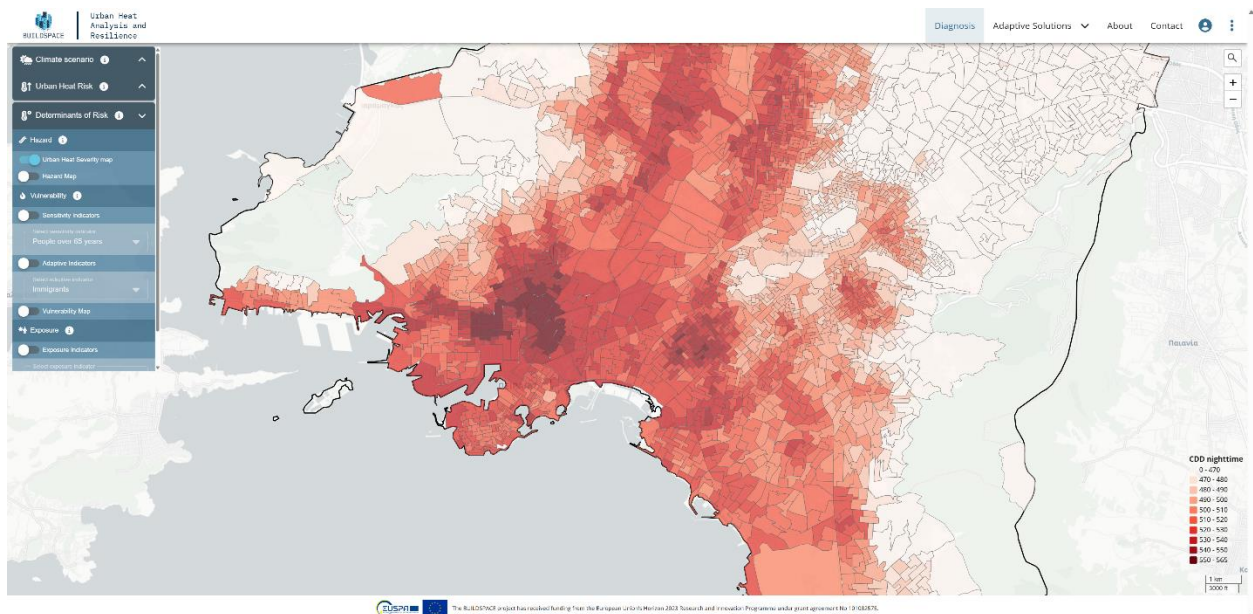




Enabling Innovative Space-driven Services for Energy Efficient Buildings and Climate Resilient Cities

BUILDSPACE Service: Urban heat analysis and resilience – Step-by-step user guide



BUILDSPACE offers a set of interactive, city-scale services that help urban planners, municipalities, and decision-makers understand how climate change affects buildings and neighbourhoods. These services combine satellite data (Copernicus, EGNSS), local information and advanced modelling to visualise risks and opportunities for energy, heat and floods. Through intuitive map-based tools, cities can explore their current situation, test future scenarios, and assess strategies for resilience and sustainability. Each service focuses on a different aspect of urban resilience, but together they provide a common decision-support framework for climate-smart planning.

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Abbreviation and acronyms

Acronym	Description
BED	Building Energy Demand
CDD	Cooling Degree Days
GIS	Geographical Information System
SE4	Service 4. Urban Heat Analysis and Resilience
SSP	Shared Socioeconomic Pathways
UCZ	Urban Climate Zones
UHR	Urban Heat Risk

1 Introduction



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101082575.

This step-by-step guide is designed to help users navigate and effectively use the Urban Heat Analysis and Resilience web application. Whether you are a city planner, researcher, policymaker, or simply interested in understanding urban heat patterns and resilience in your area, this guide will walk you through each key feature of the tool.

By the end of this guide, you will be able to:

- Access and explore the web application from your browser
- Understand the layout and main components of the user interface
- Select and view different urban heat and resilience indicators on the map
- Interpret visual results, including map layers and colour legends
- Compare different areas or indicators
- Export data and maps for further use in reports or analysis

No prior Geographical Information System (GIS) is required. The guide is written in plain language and includes annotated screenshots to support each step.

Throughout this guide you may come across some terminology that you are not familiar with, but don't worry! We have added a glossary at the end of the document, which is also available in the service application.

The Urban Heat Analysis and Resilience service (SE4) addresses the increasing concern over urban heat and its social and environmental impacts. It is designed to assess urban heat risk at high spatial resolution by combining heat exposure data with demographic and socioeconomic indicators. This enables the evaluation of social vulnerability to heat, highlighting which sections of the urban population are at greatest risk due to factors such as education levels, household composition, etc. The service also focuses on assessing how urban heat impacts on the energy demand of buildings and supporting climate adaptation and mitigation strategies for urban stakeholders. The service is designed with replicability across European cities in mind, using open data sources and flexible methodologies to ensure broad applicability.

This guide will help you make most of the SE4 web application by providing a clear and practical overview of its features and functionalities. Whether your aim is to explore spatial patterns of heat exposure, identify vulnerable populations, or support local decision-making processes, the tool offers a user-friendly platform for analysis and insight.

System requirements:

The application runs entirely in a web browser and requires no installation. A stable internet connection is recommended. For optimal performance, use an up-to-date version of Google Chrome, Mozilla Firefox, or Microsoft Edge on a desktop, laptop or tablet.



2 Getting started

2.1 Log in

To access the service application go to <https://buildspace-s4.web.app/> and click on the user icon in the top right corner to log in. Once you log in, you will be redirected to the application landing page.

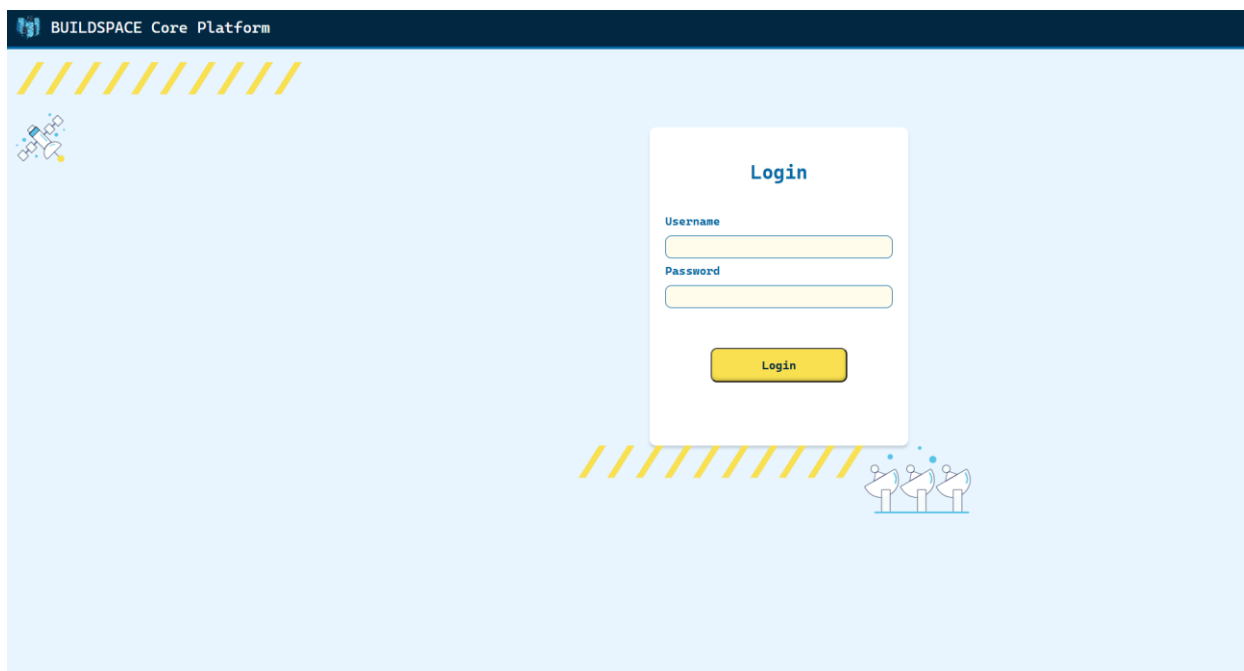


Figure 1. Log in page

2.2 Landing on the main interface

To begin using the Urban Heat and Resilience Analysis web application, follow these steps:

1. Open your preferred web browser (e.g. Chrome, Firefox, Safari)
2. Go to the following URL: <https://buildspace-s4.web.app/>
3. A welcome window will appear, close it and then Log In in the user icon in the upper left menu bar.
4. The application will load automatically.



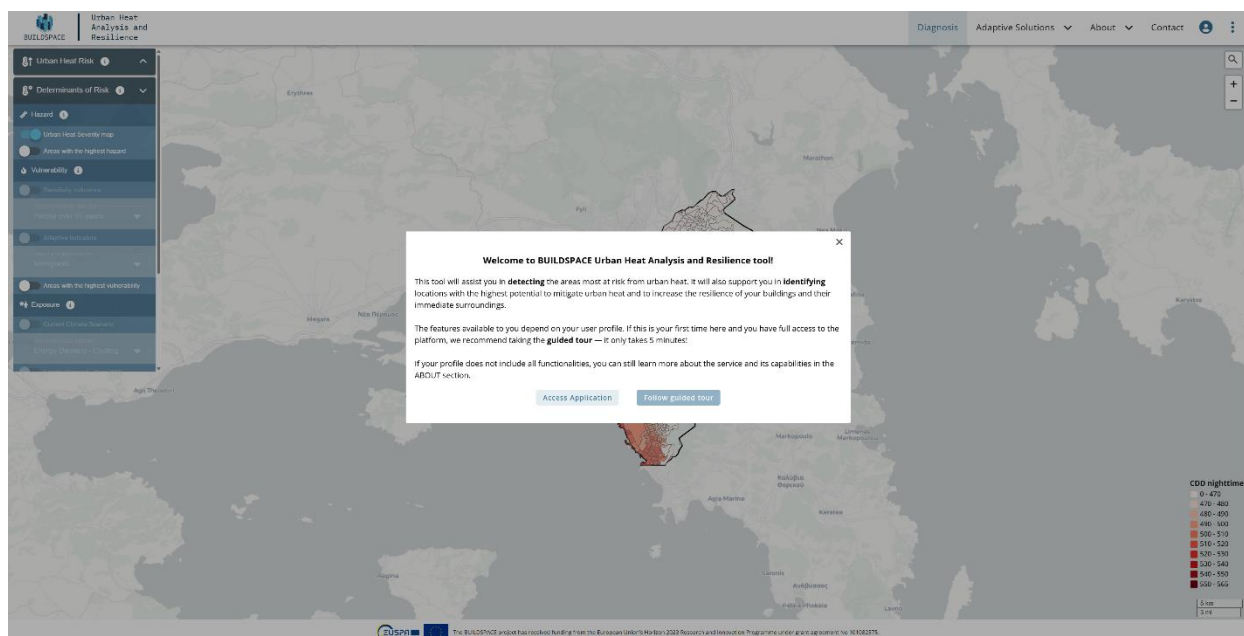


Figure 2. Landing on the SE4 application

3 Navigating the interface

3.1 Map Controls

Once the application has loaded, a pop-up window will appear providing a brief description of SE4 and giving you the option to follow a guide tour. For this guide purpose, is not necessary to perform the guide tour. After closing that window, you will see a map-centred interface with several control panels and options (**Figure 3**). The main components are:





