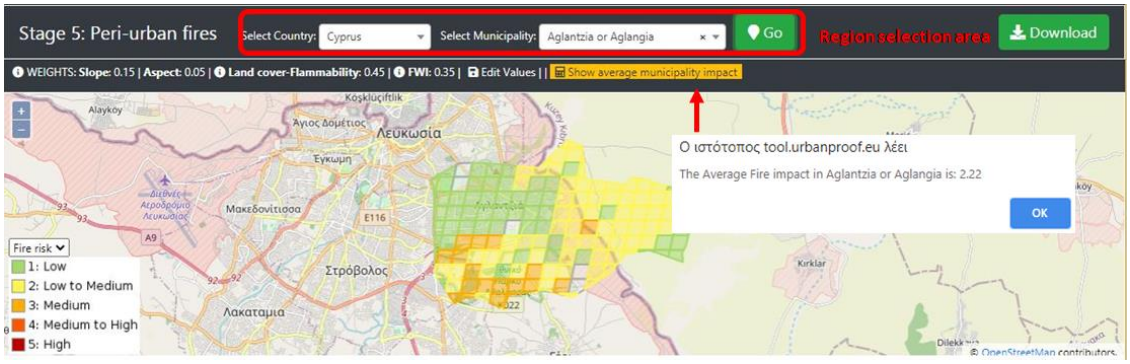


Figure 51: Top: Select Country and Municipality as well as social vulnerability indicators, Bottom: Municipality map view separated in cells

Below the map, a table appears where each row corresponds to a cell of the selected municipality. The parameters in this table correspond to hazard (FWI before and after the intervention) and exposure (Slope, Aspect, Corine land use). The final column ("Peri-urban fire risk") corresponds to the estimation of the total vulnerability after the implementation of adaptation measures in the specific Municipality's cell (Figure 52).

Id	Slope	Aspect	Corine land use code	Corine land use	Mean summer FWI for present climate	Mean summer FWI for future climate (RCP4.5)	Mean summer FWI for future climate (RCP8.5)	FWI after the intervention	Peri-urban fires impact assessment

Figure 52: Parameters for the monitoring of the effect of adaptation measures in peri-urban fire risk

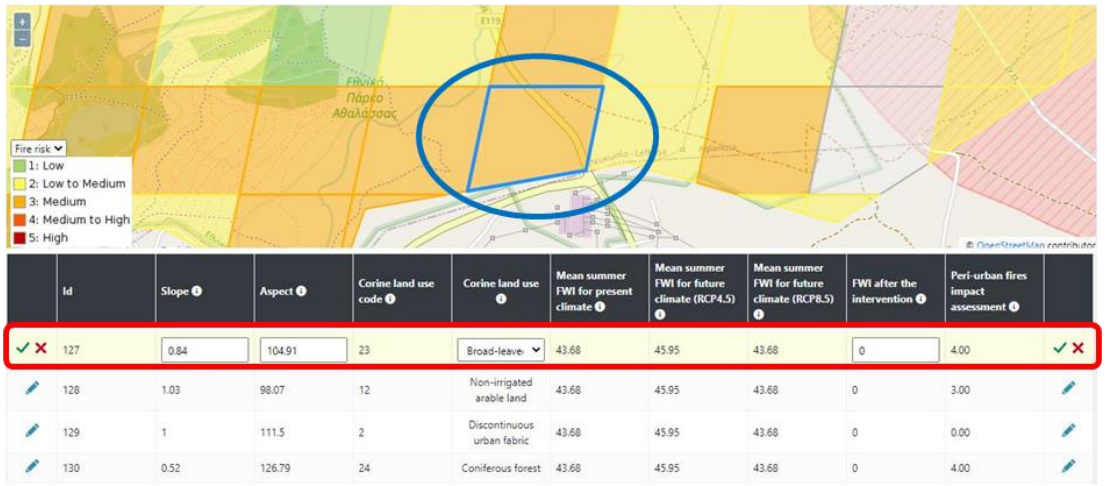
The parameters displayed on the table are explained in Table 4.

