# URBAN DESIGN CLIMATE WORKSHOP

# TABLE OF CONTENT

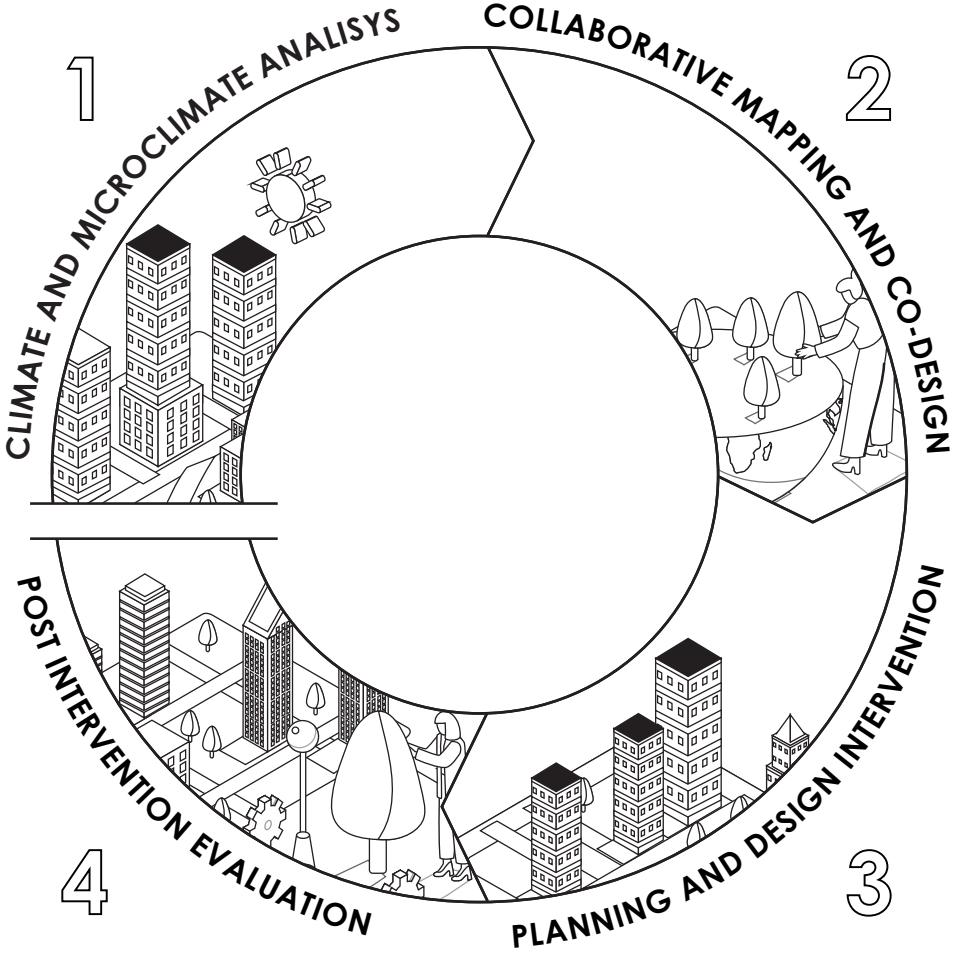
# URBAN DESIGN CLIMATE WORKSHOP

Climate change impacts are already visible today, with extreme heat and precipitation events increasingly growing in frequency and intensity worldwide. Urban climate must be a key consideration in the planning and design of contemporary cities.
Climate resilient principles need thus to be integrated in the design process as a knowledge area linked to architectural disciplines. The issue of climate resilience in urban areas requires the development of innovative design methods that can handle the complexity of the information needed to guide sustainable urban regeneration and retrofitting strategies, as well as to manage the technological and environmental solutions in a multi-scale perspective.

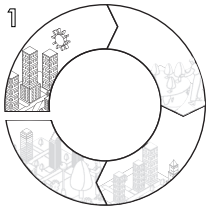
The UCCRN Urban Design Climate Workshop (UDCWs) aims to integrate design strategies for configuring or retrofitting compact and mixed-use eco-districts that can adapt and thrive in the changing global conditions, meet carbon-reduction goals and provide new public spaces and facilities in relation to community priorities.
UCCRN UDCWs have been carried out since 2015 based on the climate-resilient design principles and methodological process introduced by the Urban Planning and Urban Design working group within the Second Assessment Report on Climate Change and Cities (ARC3.2).

# The proposed design method, based on the principles and methodology, is process-oriented and focuses on sequential and iterative design steps implemented through a multi-disciplinary and multiscale approach

The UDCW methodology focuses on sequential and iterative phases that lead to the development of the project through a multi-disciplinary and multi-scale approach. All phases of the methodology are implemented with the support of UCCRN multidisciplinary experts and urban stakeholders, defining an intervention model that combines knowledge-sharing and co-design actions with urban decision- makers and local communities together with the development of simulations based on computational design tools to control the main indicators that determine the performance of buildings and open spaces in relation to climatic stress conditions.

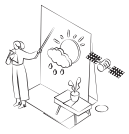


# climate and micro-climate analysis



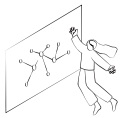

“Climate and microclimate analysis mapping” identifies urban areas most affected by extreme events and seasonal variations, including local climate projections, as preliminary project information. Historical climate data and Regional Climate Models (RCMs) are processed through simulation models integrated into different design tools: GIS systems for city/district-level analyses, providing as output urban heat hotspots and flood zones; parametric 3D modelling tools (Rhinoceros+-Grasshopper) assess technical solutions at the block/building scale, integrating climate-resilience aspects with other green building and environmental design criteria and benchmarks.