BUILDSPACE

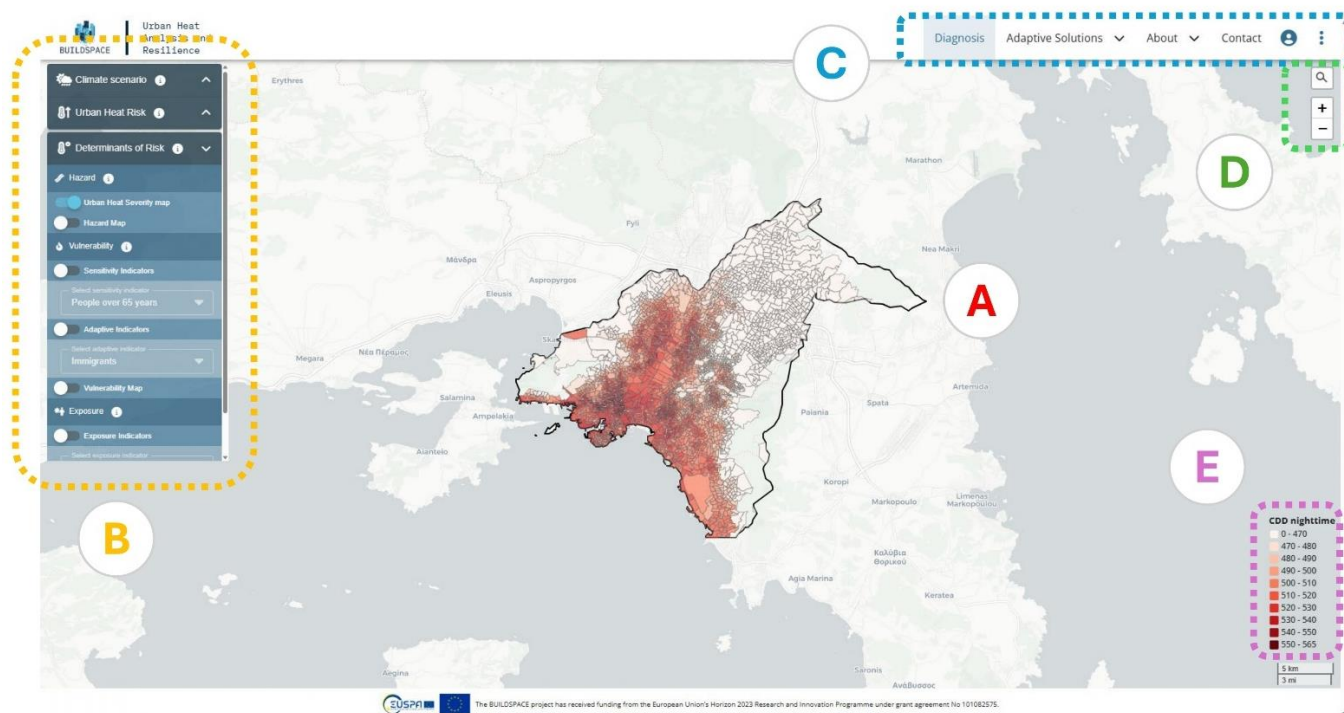


Figure 3. Overview of the key interface components of SE4 application.

- A. Interactive map:** Displays spatial data layers. You can zoom in/out and pan to different areas.
- B. Left Panel (Indicator selection):** Allows you to choose the indicator you wish to visualise. Options include urban heat severity metrics, socio-economic and gender vulnerability, capacity to adapt. Bonus track: in each layer you'll see an 'i' icon, click on it to have a quick description of the layer.
- C. Top Toolbar:** Here you can switch between the Diagnosis and the Adaptive Solutions section. Also, you can find the following: Information about the BUILDSPACE project and the Service 4; Contact info; User profile management and by clicking on the three dots the Guide tour and Download data section.
- D. Zoom buttons:** Zoom in button (+), and zoom out button (-)
Search bar: Use this search engine to find specific addresses or locations
- E. Legend:** Located at the bottom left, the legend of the activated map will appear here, indicating the unit of measurement. If more than one map is selected, it will become a scrollable element.



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Let's explore first the 'Diagnosis' section. Here you will find the results of the urban heat risk analysis, providing layered insights into hazard, vulnerability and exposure.

4 Climate scenario selection

In this section, you will be able to obtain estimated information on how each one of the identified Urban Climate Zones (UCZ) will be affected depending on the future climate scenario and time frame selected. The UCZs were constructed on the Athens metropolitan scale.

1. Turn the Climate scenario toggle on
2. Click on the pencil icon to select the future climate scenario and time frame. When selected, a description of the climate scenario can be found in the upper right-hand corner (**Figure 4**).
3. Now click on any of the UCZ and check out the data shown at the bottom of the display. Besides the information related to climate severity, you will have at your disposal the weather file for that UCZ for the selected scenario and time frame. This can be used in building energy simulations (**Figure 5**).

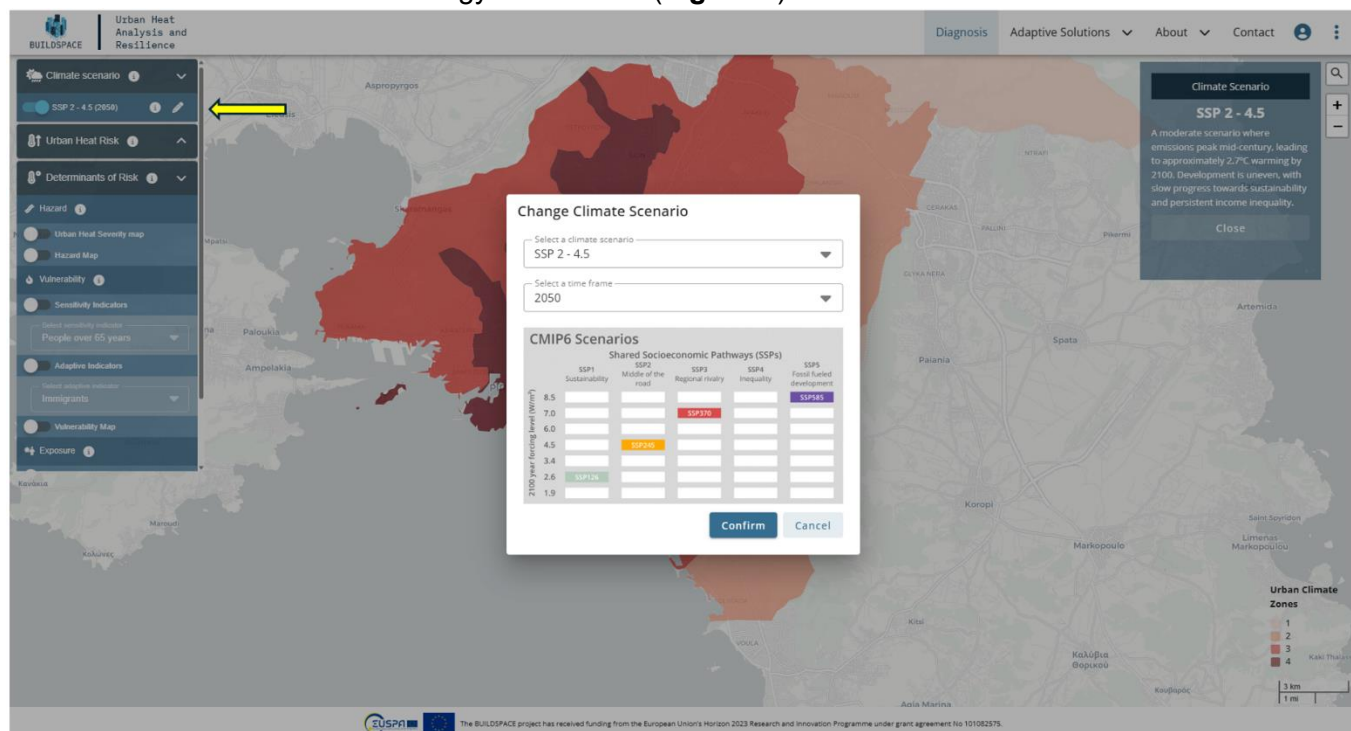


Figure 4. Climate scenario selection

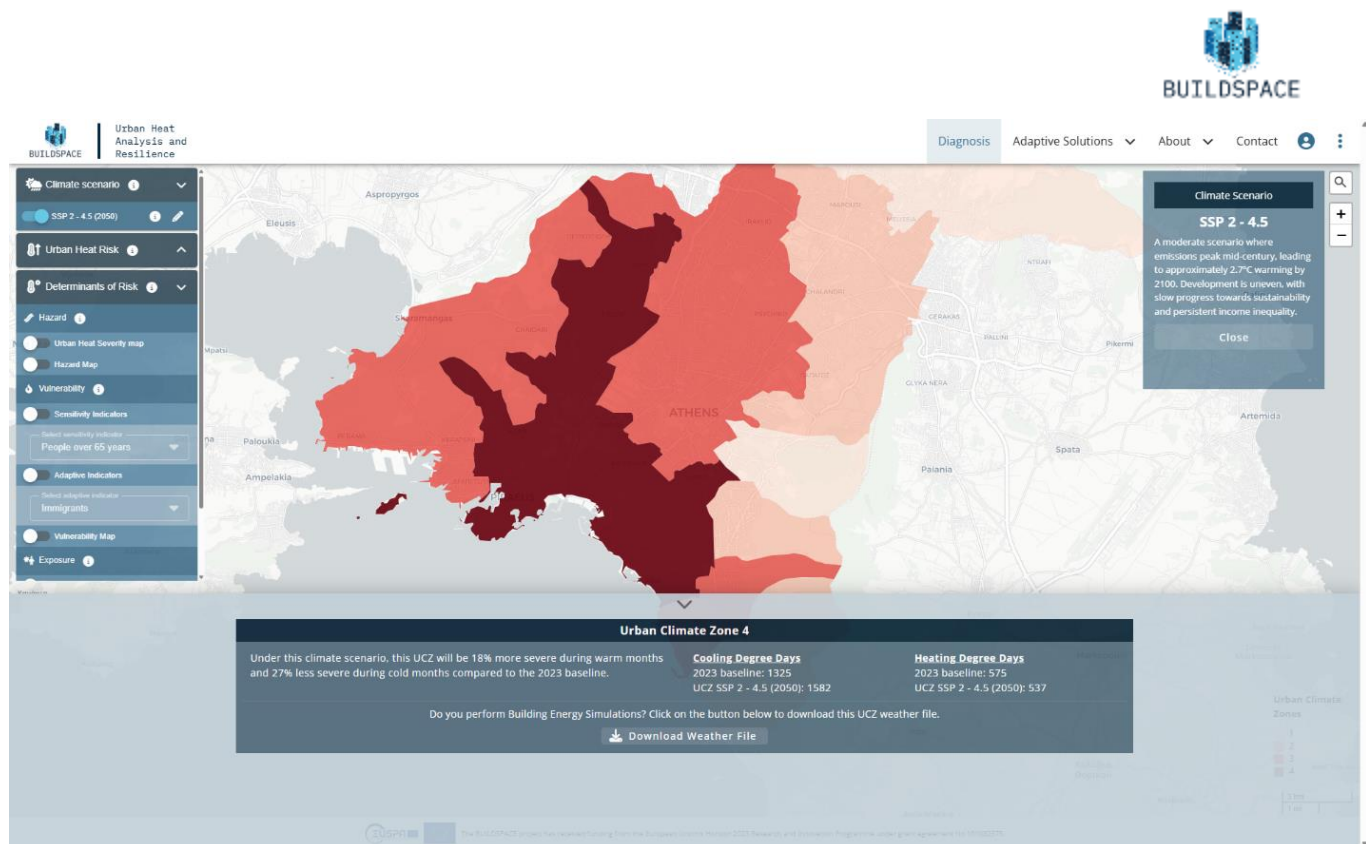


Figure 5. Estimated information for the selected UCZ.