Slope	This parameter presents the slope of each grid cell. Intense slopes increase fire spread velocity and also affect strongly the fire suppression capability
Aspect	This layer presents the aspect of each grid cell. Southern/southwestern orientation slopes favour drier environments as the soil temperature is increased due to higher solar radiation absorption, leading to more fire prone conditions.
Corine land use code	Land use code from the CORINE database
Corine land use	Land use category from the CORINE database.
Fire Weather Index	For the assessment of peri-urban fires, the Fire Weather Index (FWI) was used for the assessment of climatic hazard. FWI is a meteorologically -based index used to estimate fire danger based on temperature, relative humidity, wind speed and precipitation. In specific, the expected number of days with

	(FWI) above 30 (i.e. days with high fire danger) was used for the assessment. Other parameters of relevance for the assessment were also used, i.e. slope, aspect and land cover flammability. The impact indicator is normalized in the scale [0 (low) – 5 (high)] to express different levels of impact
Mean summer FWI for present climate	Mean value of the Fire Weather Index (FWI) during summer for present climate..
Mean summer FWI for future climate (RCP4.5)	Mean value of the Fire Weather Index (FWI) during summer for future climate based on the RCP4.5 emissions scenario.
Mean summer FWI for future climate (RCP8.5)	Mean value of the Fire Weather Index (FWI) during summer for future climate based on the RCP8.5 emissions scenario.
FWI after the intervention	Calculate the mean FWI during summer after the implementation of adaptation interventions
Peri-urban fires impact assessment	Peri-urban fires impact assessment after the implementation of adaptation interventions.

Table 4:Parameters' description of peri-urban fire risk assessment

By selecting a cell on the map, the table goes to the cell's corresponding row, where values can be edited to evaluate the impact of an intervention (Figure 53).



	Id	Slope	Aspect	Corine land use code	Corine land use	Mean summer FWI for present climate	Mean summer FWI for future climate (RCP4.5)	Mean summer FWI for future climate (RCP8.5)	FWI after the intervention	Peri-urban fires impact assessment	
✓ ✗	127	0.84	104.91	23	Broad-leave	43.68	45.95	43.68	0	4.00	✓ ✗
	128	1.03	98.07	12	Non-irrigated arable land	43.68	45.95	43.68	0	3.00	
	129	1	111.5	2	Discontinuous urban fabric	43.68	45.95	43.68	0	0.00	
	130	0.52	126.79	24	Coniferous forest	43.68	45.95	43.68	0	4.00	

Figure 53:Make intervention to a cell

In this row, the user should provide the FWI after the intervention (information about the calculation of this indicator is followed) and change the preexisting values of slope and aspect as well as the Corine land use category from the drop-down menu if new updated data are available. (Figure 54).

It is clarified that in the case of slope and aspect the value displayed for each cell is the average value of cell slope and aspect derived from the digital elevation model (DEM). On the other hand, land uses referred to the use with the largest area in each cell derived from CORINE.

Id	Slope	Aspect	Corine land use code	Corine land use	Mean summer FWI for present climate	Mean summer FWI for future climate (RCP4.5)	Mean summer FWI for future climate (RCP8.5)	FWI after the intervention	Peri-urban fires impact assessment	
127	0.84	104.91	23	Broad-leaved f	43.68	45.95	43.68	0	4.00	✓ ✗

Figure 54: Parameters that have to be filled for the monitoring of the effect of an adaptation measure on peri-urban fire risk

After setting the desired values, by pressing the "Update" button, the impact score is recalculated and shown on the relevant field (Figure 55).