## Who is involved?

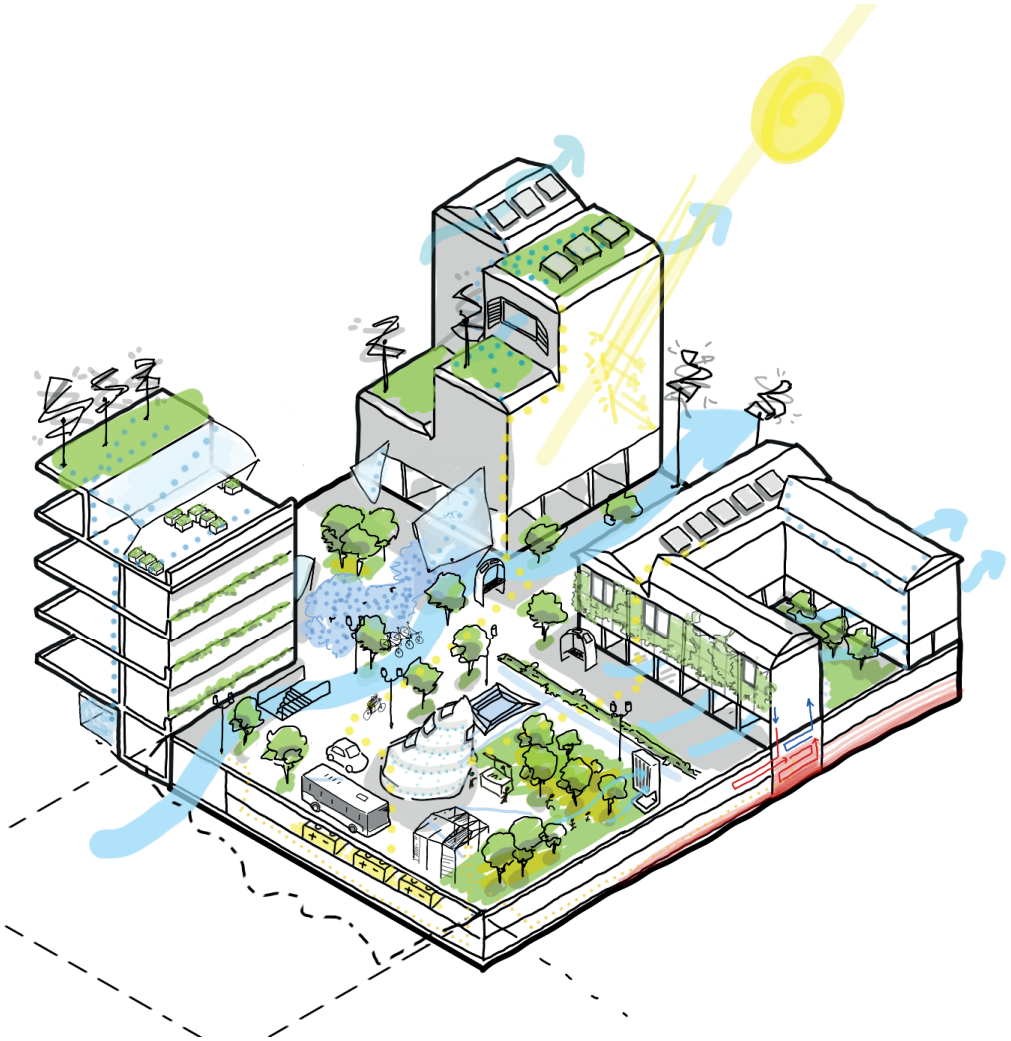


Climate scientists

Urban climate modellers



Vulnerability/ impact modellers



## Scales

City/district scale

Block/building scale

## Tools

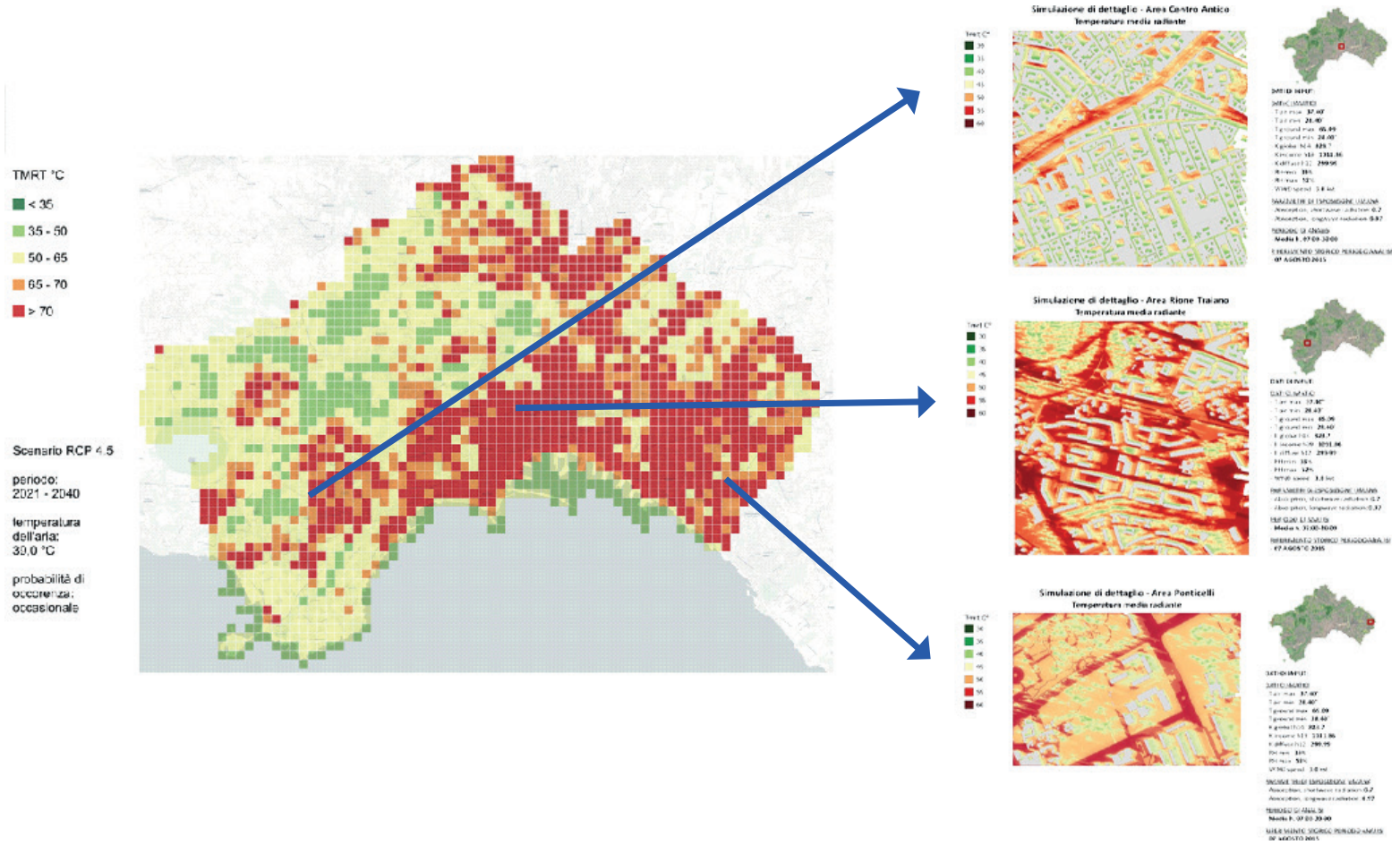
GIS tools

3D modelling tools

## Outputs

Detection of urban heat hotspots and flood zones

Assessment of technical solutions at the block/building scale



# collaborative mapping and co-design



“Collaborative mapping and co-design” aims at assessing the quality of urban spaces and combining climate-related considerations with needs and expectations of local authorities, practitioners and communities. Relevant local strategies and plans are critically analysed to identify barriers and opportunities for integrating climate resilient design principles. Residents, local administrations, neighborhood and category associations are engaged through collaborative mapping and co-design exercise to collectively develop a shared reading of the main critical aspects of the urban system in relation to environmental, functional-spatial and socio-economic aspects. The synthesis of the results outlines a picture of shared needs and possible divergence elements between categories of stakeholders to integrate in the project.