5 Urban Heat Risk

Now, we'll look at the Urban Heat Risk (UHR) related indicators. Except for the indicators related to climate severity (hazard), which have been calculated at the Athens metropolitan scale, all other indicators (vulnerability, exposure) are available exclusively for the municipality of Piraeus at the census tract scale.

While an estimate has been made of how UCZ conditions could change under future climate scenarios, for socio-economic and demographic indicators they show data only for the current climate scenario. Finally, indicators related to the climate severity (UHR, Urban Heat Severity map and Hazard map) have been calculated based on a Typical Meteorological Year.

First, let's check out the Urban Heat Risk map. This map is the result of the overlapping combination of the three determinants of risk: hazard, vulnerability and exposure. The indicators shown in this layer are located in the most unfavourable quintile of the entire municipality.

1. Turn off the toggle from the Climate Scenario section and turn on the one from Urban Heat Risk
2. Hover around over the different census tracts to obtain statistical data.



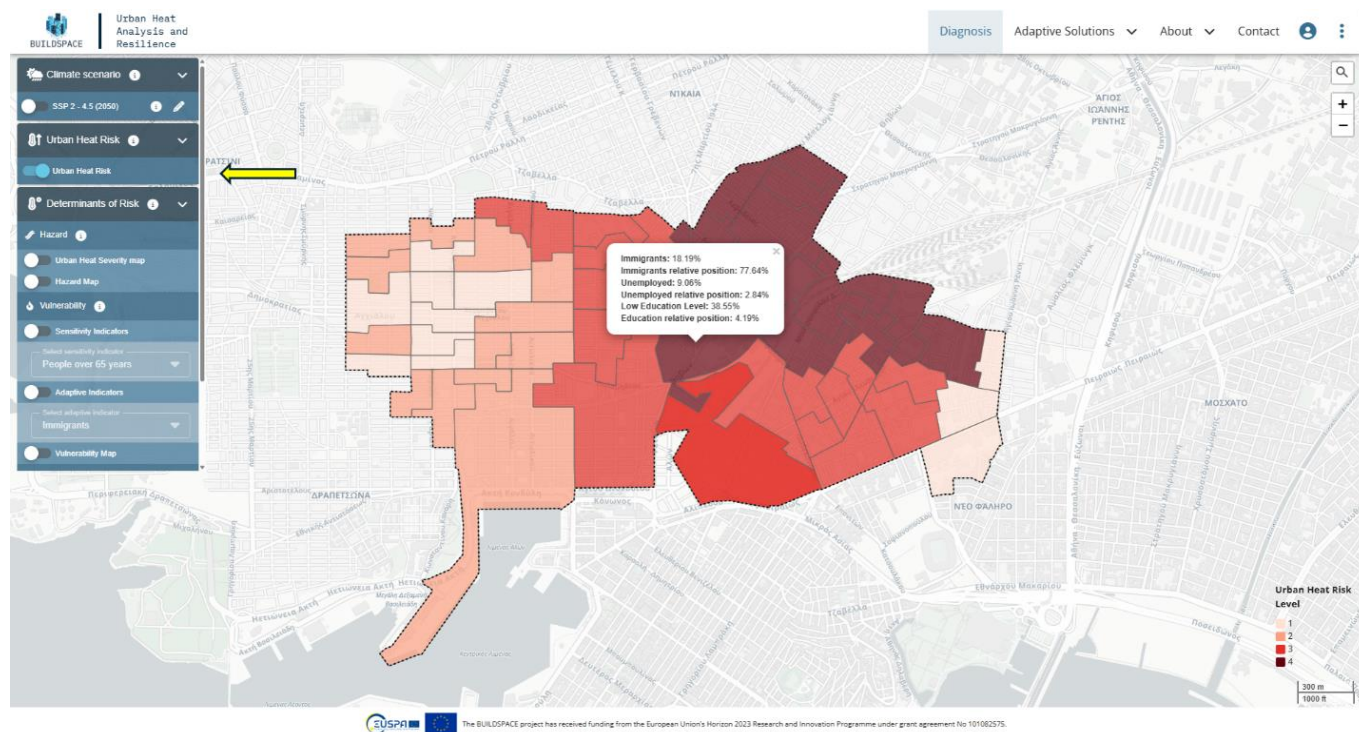


Figure 6. Urban Heat Risk map.

6 Determinants of Risk

As mentioned in the previous step, risk is constructed from three determinants: hazard, vulnerability and exposure. Now we will activate each of these and explore what we can find.

6.1 Hazard

Let's explore the Hazard section:

1. In case you have activated the layer from the UHR map, now turn the toggle off.
2. Activate the Urban Heat Severity map. At the bottom right corner, you can see the legend with the measure unit, in this case, to measure heat severity, we have used the Cooling Degree Days (CDD) unit. The higher the CDD value, the greater the severity. (**Figure 7**)
3. Now, let's activate the Hazard map. What you are looking at here is the identification of spatial clusters of high CDD values, i.e. where census tracts with higher heat severity are clustered. These can be referred as urban heat 'hotspots'. (**Figure 8**)



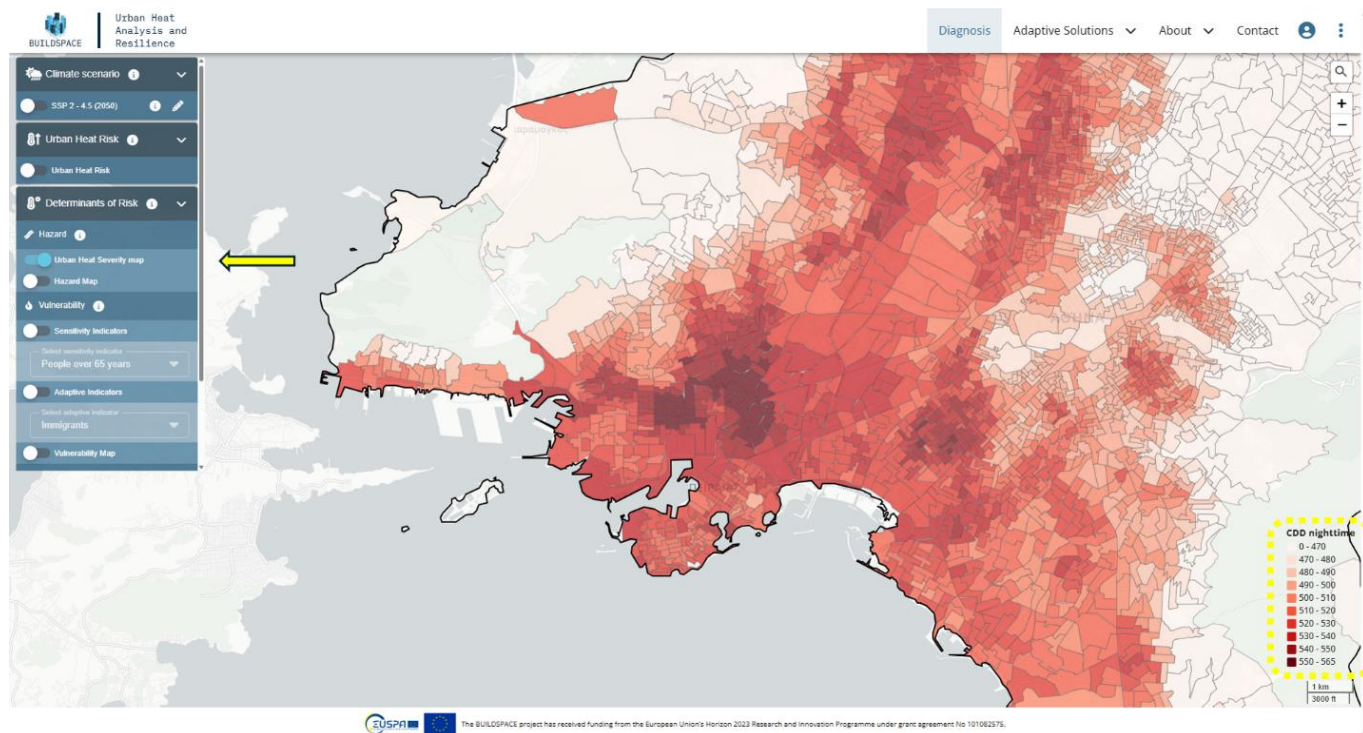


Figure 7. Urban heat severity map.



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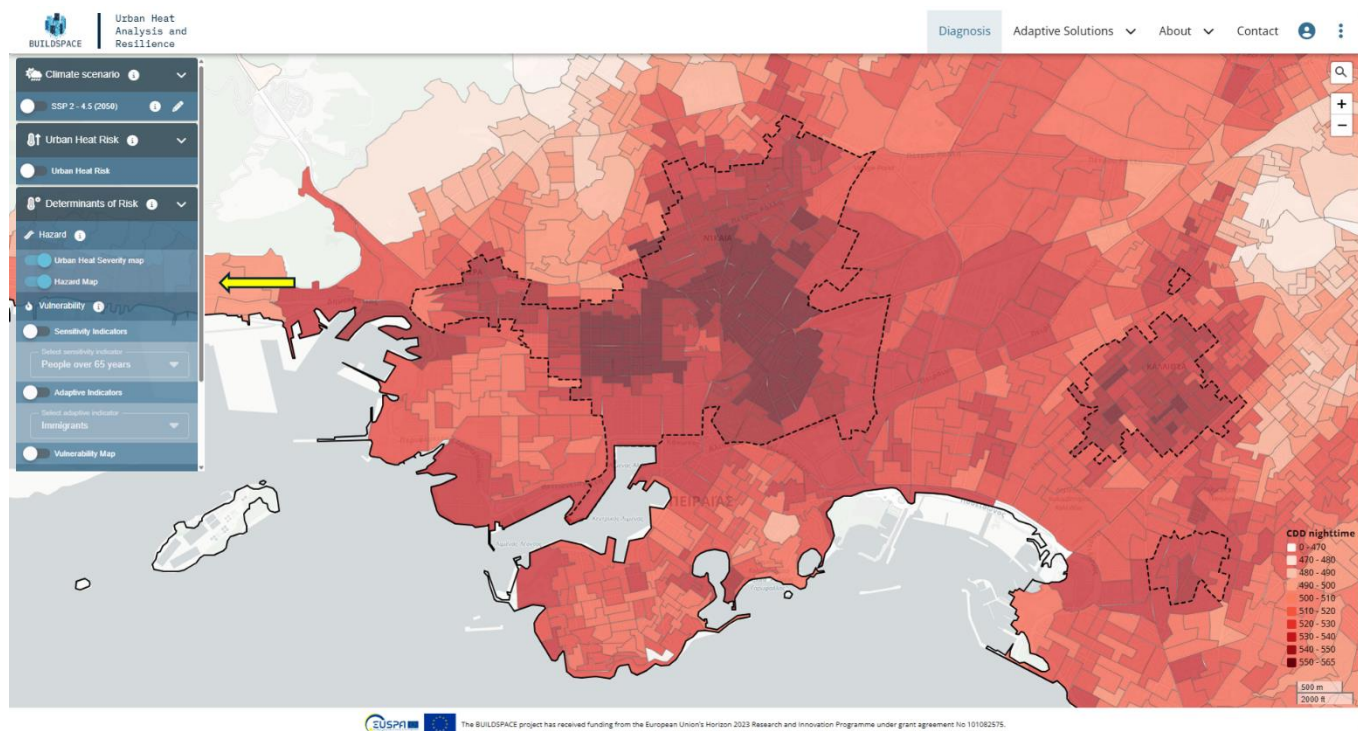


Figure 8. Hazard map.