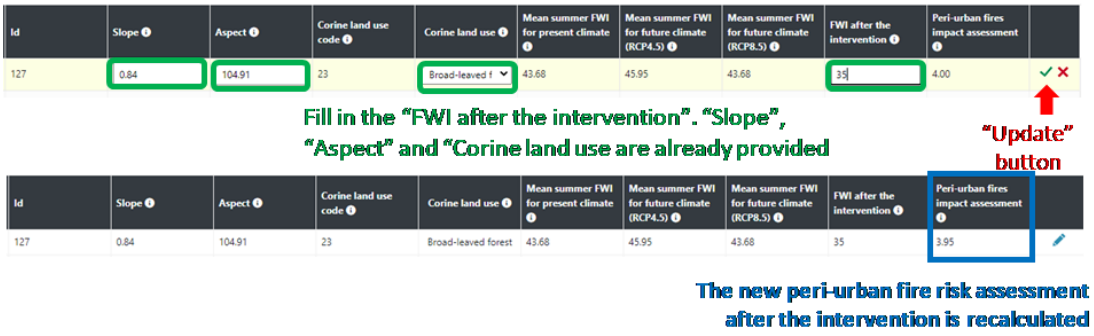


Figure 55: Set the values in the corresponding fields and press "Update" button (top). The new recalculated value of the impact is provided in the final column (bottom)

To calculate the FWI after the intervention, click on the Peri-urban fires section of Stage 5. On the initial screen with guidelines click on the link for calculating the FWI index (Figure 56).

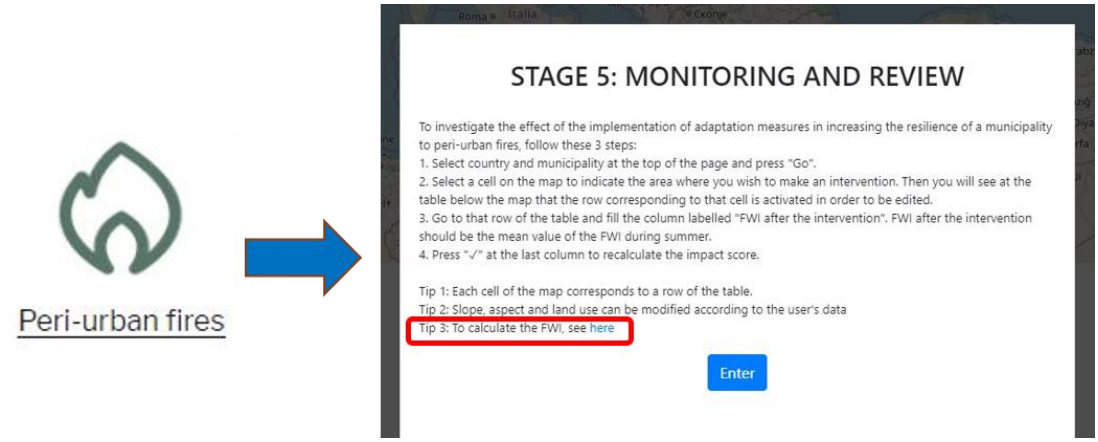


Figure 56: Steps for opening the online FWI calculator tool

After the above steps the online calculator opens where the user is able to calculate the FWI by inserting Date (mm/dd/yy), Temperature (°C), Relative humidity (%), Wind speed (kmh), and Precipitation (mm) according to the information provided on the portal (Figure 57). More specifically, the user should provide tabular data with the above parameters for all summer days and calculate the FWI respectively. After that, the mean value of the FWI (mean value from all summer days) should be inserted to the UrbanProof toolkit (Figure 57).