## Who is involved?

Planners/ designers

Computer scientists

Social scientists

Local communities/ NGOs

Economists

## Scales

City/district scale

Block/building scale

## Tools

Collaborative mapping

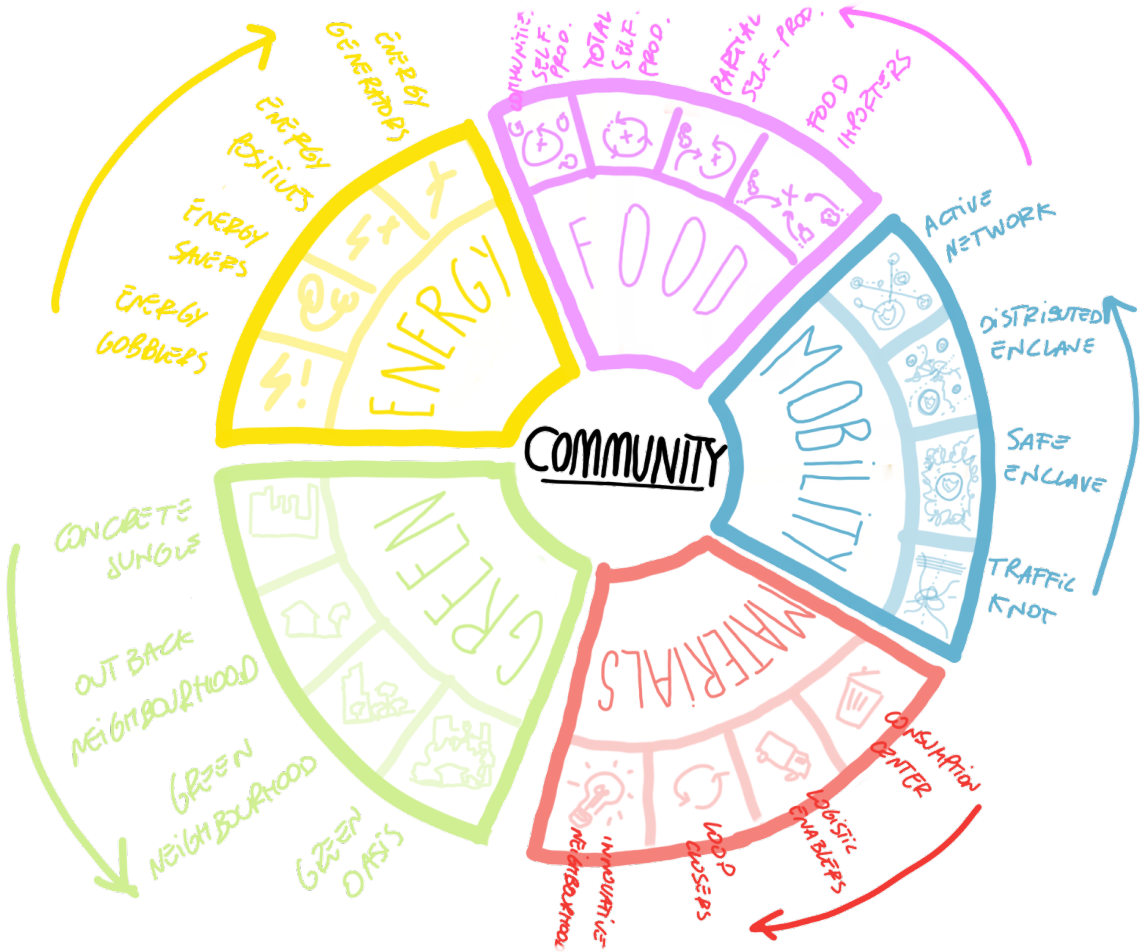
A day in the life exercise

City visions and local needs

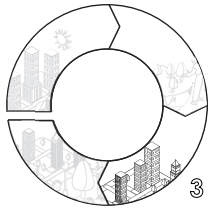
3D neighbourhood configurator

## Outputs

Overview of shared needs and possible divergence elements between categories of stakeholders to integrate in the project