6.2 Vulnerability

Here we will explore the indicators that form the basis of the SE4 vulnerability analysis. The indicators you have at your disposal have been selected from a literature review that shows a direct link to how heat has a major impact on the population groups. The indicators are divided into two groups: sensitive and adaptive.

1. Turn off the Hazard maps, and toggle on the Sensitive indicators
2. If you hover over the census tract automatically a pop-up window will appear with statistical information. (**Figure 9**)
3. Then, click on any of the census tracts. You will now see a window appear from the bottom. Here you can view more detailed statistical information related to the indicator in the selected census tract. (**Figure 10**).
4. Repeat the same steps but for the Adaptive indicators and explore the data.



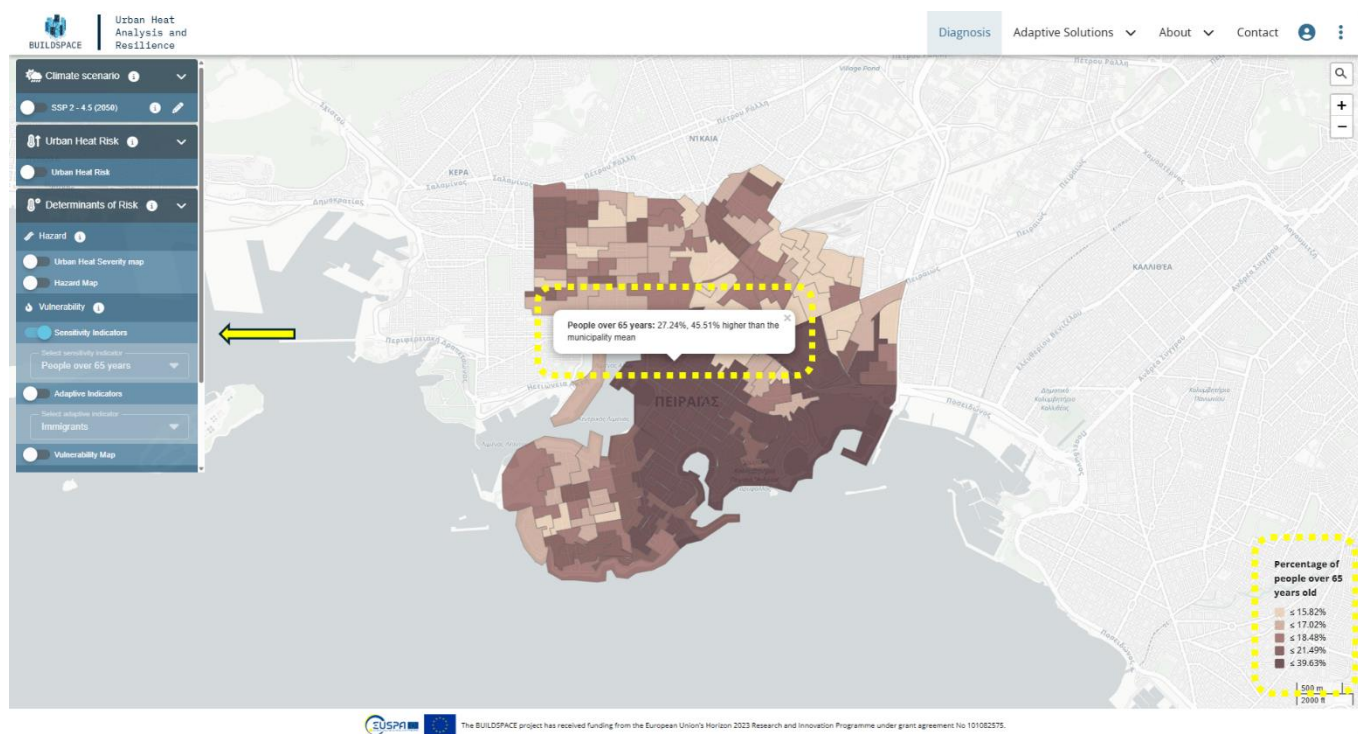


Figure 9. Vulnerability – Sensitive indicators map.

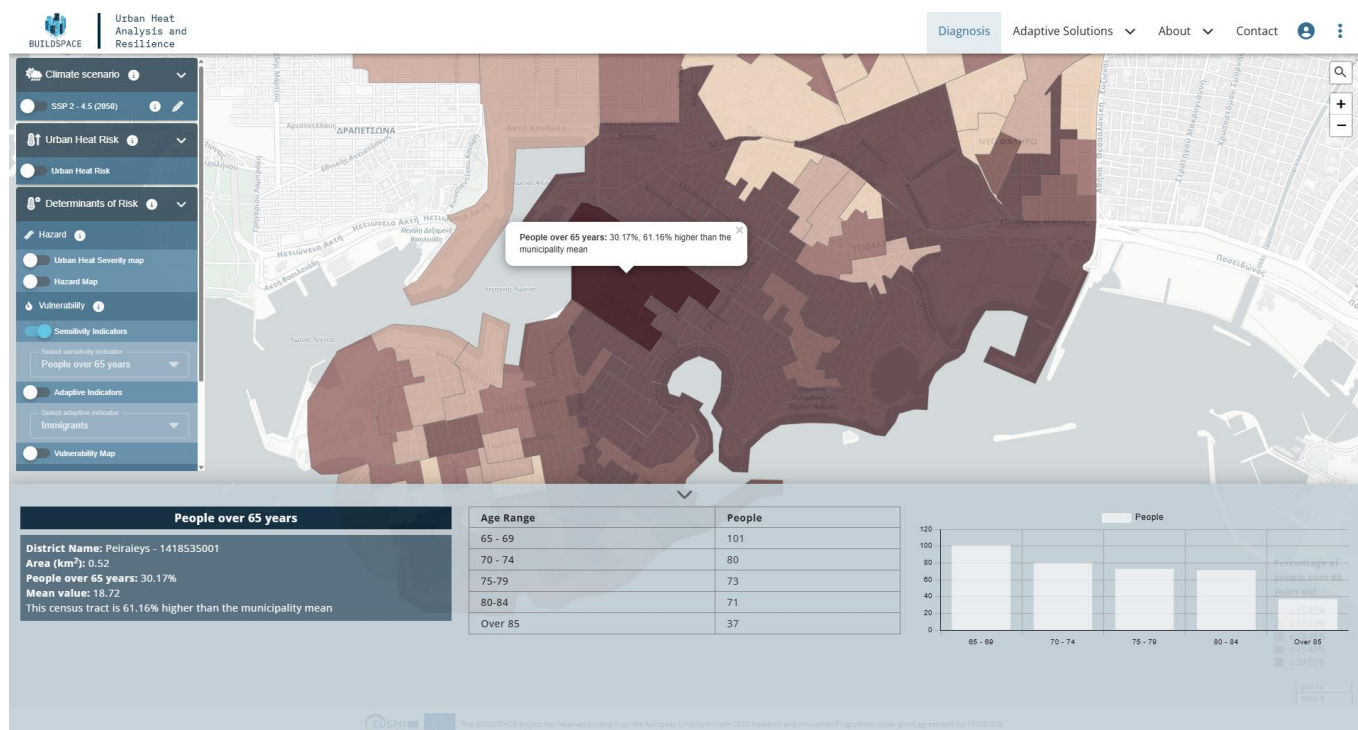


Figure 10. Statistical information for the selected census tract.



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6.3 Exposure

This is the last determinant of risk. Exposure identifies where the most exposed population is concentrated (population density) and where the most energy-deficient buildings are located and which are therefore assumed to be more overheated inside during the summer season.

In SE4 we have utilized two indicators:

- Population density
- Building Energy Demand (BED)

For the BED layer, it has been calculated for the current and future climate scenario. Choose one of them to explore its data.

1. Turn on the Exposure toggle. (**Figure 11**)
2. Select one of the available BED layers.
3. Click in one the buildings. Statistical information will appear. (**Figure 12**)