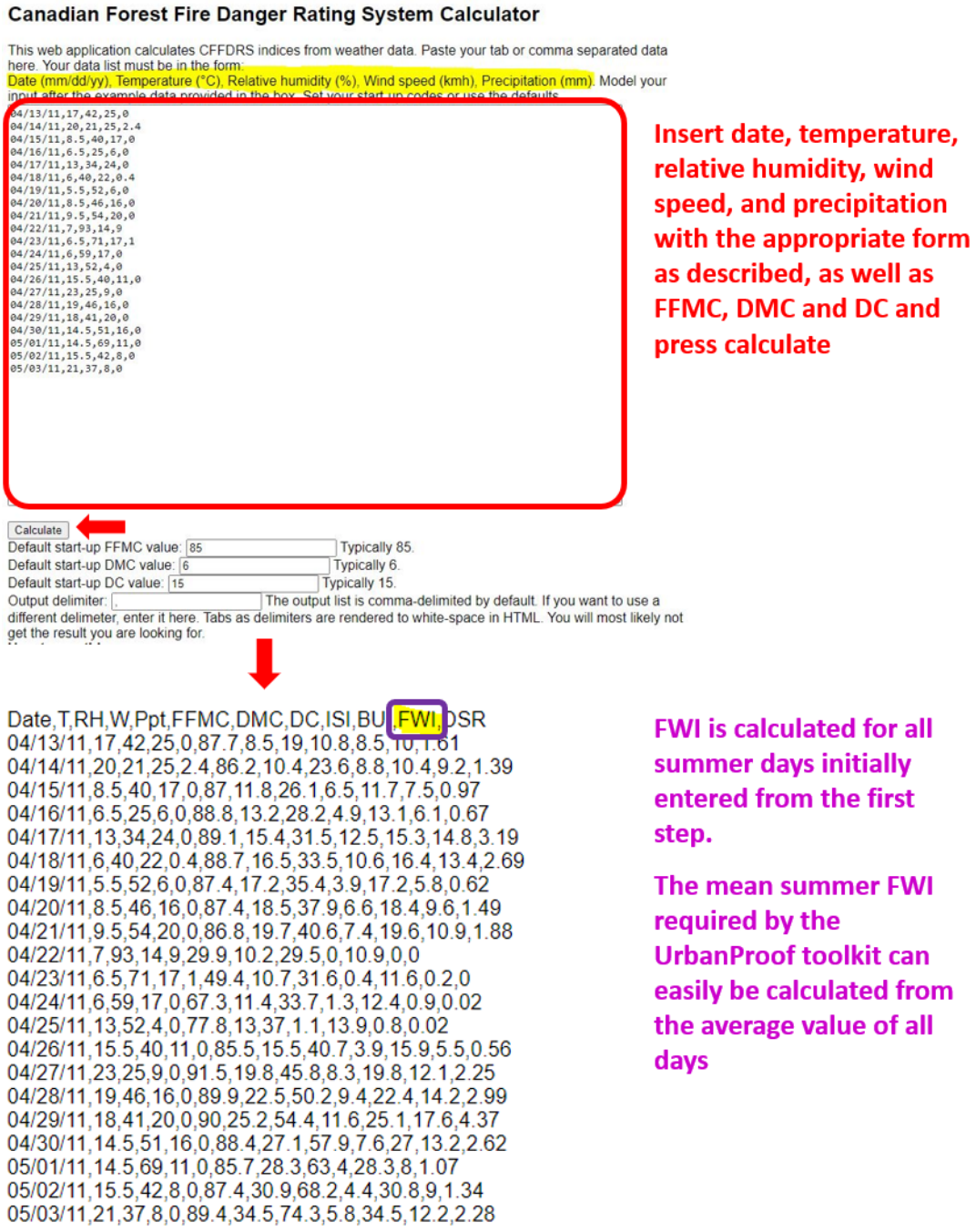


Figure 57: The online tool to calculate the requested "FWI after the intervention"

Finally, the user may change the contribution (weight) of each parameter (slope, aspect, land cover- flammability and FWI) used for the assessment of total peri-urban fire risk as seen in Figure 58. The sum of all given weights should always be equal to one (Figure 58).

Figure 58: Modify weights of hazard and exposure indicators

The effect of the implementation of the examined adaptation measures to the selected impact can be downloaded to be used in other applications by clicking on the "Download" button on the upper right part of the screen, as shown in Figure 59.

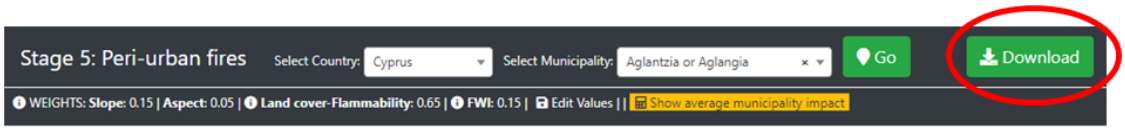


Figure 59: Download examined adaptation measures' effect to a selected impact

Electricity demand for cooling

As in previous cases, the user first selects the required impact, by clicking on the respective icon on the toolkit's homepage, in this case the "Energy demand for cooling" icon, and is directed to the home page of the Monitoring and review stage of the selected impact. On this screen, the user may select the country and the municipality that wishes to examine, at the top of the screen and press the "Go" button. The selected municipality appears on the screen separated in cells of different colour, depending on the value of the examined impact on each cell By clicking on "Show average municipality impact" a pop-up window appears where the use can examine the initial average value of the impact (before the implementation of adaptation measures) in the selected municipality (Figure 60).