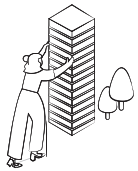
# planning and design



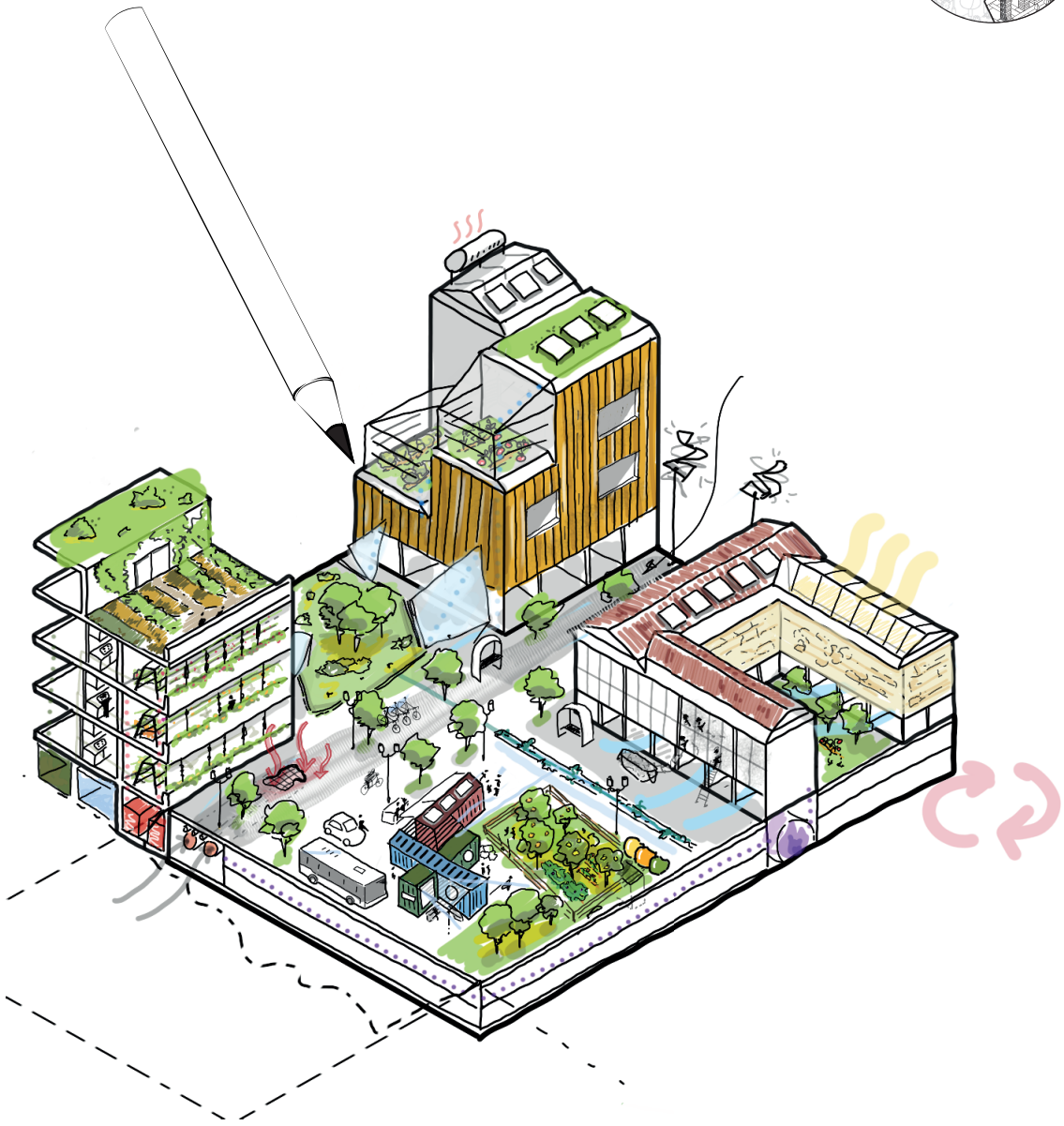

"Planning and design" is based on a critical review of the information collected to identify synergies and tradeoffs that can be implemented in relation to the planning initiatives envisaged by the local authorities. Urban plans and building regulations define the limits within which to develop the most appropriate technical-design strategies and solutions to achieve the set of objectives. Visual tools link multiple factors orienting local policy and transformative actions; meta- design layouts support the production of innovative solutions addressing climate change impacts while increasing environmental quality in cities.

## Who is involved?

Planners/designers and communities



Project-related multidisciplinary expertise (Urban ecology, social science,...)



## Scales

City/district scale

Block/building scale

## Tools

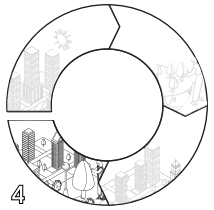
GIS tools

3D modelling tools

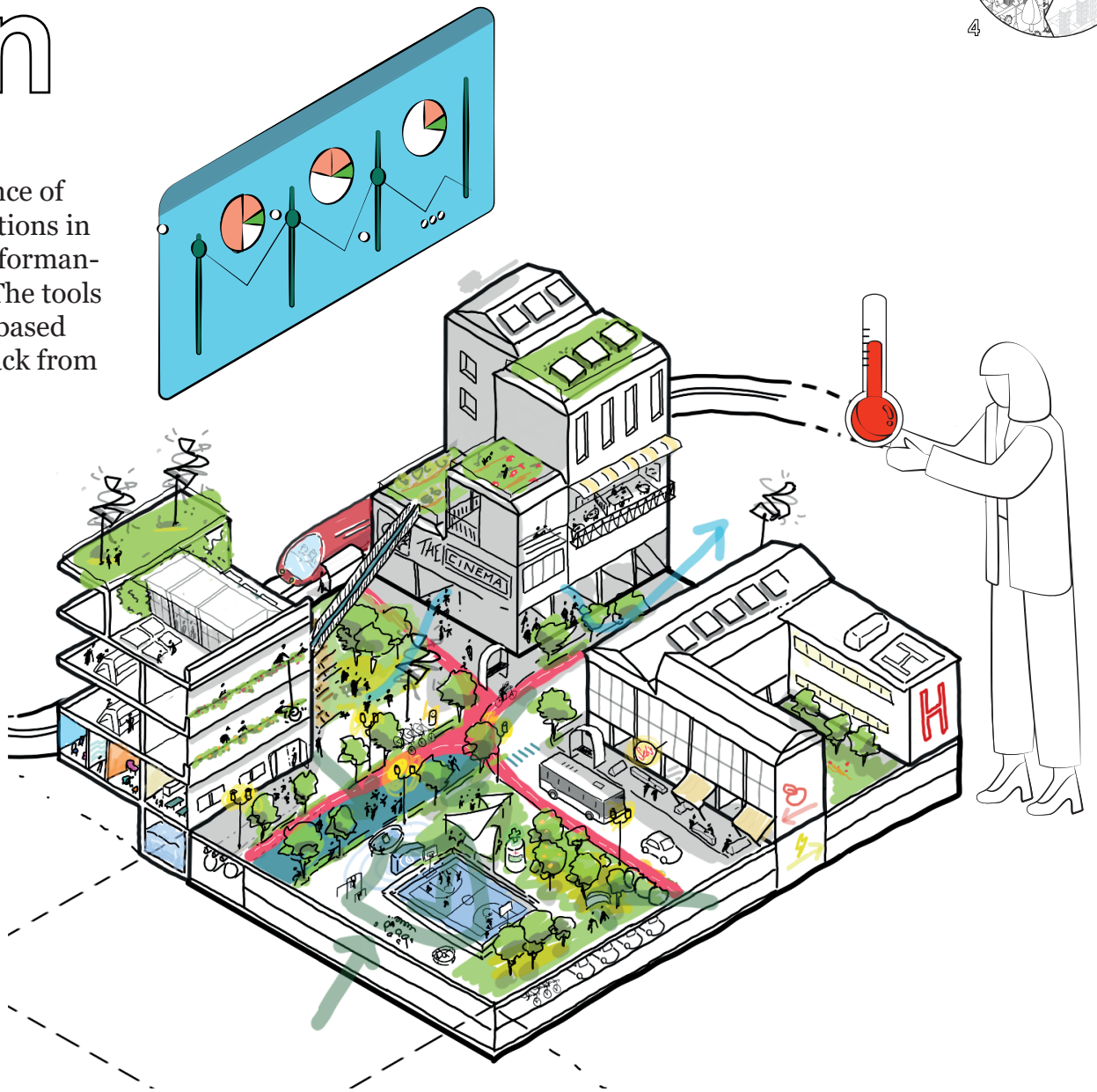
## Outputs

Development of the most appropriate technical-design strategies and solutions to achieve the set of objectives addressing climate change impacts while increasing environmental quality in cities

# post intervention evaluation

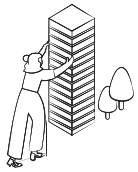



“Post-intervention evaluation” is intended as a sequence of activities to evaluate the benefits of the proposed solutions in terms of microclimate, energy and environmental performance, as well as compliance with community priorities. The tools include instruments for simulation-driven/indicator-based scenario comparisons, and for gathering direct feedback from residents and local stakeholders.



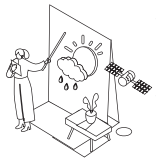

## Who is involved?

Planners/designers and communities



Project-related multidisciplinary expertise (Urban ecology, social science,...)