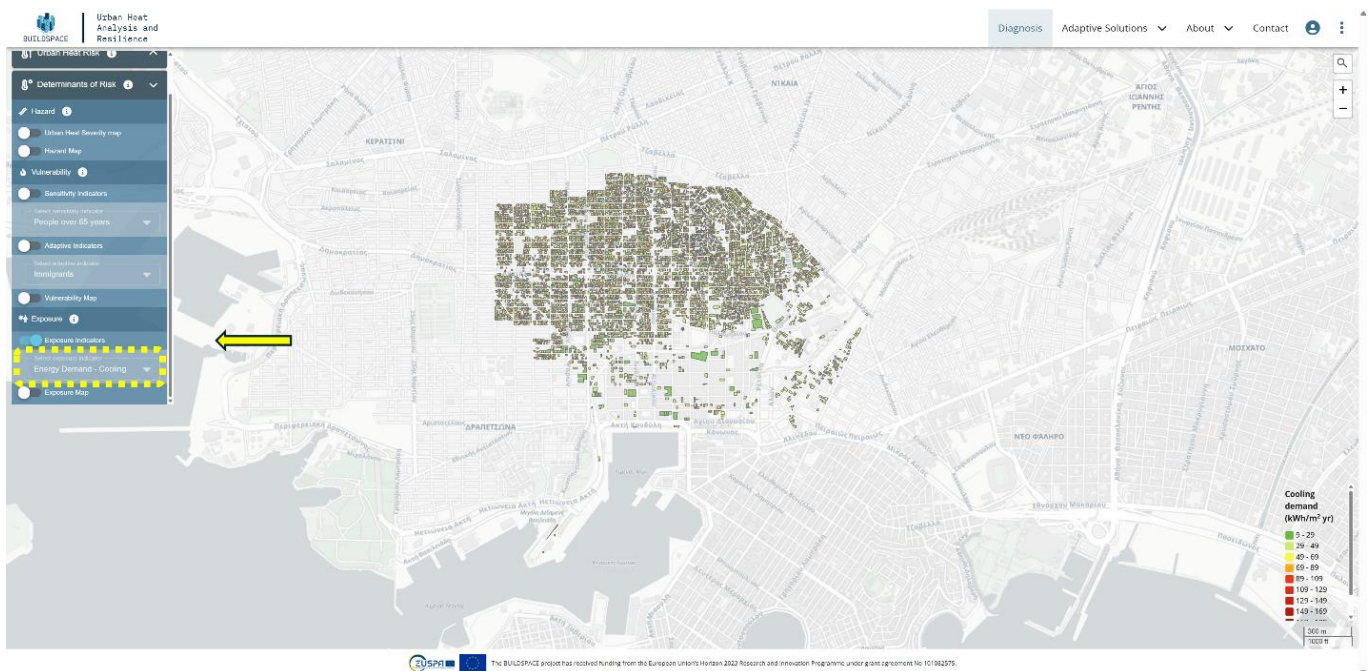


Figure 11. Exposure – Building Energy Demand



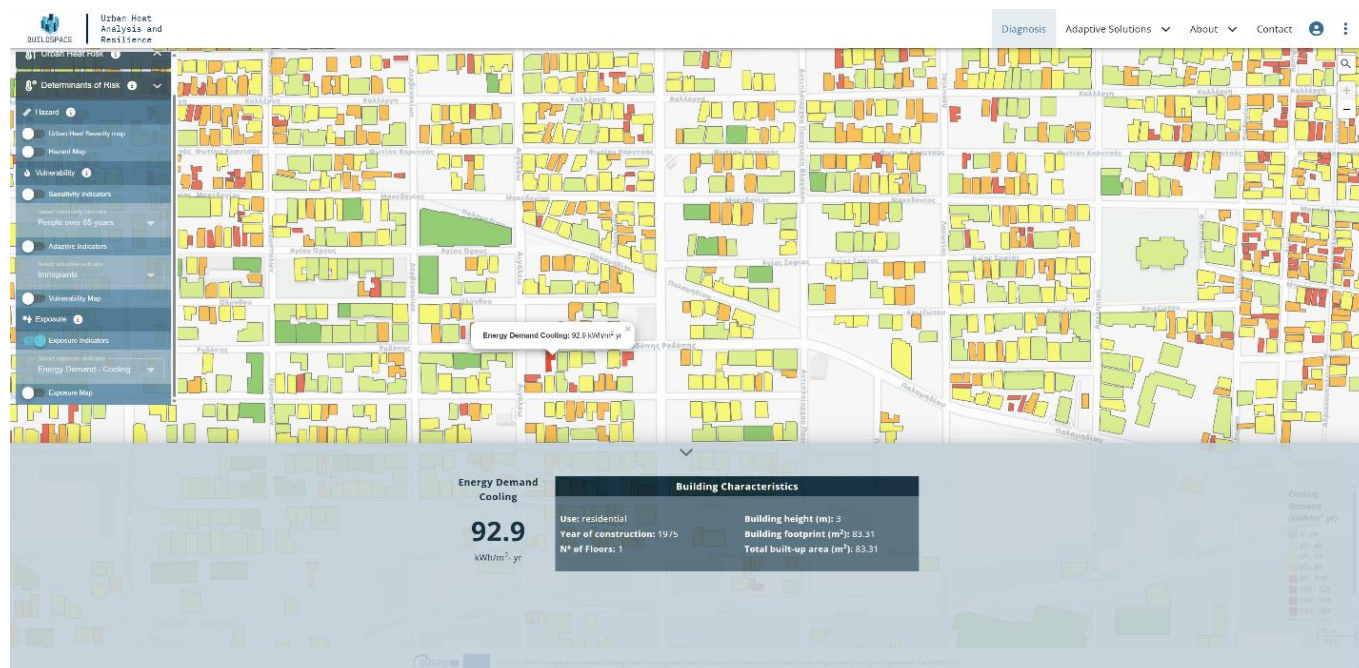


Figure 12. Building Energy Demand statistical information.

7 Adaptation Solutions

Now that you are familiar with the ‘Diagnosis’, we invite you to explore ‘Adaptive Solutions’. This section provides a comprehensive catalogue of strategies to address urban heat and enhance resilience. It also includes an interactive viewer displaying priority areas for action, based on the suitability of different solution types.

1. On the top tool bar, click on ‘Adaptive Solutions’ (**Figure 13**). A drop-down menu will appear. Let’s begin with the adaptive solutions catalogue:
2. Click on ‘What can we do?’
3. The catalogue has been classified in four different categories: Collect heat, Evade heat, Deviate heat and Reduce heat.
4. For demonstration purposes let’s click on ‘Avoid heat’. (**Figure 14**) Now you can choose one category: Solar or Heat prevention.
5. Click on ‘Solar prevention’ (**Figure 15**). Now the application will show you solutions at city, building and human scale. Note: not all the solutions are available for all scales.



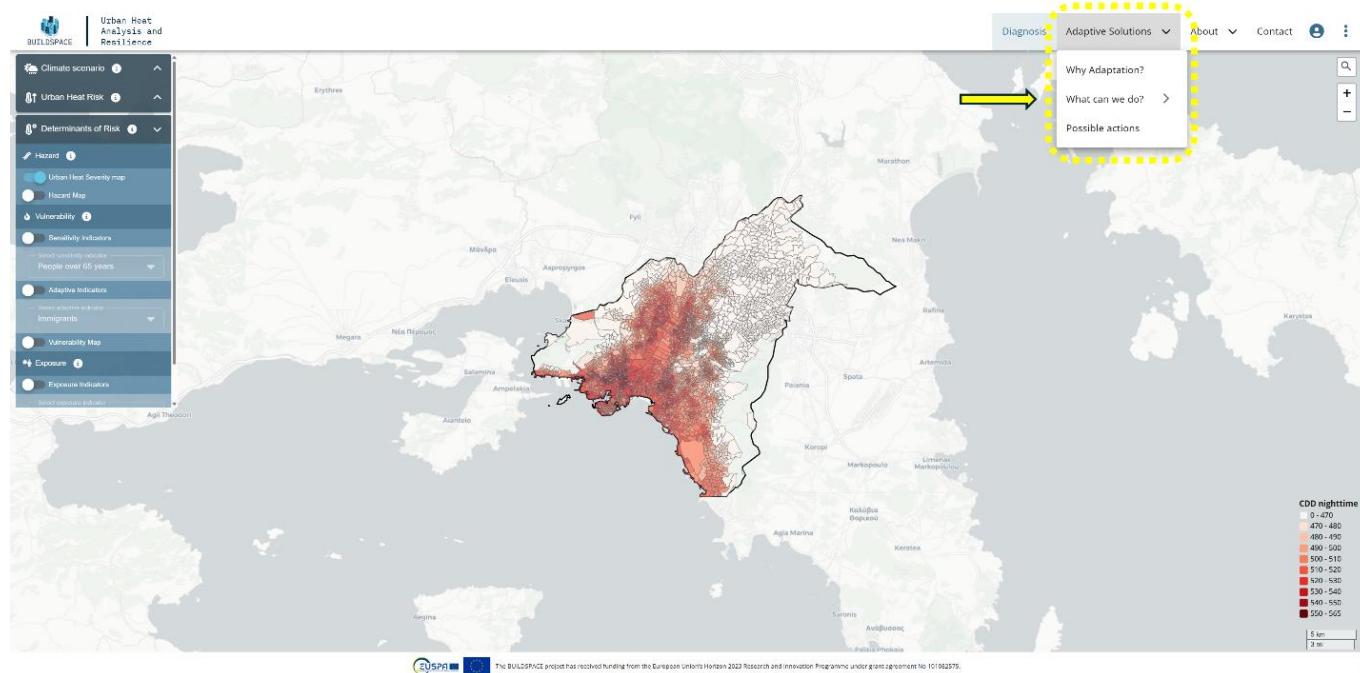


Figure 13. Adaptive Solutions section.

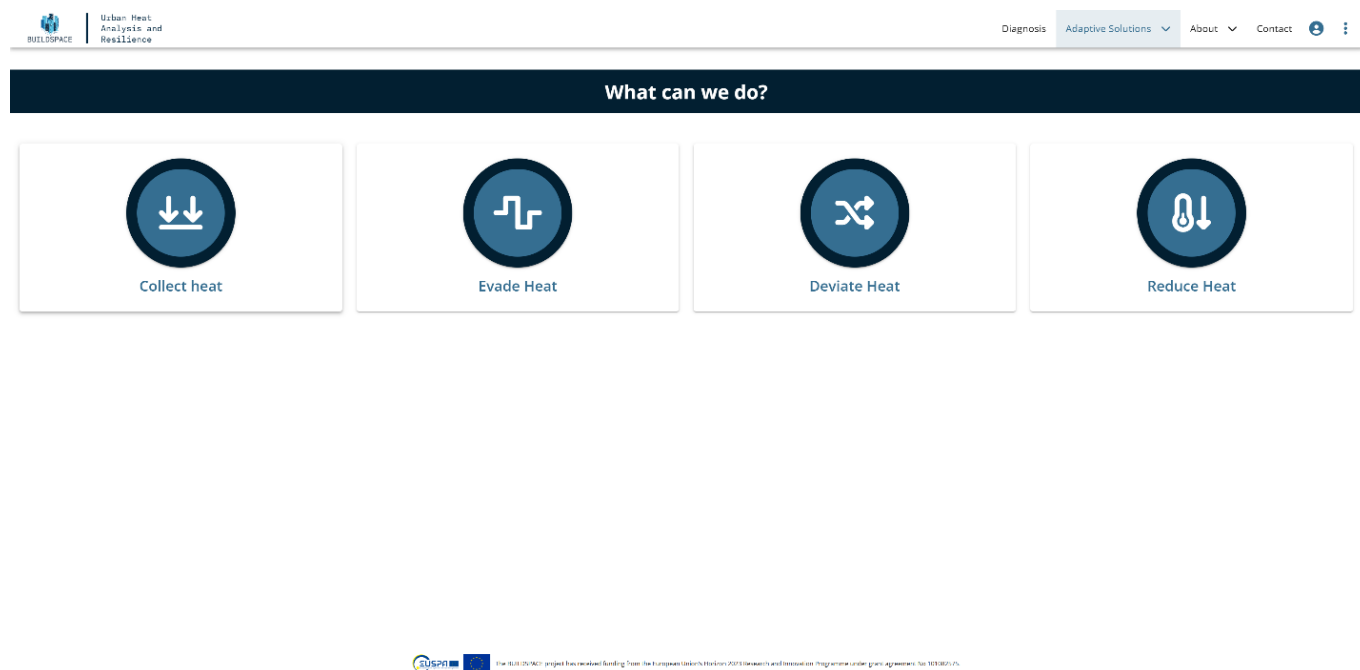


Figure 14. What can we do? – Adaptive and mitigation solutions catalogue.