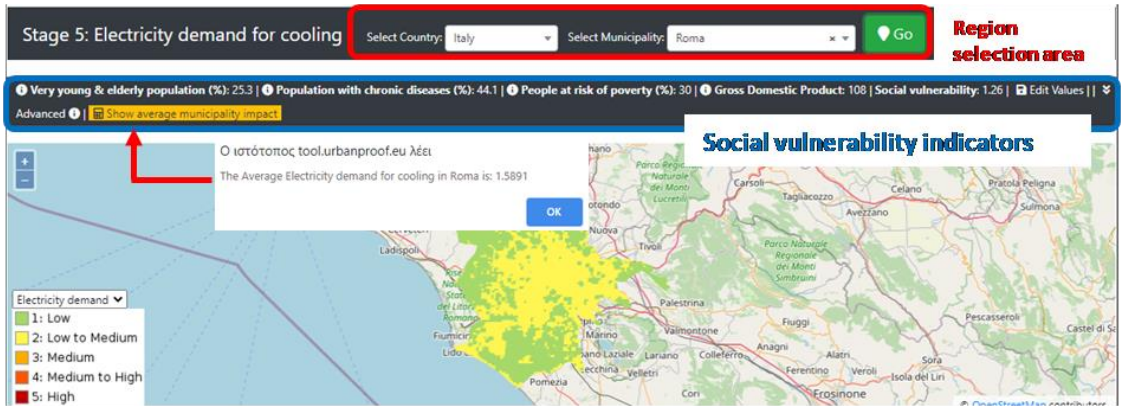


Figure 60: Top: Select Country and Municipality as well as social vulnerability indicators, Bottom: Municipality map view separated in cells

Below the map, a table appears where each row corresponds to a cell of the selected municipality. The parameters in this table correspond to hazard (Mean summer CDD, Base indoor temperature and Indoor temperature after the intervention) and exposure (Population density).

The final column ("Electricity demand for cooling") corresponds to the estimation of the total vulnerability after the implementation of adaptation measures in the specific Municipality's cell. (Figure 61).

Figure 61: Parameters for the monitoring of the effect of adaptation measures in electricity demand for cooling

The parameters displayed on the table below the map are explained in Table 5.

Population density	Density of population, expressed as the number of people per cell (500x500m)
CDD Indicator (Cooling Degree Days)	The indicator CDD (Cooling Degree Days), reflects the demand for energy needed to cool a building. In specific, the number of days where the Cooling Degree Days (CDD) is above 5 (i.e. days with great electricity demand for cooling) was used for the assessment of the climatic hazard. The vulnerability of the exposed population was estimated based on the composite Social Vulnerability index and the population density. The impact indicator is normalized in the scale [0 (low) – 5 (high)] to express different levels of impact.
Mean summer CDD for present climate	Mean value of the Cooling Degree Days index during summer for present climate
Mean summer CDD for future climate (RCP4.5)	Mean value of the Cooling Degree Days index during summer for future climate based on the RCP4.5 emissions scenario
Mean summer CDD for future climate (RCP8.5)	Mean value of the Cooling Degree Days index during summer for future climate based on the RCP8.5 emissions scenario
Base indoor temperature	Set the desired base temperature (the room temperature after which the need for cooling starts
Indoor temperature after the intervention	Calculate the average indoor temperature during summer after the implementation of adaptation interventions.
Electricity demand for cooling	Electricity demand for cooling assessment (scale 1-5)after the implementation of adaptation interventions.

Table 5: Parameters desscription

By selecting a cell on the map, the table goes to the cell's corresponding row, where values can be edited to evaluate the impact of an intervention (Figure 62).