## steps



Step 1 expertise (post-design)

Step 2 expertise (post-implementation)

## Scales

City/district scale

Block/building scale

## Tools

GIS tools

3D modelling tools

## Outputs

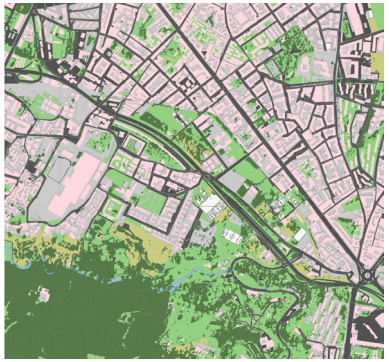
Assessment of the performance and benefits of design solutions at urban scale

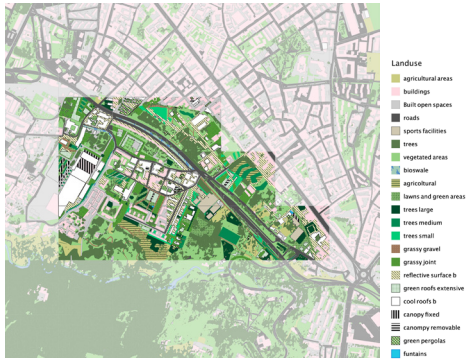
Assessment of technical solutions at the block/building scale

## current state

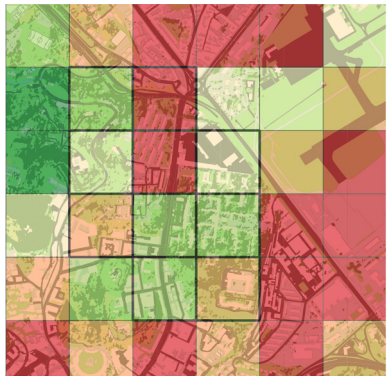
## adaptation

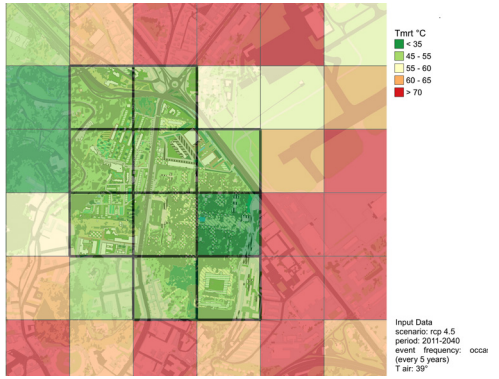
Landuses



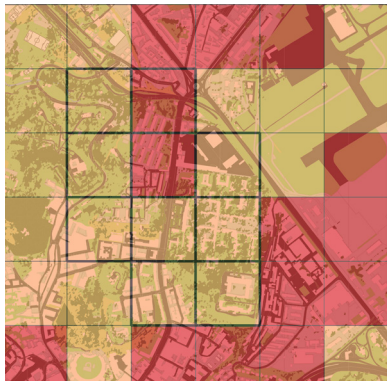


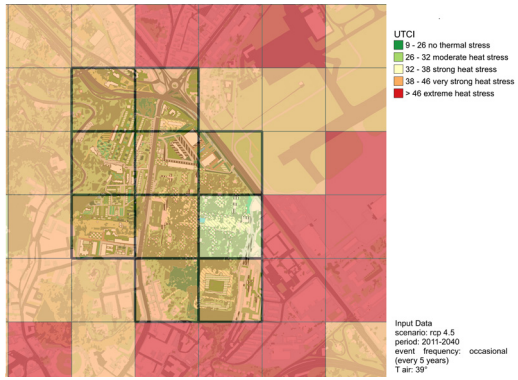

Mean Radiant Temperature (TMRT)






Universal Thermal Climate Index (UTCI)

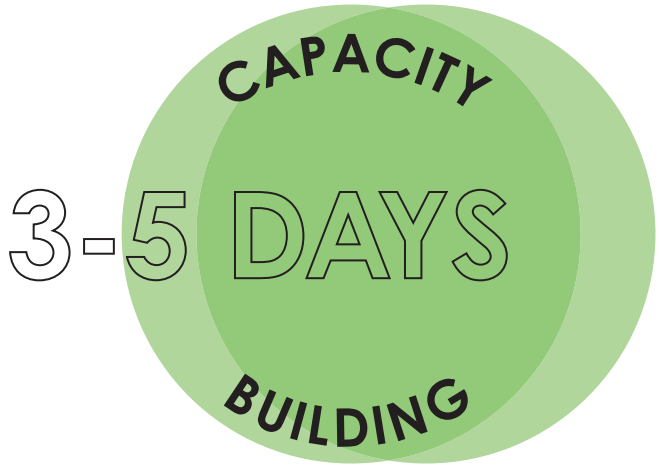




# workshop formats


Panel discussion/post-it session prompted by a pitch from UCCRN facilitators, session or side event within a conference (with experts, scientists, practitioners). (example: Bonn UDCW 2019)

It requires 2-4 weeks preparatory activities involving UCCRN team



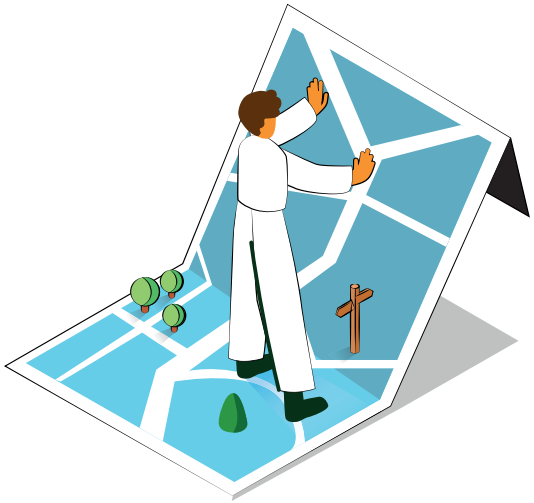

A workshop with multidisciplinary UCCRN experts and local authorities' representatives (experts, scientists, practitioners, local authorities and communities) (examples: Gowanus Brooklyn UDCW, 2019; Durban UDCW, 2019).

It requires 4-8 weeks preparatory activities involving UCCRN team and local hosts


A workshop with multidisciplinary UCCRN experts and students/practitioners (experts, scientists, students/practitioners, local stakeholders and communities), with an opening conference and a final presentation as events involving also external audience (examples: Napoli UDCW, 2018; UCCRN_edu UDCW series, 2022-202).