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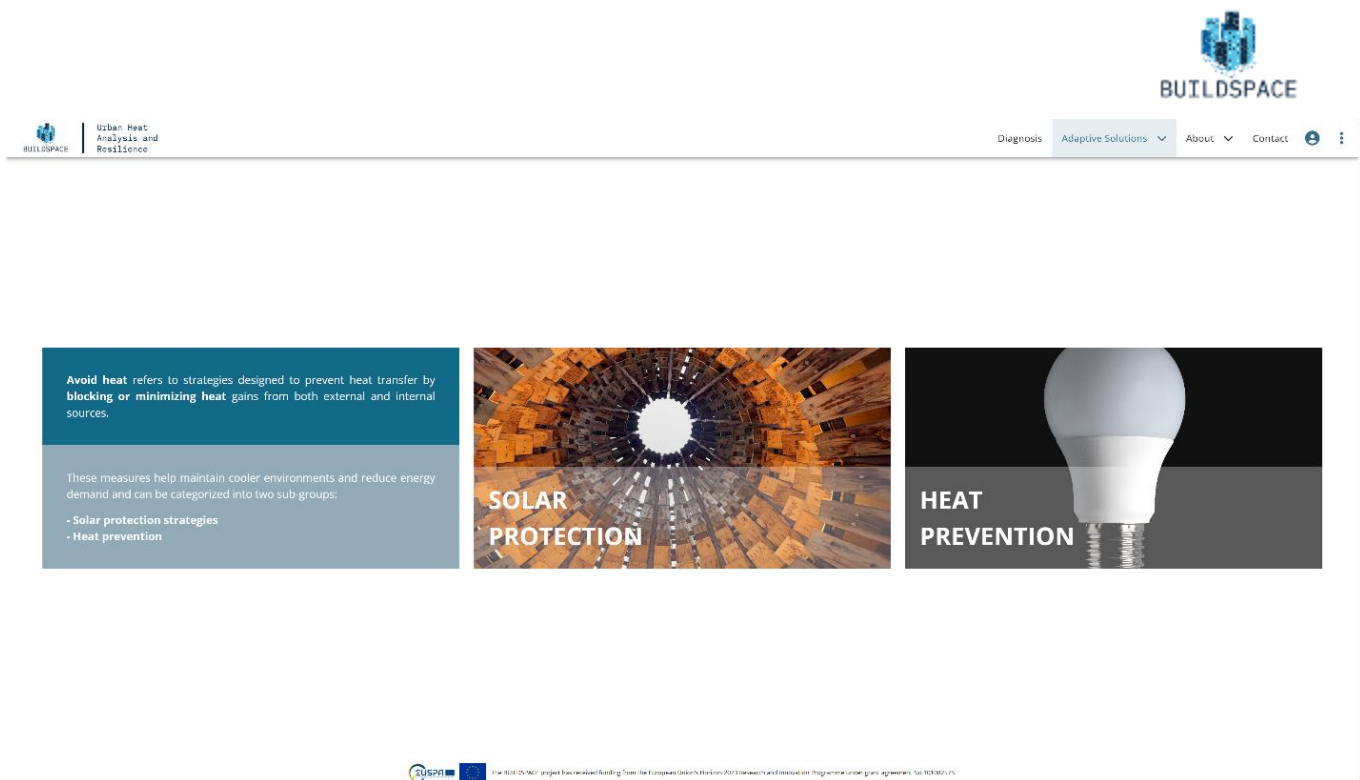


Figure 15. Avoid Heat section.

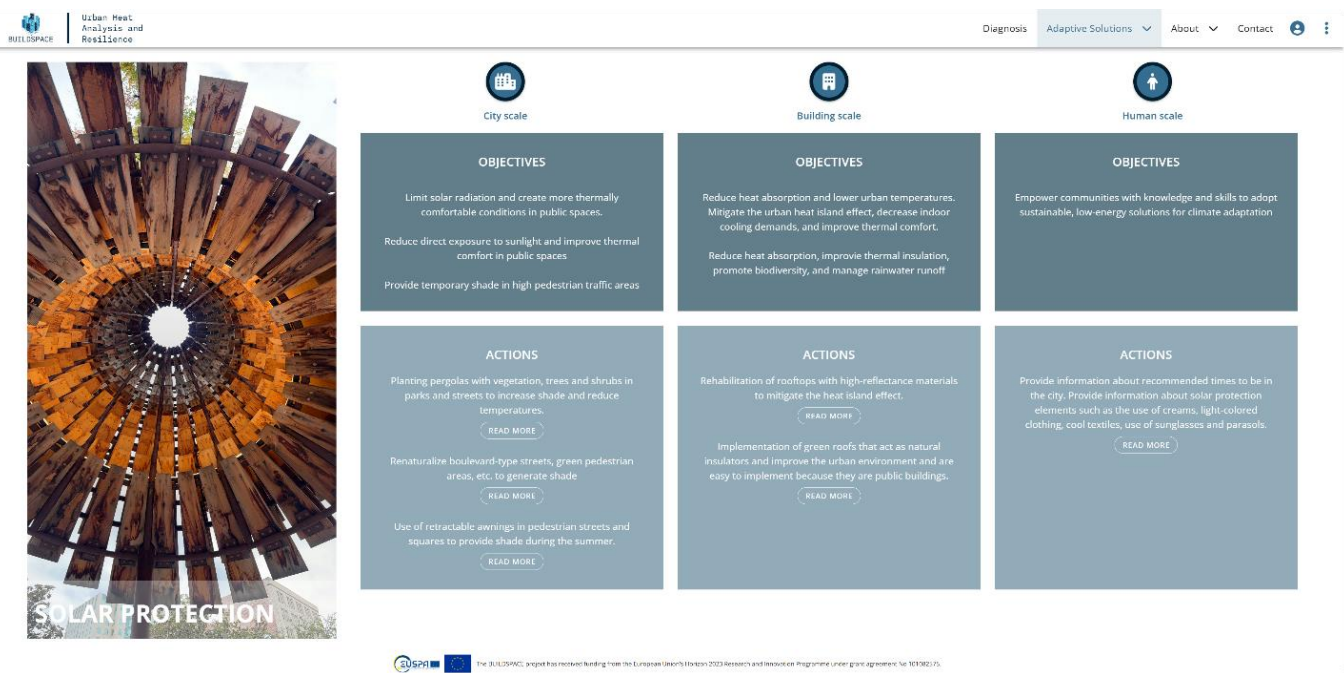


Figure 16. Solar protection solutions for three scales: City, Building and Human.



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Next, we are going to visualize which parts of the municipality have priority for action depending on the type of strategy and scale of intervention:

1. On the top tool bar, go to 'Adaptive Solutions', and then 'Possible actions'. (**Figure 17**)
2. Now you will see the Piraeus' municipality delimitation on the map. On the left bar menu (**Figure 18**), you have some of the possible solutions we could implement in Piraeus and these are divided by type of strategy and subdivided by scale of intervention.
3. Click on 'Increase vegetation coverage in public spaces'. Zoom in and explore the streets that should be prioritised for this type of intervention. On the right upper corner you can find detailed information regarding this solution.

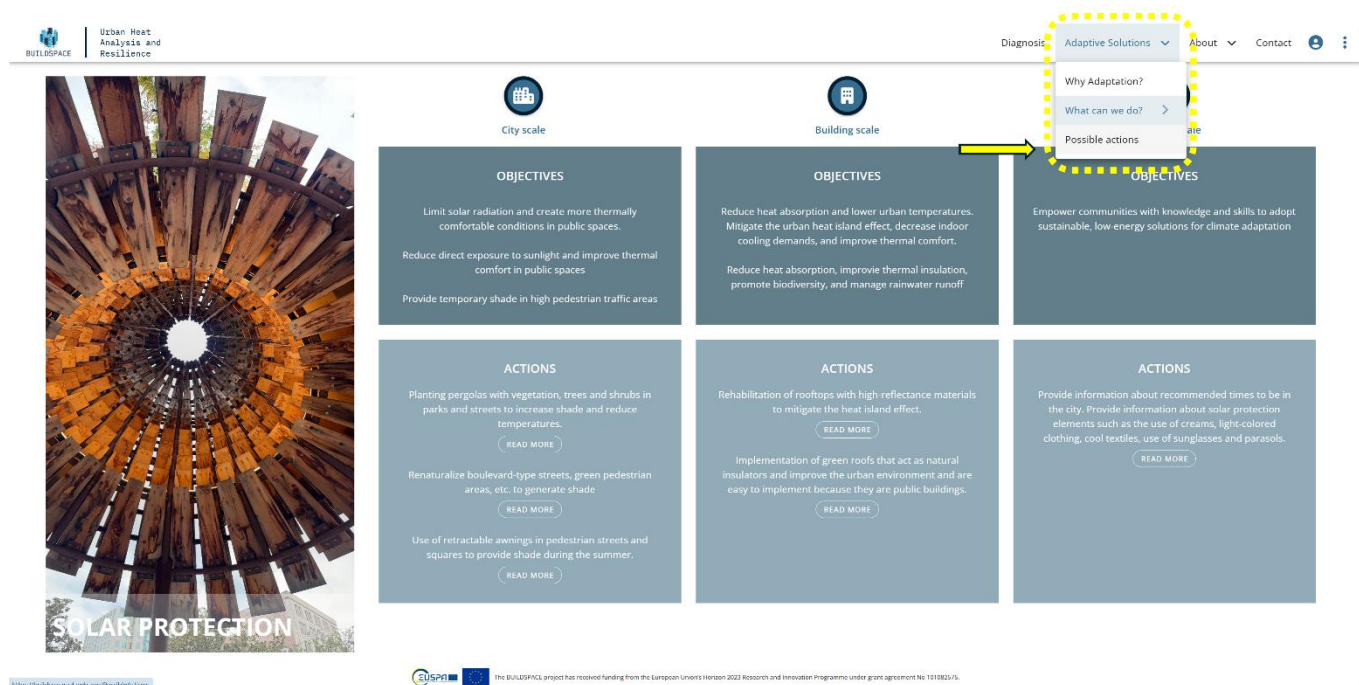


Figure 17. Possible actions selection.