Figure 62:Select cell on the map, zoom table to the selected cell

In this row, the user may enter the Base indoor temperature as well as the Indoor temperature after the intervention which are basically the two parameters needed to calculate the CDD index after the adaptation interventions. Additionally, the user is able to change the preexisting value of the population density if new updated data are available (Figure 63).

Figure 63: Parameters that have to be filled for the monitoring of the effect of an adaptation measure on electricity demand for cooling

After setting the desired values, by pressing the "Update" button, the impact score is recalculated and shown on the relevant table field (Figure 64).

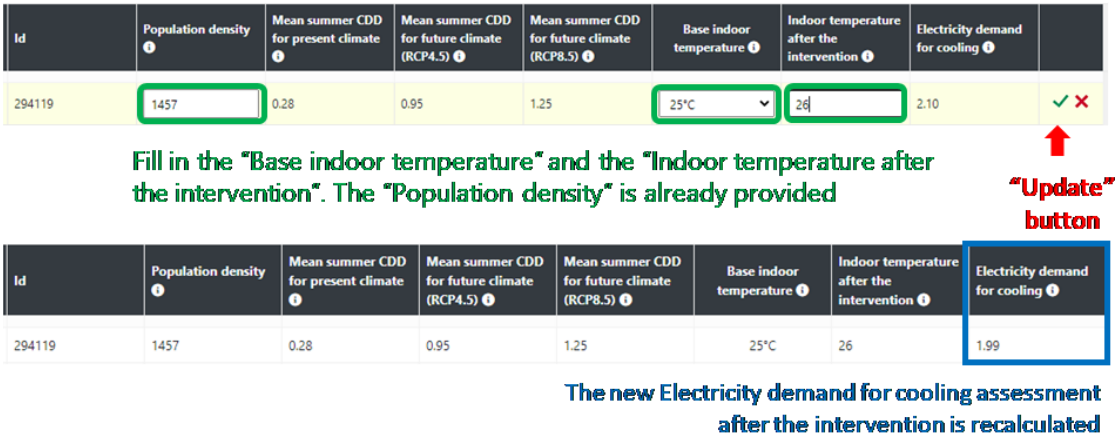


Figure 64: Set the values in the corresponding fields and press "Update" button (top). The new recalculated value of the impact is provided in the final column (bottom)

As in the case of floods, the user is able to edit the default values of the social vulnerability parameters shown below the region's selection area, to affect the result on impact calculation. The values of social vulnerability parameters can be edited by clicking on the "Edit values button", inserting the values that the user wishes and then clicking on the "Save values" button (Figure 38).

Although you can update all the fields concerning social vulnerability indicators, you are advised to change the default values only if you have available reliable updated data concerning these fields

The effect of the implementation of the examined adaptation measures to the selected impact can be downloaded to be used in other applications by clicking on the “Download” button on the upper right part of the screen, as shown in Figure 65.

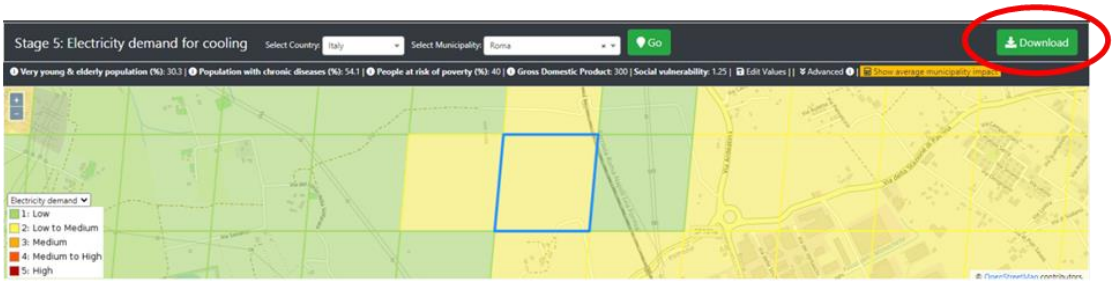


Figure 65: Download examined adaptation measures' effect to a selected impact