It requires 8-16 weeks preparatory activities involving UCCRN team and local hosts

# UDCW TOOLKIT



The UDCW toolkit contains two different tool packages, aimed at supporting the four steps of the UDCW methodology:

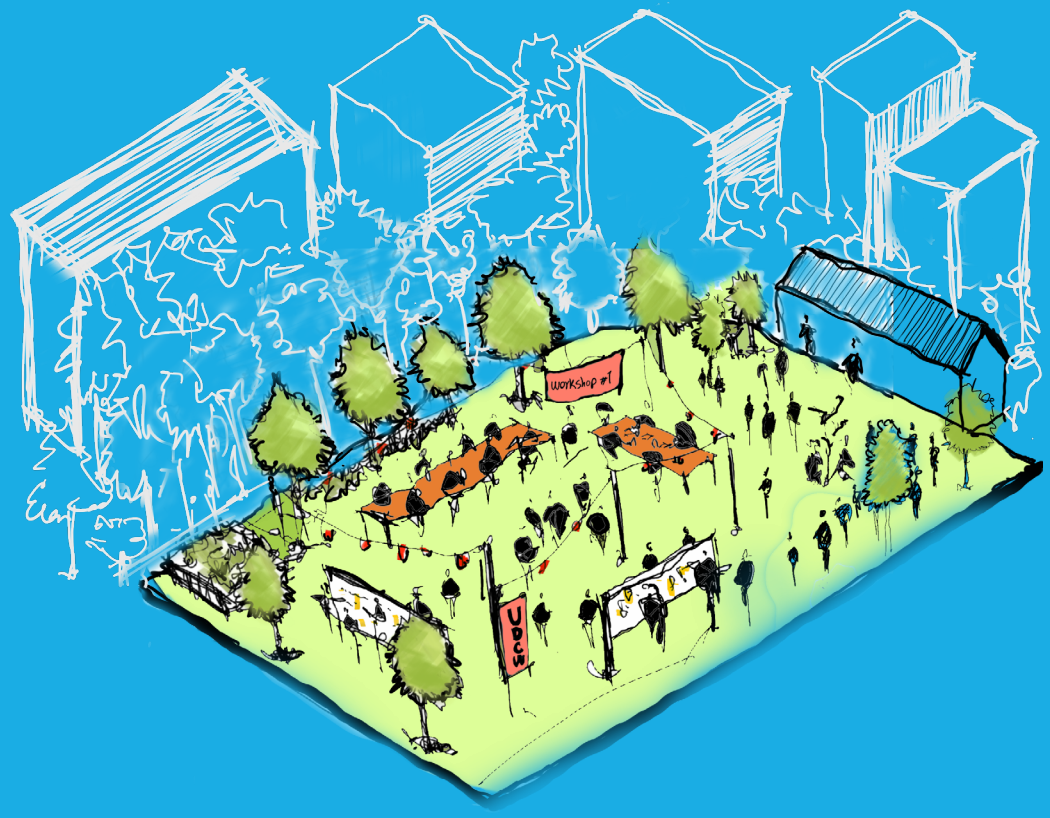

**The Facilitation toolkit** includes a set of participatory tools that allow to engage with different typologies of expert and non-expert city actors in a co-created climate resilient design process. The tools are aimed at collaboratively mapping both the critical elements of knowledge of the territory and the priorities for urban development in consideration of key social, economic and environmental issues, based on insights from local communities, public and private stakeholders.

**The Simulation toolkit** includes a set of user-friendly tools for planners and designers, which allow to identify climate change impacts in relation to temperature and precipitation slow-onset variations and extreme events taking into account the urban microclimate factors that determine aggravating conditions due to urban morphology, efficiency of urban systems, building and open space surface materials and green an blue infrastructures. 2D analyses are embedded within Geographic Information Systems (GIS) tools, while 3D modelling is carried out through Algorithm Aided Design (AAD) tools.

# FACILITATION TOOLKIT

The UDCW Facilitation toolkit is a family of participatory tools supporting knowledge sharing and co- production in a multi-stakeholder context, facilitating communication about urban climate resilience topics and bridging complex and science-based inputs with tacit knowledge. The tools are conceived to foster the dialogue between experts and non-expert and to match urban design solutions for mitigation and adaptation with everyday practices and needs of citizens and as well with capacity building issues of public administrations and decision makers.

The UDCW Facilitation toolkit supports the implementation of the Collaborative mapping and co- design phase of the UDCW Methodology. It can be used as a standalone toolkit (and its tools as standalone components for partial analyses), but provides significant additional outcomes if used in synergy with the UDCW Simulation toolkit.




## Tools

_Collaborative mapping
_City visions and local needs matching
_A day in the life
_3D Neighbourhood Configurator

# collaborative mapping

~1,5h-2h

*depending on the size of the focus group, on the level of detail desired, on UCDCW formats and on participants*

## OBJECTIVES

- Engage community in collaborative mapping
- Gather information about urban environment
- Geospatialize the collected data
- Exchange knowledge, between experts and non-experts
- Inform urban policies, promote resilience
- Promote community bases resilience goals

## DESCRIPTION

This process involves the co-production of data regarding climate risks, local issues, and opportunities, as well as the quality of urban spaces, environmental pressures, social capital, socio-spatial issues, infrastructures, service availability, and everyday risks. Data collection can be conducted using analogic tools like boards and stickers or digital tools like P-GIS (Participatory Geographic Information System). The aim of the collaborative mapping within the methodology for climate-resilient design is to create knowledge exchange between expert and non-expert, including tacit knowledge in an inclusive way.

## OUTCOMES

Digital map integrating baseline information from city-level strategies and regional, municipal, district planning documents with key information mapped by local stakeholders and communities engaged. [link to example map]

## FACILITATORS

Experts in collaboration with key stakeholders (e.g. representatives of local organizations/ Third Sector, community leaders).

## TARGET GROUP

Communities, decision makers, policy-makers, city officials, local experts, practitioners, students, community leaders, NGOs, Third Sector, private stakeholders.

# collaborative mapping | how to

01

## BASELINE MATERIAL PREPARATION

At this stage, experts prepare digital maps of a specific area (aerial photographs; satellite imagery) with geospatial information (e.g. open street maps, google maps) also define set of categories to be mapped in the collaborative mapping exercise organized in macro-groups.
Baseline material also includes printed map, post-its, category stickers, markers, digital devices.

02

## NEIGHBOURHOOD WALK OR FOCUS GROUP

Through a focus group or a neighborhood walk, we initiate the engagement of participants in the collaborative mapping process to gather information about the urban environment.

03

## MAPPING EXERCISE

Participants are invited to develop a mapping exercise on physical maps to collect bottom-up data. These data are depending on the specific aim of the activity and on the specific local focus and issues to be interlinked with climate topics.

04

## CREATING DIGITAL MAPS

Experts gather the collected data and incorporate it into digital maps in which both top-down (expert-driven) and bottom-up (participants) information are overlapped and available for communities and decision-makers.