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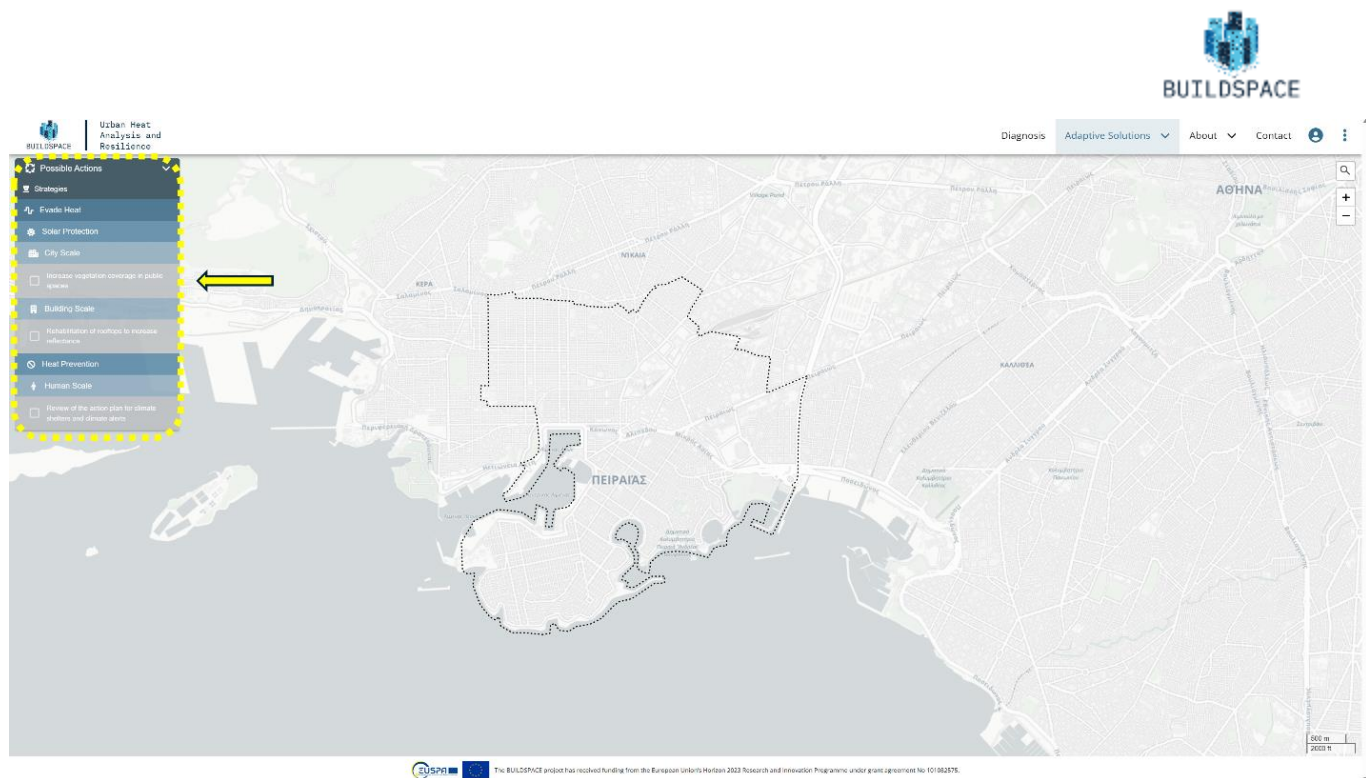


Figure 18. Possible actions section.

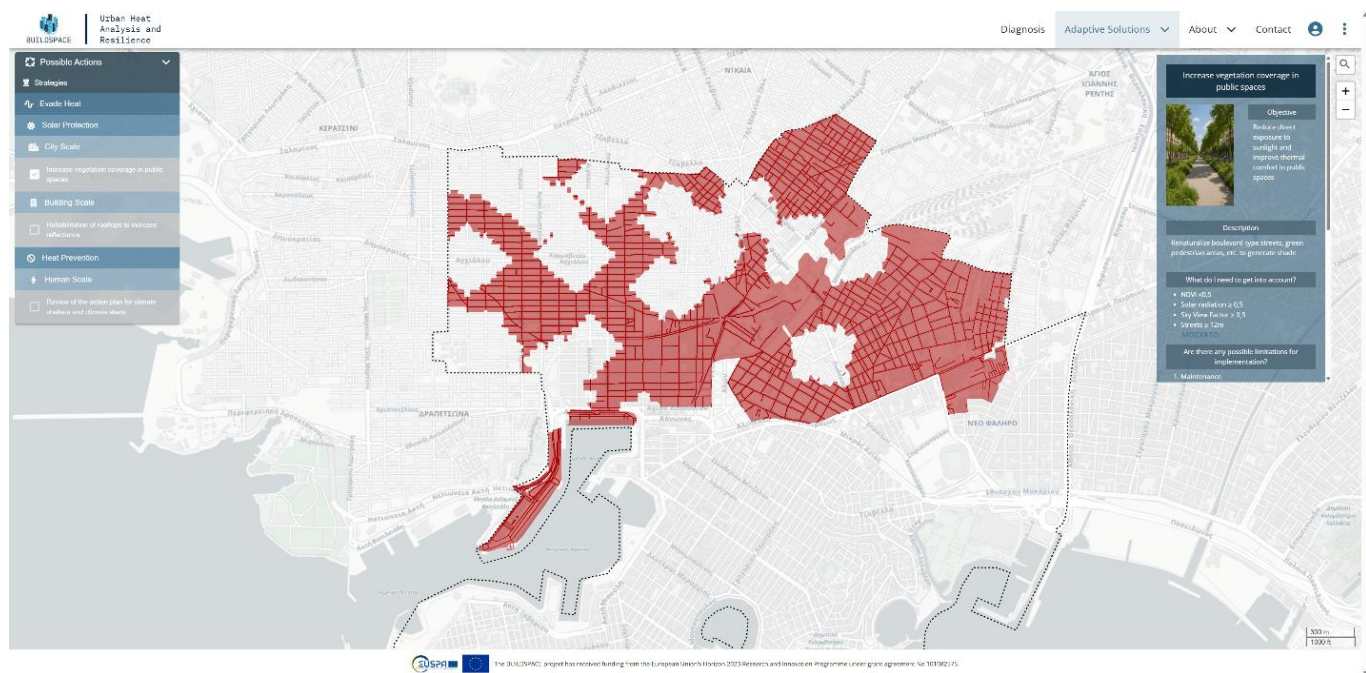


Figure 19. Possible actions – City scale solution for 'Evade Heat': Increase vegetation coverage in public spaces.



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8 Support & Resources

8.1 Download data

We want to give our users the opportunity to get even more out of the SE4 results, so we are providing the option to download the layers that make up the results of the urban heat analysis as well as the adaptation and mitigation solutions. We hope, this will enhance the usage of the service among a diverse of real-world applications.

To download the data (shapefiles format):

1. Click on the three dots icon.
2. Then, click on 'Download shapefiles'. (**Figure 20**)
3. Choose the layer that you are interested in explore in your own GIS software and download the shapefile. (**Figure 21**)

Remember you can download as well the weather files from the 'Climate Scenarios' section.

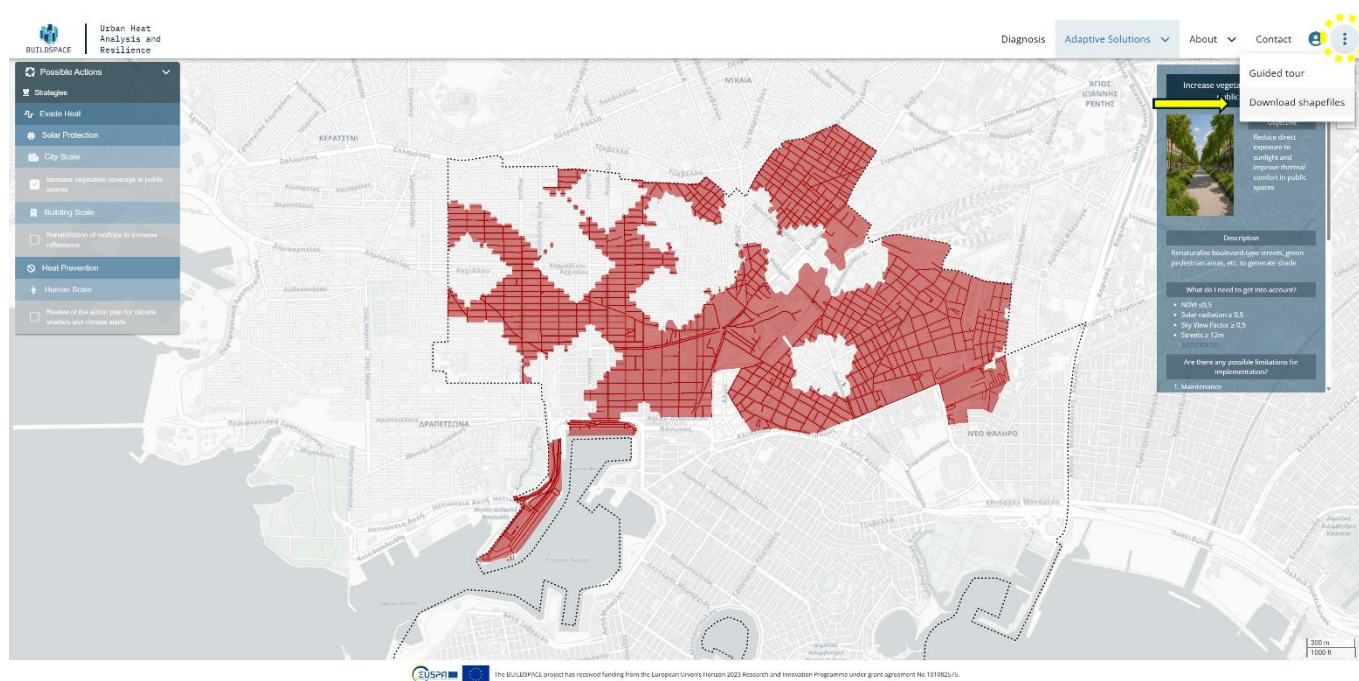


Figure 20. Download data procedure.



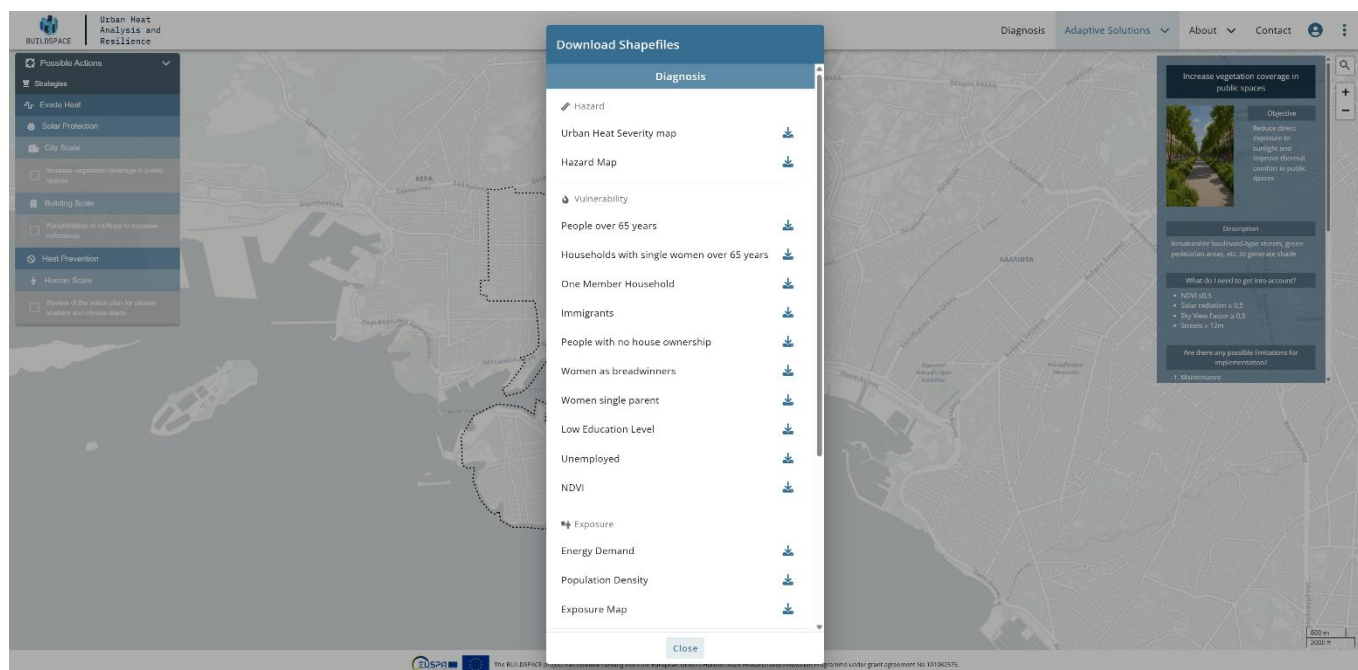


Figure 21. Download shapefiles section.