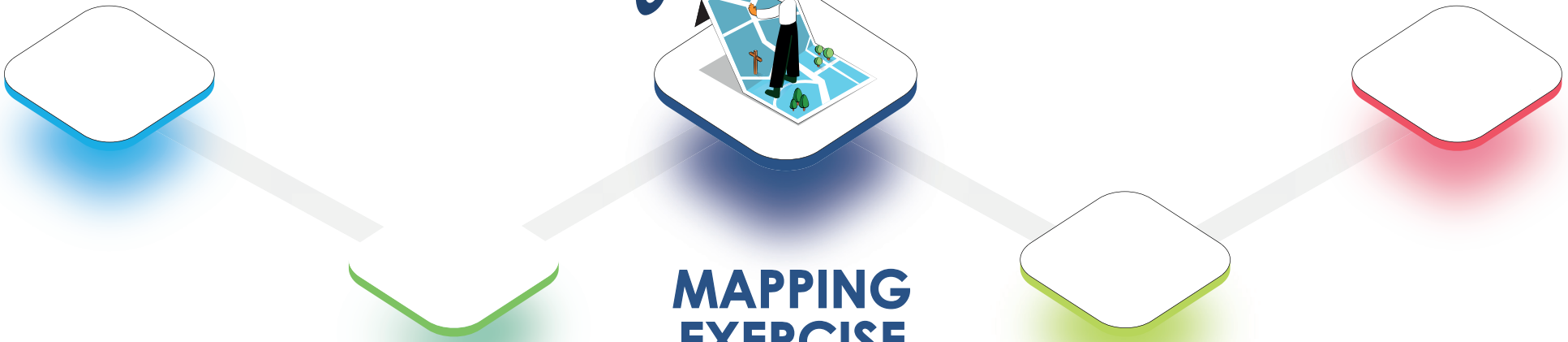
05

## USING PUBLIC PLATFORM

The ultimate objective is to geospatialize the information using an open-source tool creating a public platform for knowledge sharing that is accessible to communities and decision-makers.

collaborative mapping | focus on

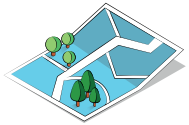
03



# MAPPING EXERCISE

## CATEGORIES

Set of categories to be mapped in the collaborative mapping exercise (depending on the purpose and characteristics of the area) for example:

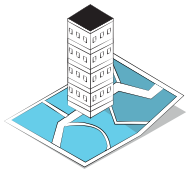


### Environmental quality

Critical spaces affected by environmental factors (e.g., waste, illegal dumping, fire risk, high pollution)

### Socio-cultural capital

Critical spaces affected by socio-spatial factors (e.g., unsafety, segregation, local initiatives)



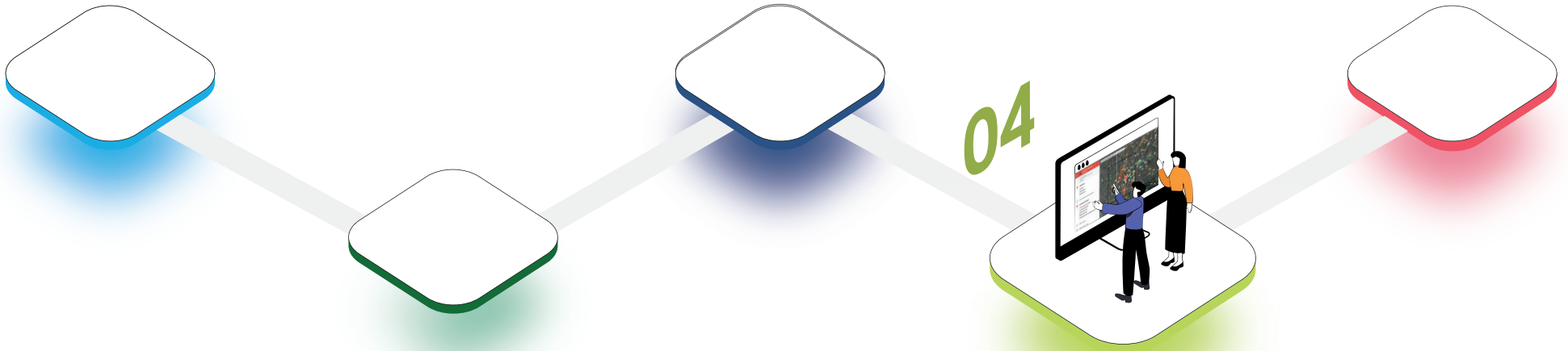
### Urban quality

Abandoned areas, spaces for leisure activities, meeting spaces

## MATERIALS

- A1 printed base map(s) of the study area for the collaborative mapping exercise (with names of streets), 1 each 6 participants
- A1 printed diagram with city visions (pdf file shared by facilitators)
- Sticky notes
- Printed stickers (provided by facilitators) with categories of elements to be mapped
- Markers