8.2 About the project and the SE4

If you wish to learn more about the BUILDSPACE European project and explore its full range of services beyond SE4, please visit the 'About > The project' section. You can also find more detailed information about SE4 in the 'About SE4' section (**Figure 22**), which includes a dedicated glossary for both the 'Diagnosis' and 'Adaptive Solution' sections (**Figure 23**).

8.3 Guided tour

At the beginning of our step-by-step guided we omitted the Guided Tour offered in the welcome window. In case you want to take the tour, you can find it by clicking on the three dots located in the top tool bar (**Figure 24**) and then just follow each step.



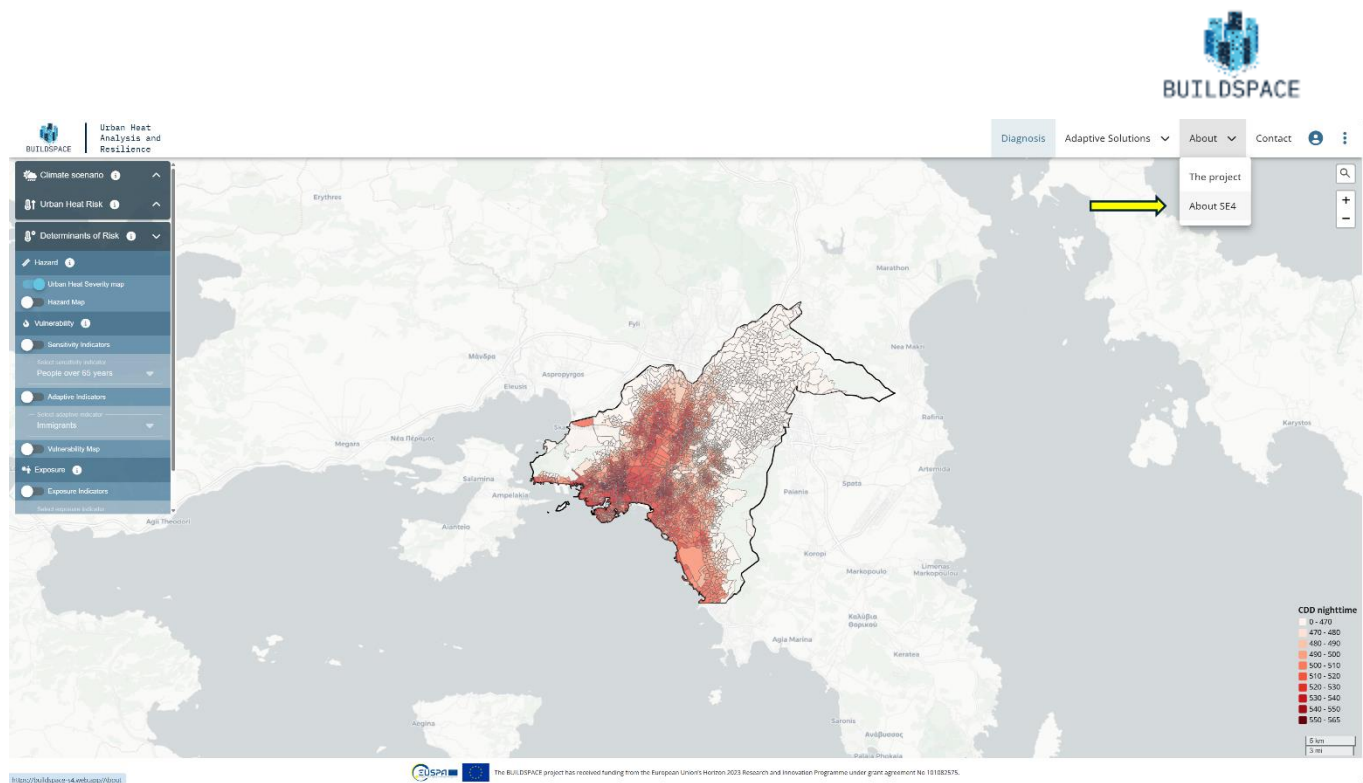


Figure 22. 'About SE4' procedure.



Figure 23. About Service 4 section.



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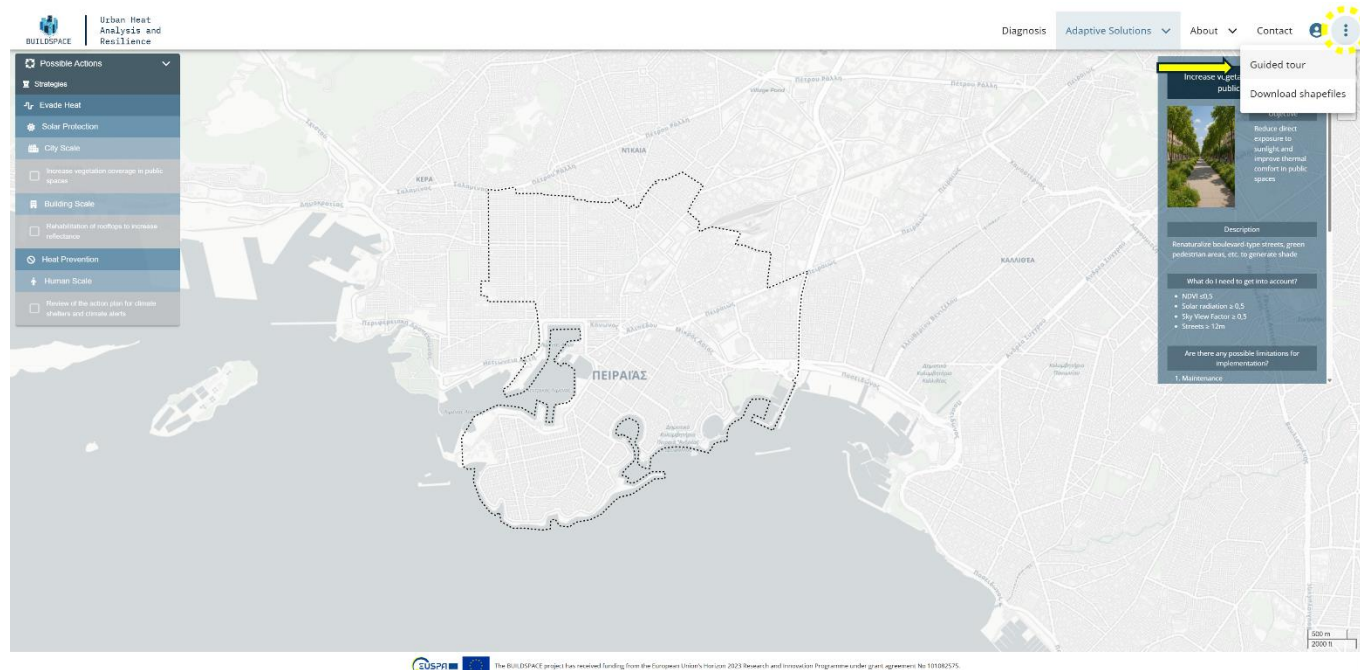


Figure 24. 'Guided tour' procedure.

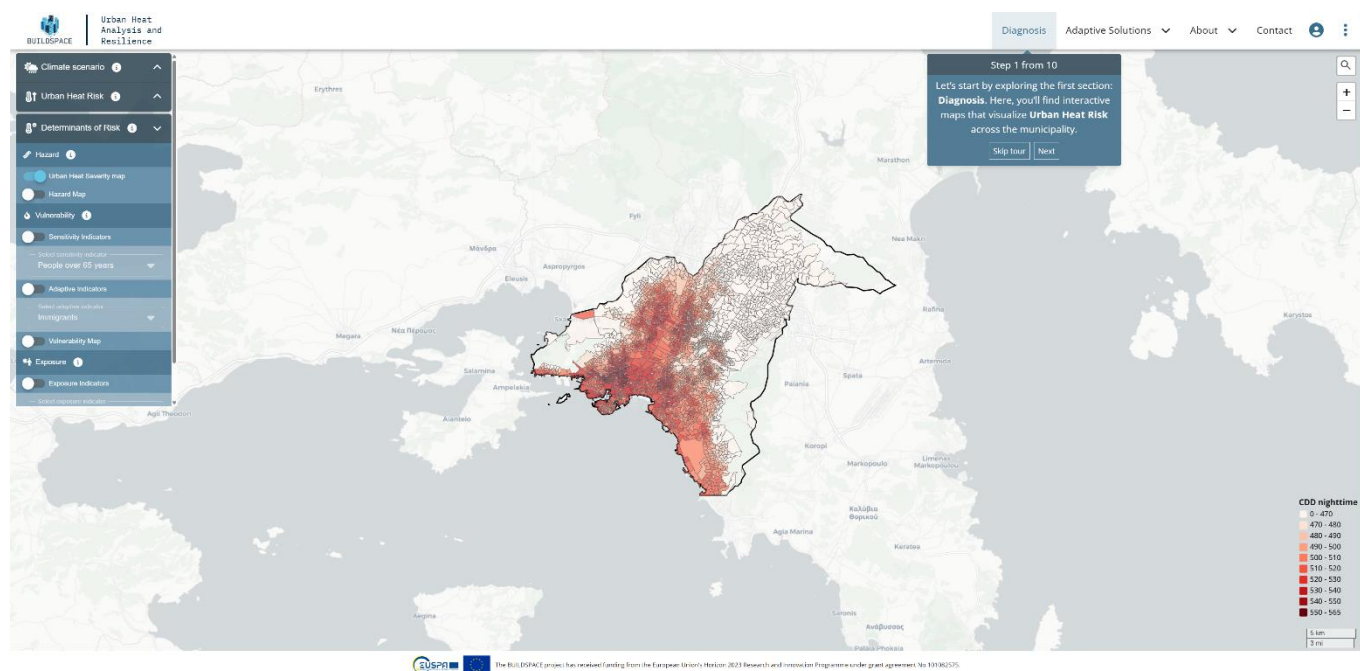


Figure 25. Guided tour steps.



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Thank you for following the step-by-step guide. We hope this tool has helped you better understand urban heat challenges and possible responses. Feel free to revisit any section at your own pace, and don't hesitate to explore further.



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