collaborative mapping | focus on

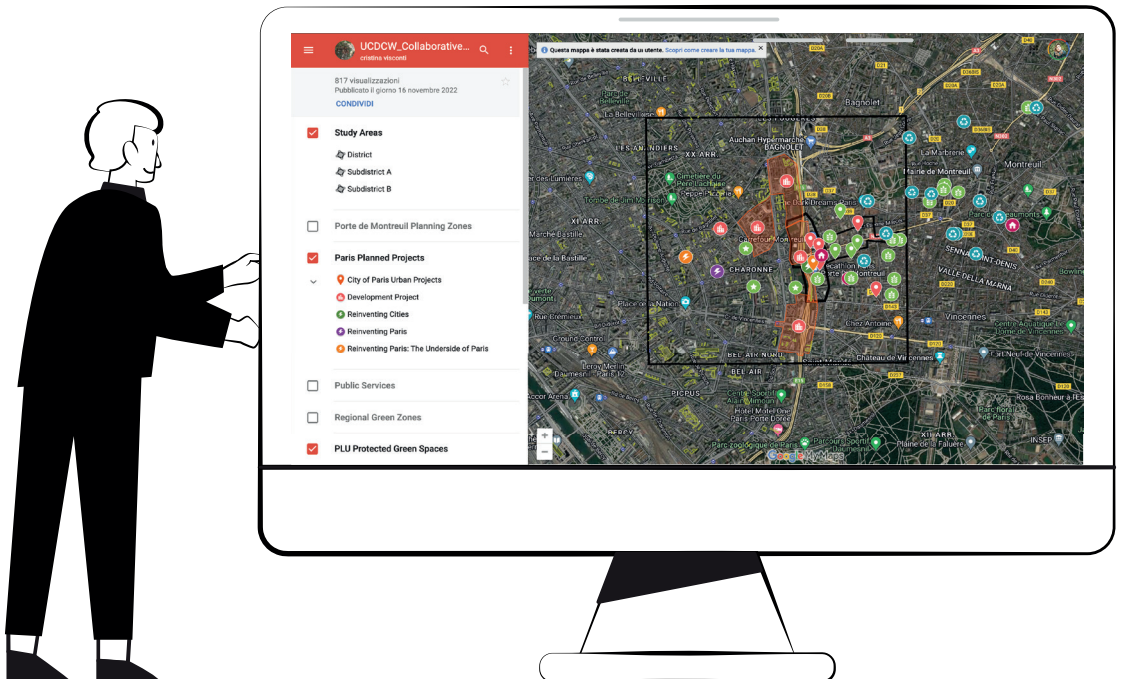



# CREATING DIGITAL MAPS

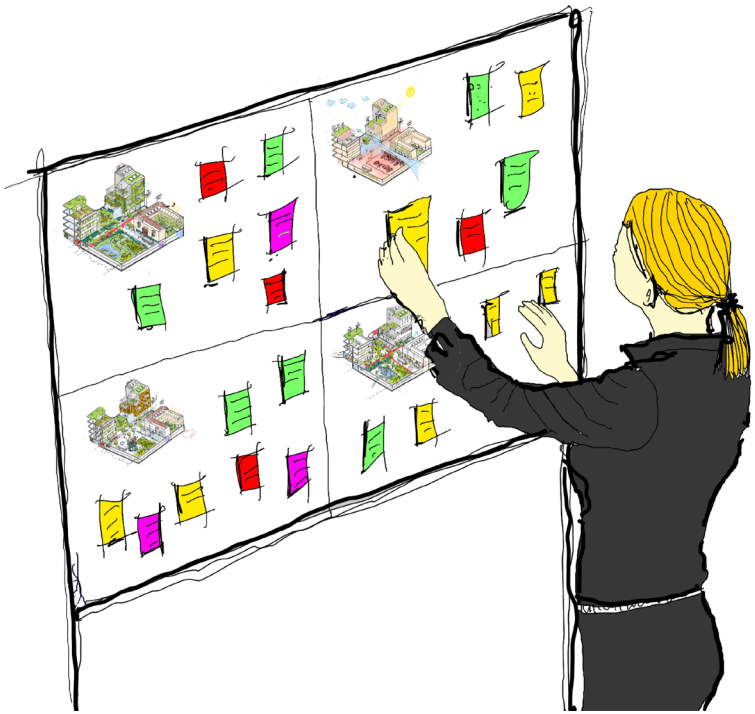
Experts gather the collected data and incorporate it into digital maps in which both top-down (expert-driven) and bottom-up (participants) information are overlapped and available for communities and decision-makers.

The collaborative mapping if web-based (on-line open source map such as open street map or google maps) allows to create a platform in which both top-down (expert-driven) and bottom- up (participants) information are overlapped and available for communities and decision-makers.

Digital maps of a specific area (aerial photographs; satellite imagery) or on-line open source maps with geospatial information (e.g. open street maps, google maps). Baseline data can be spatial information available depending on the on-line mapping platform (e.g. open street maps, google maps) or additional information implemented by researchers on the map such as data on climate-related risks and other environmental risks, vulnerability of population, building typologies etc.



# city visions and local need matching



**~1,5h-2h**

*depending on the size of the focus group, on the level of detail desired, on UCDCW formats and on participants*

## OBJECTIVES

- Identify strategies for adaptation and mitigation to create a future city vision
- Visualize and address local needs in terms of urban regeneration priorities
- Highlight opportunities to respond to local needs and non-climate priorities with climate-resilient urban design and planning solutions
- Empowering citizens in expressing their individual needs also in consideration of societal goal

## DESCRIPTION

This exercise involves identifying and visualizing local needs related to urban regeneration priorities, such as housing, transportation, and social services. Facilitated by experts, participants explore opportunities in their neighborhood or district to address daily issues through climate-resilient strategies that are synthesized in city visions, such as the Green and Blue city, Circular city, Zero-Carbon city, 15 minutes city, and Disaster Resilient city

## OUTCOMES

City visions contextualized to the specific local context identifying how the general strategy can be adapted to the specific district/neighborhood according to social, cultural and spatial opportunities, needs and claims

## FACILITATORS

It can be guided and facilitated by experts and stakeholders (local experts, preferable with a background in urban disciplines) to provide input on non climate local needs and priorities .

## TARGET GROUP

Communities, decision makers, policy-makers, city officials, local experts, practitioners, students, community leaders, NGOs, Third Sector, private stakeholders.

# city visions and local need matching | how to

01

## BASELINE MATERIAL PREPARATION

At this stage, experts prepare posters, presentations and dedicated cards about city visions (Green and Blue city, Circular city, Zero-Carbon city, 15 minutes city, Disaster Resilient city) to be delivered in a printed format.
Baseline material also includes printed posters and cards for each city visions, post-its, markers and flipchart paper..

02

## PRESENTATION OF THE CITY VISIONS

Through a plenary presentation, participants will explore innovative ideas and strategies to shape the future of cities. In particular, experts will discuss the four city visions supported by the Metadesign framework

03

## FOCUS GROUP FOR LOCAL PERSPECTIVES

In this session, we aim to gather valuable insights and perspectives from community members to better understand the needs and aspirations of the local area. Each team is associated with a specific city vision and has a facilitator who guides the focus group and directs the discussion to define potential solutions.

04

## COLLABORATIVE FINDINGS

A plenary session of all groups is set to share the results of the focus groups. One or more representatives of the group are encouraged to discuss the outcomes of each table and the facilitators support and coordinate  the discussion, creating links and insights.

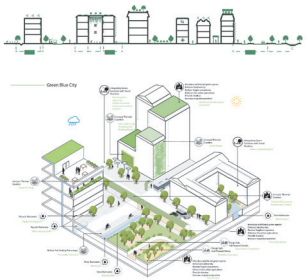
05

## IDENTIFICATION OF URBAN STRATEGIES

The ultimate objective is the identification of strategies that could be integrated as adaptation and mitigation measures based on urban project priorities to create a future city vision contextualized to the specific local context.

city visions and local need matching | focus on

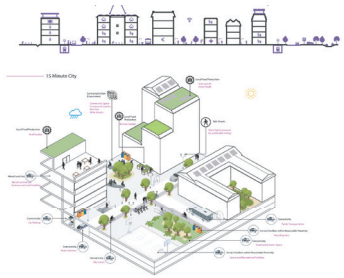

# PRESENTATION OF THE CITY VISIONS



**A GREEN-BLUE-CITY**
integrates natural systems to provide urban greening and ecological restoration, recreating a natural water cycle and enhancing the city's aesthetics through green and blue infrastructure in open spaces and buildings.

**A ZERO CARBON CITY**
relies on renewable energy, passive design, and behavioral changes to minimize energy consumption, $CO_2$ emissions, and the carbon footprint of urban activities.

**A CIRCULAR CITY**
transitions to a circular economy through integrated collaboration with citizens, businesses, and the research community. It emphasizes short supply chains, reduced consumption, and recycling to thrive rather than grow.



**THE 15-MINUTES CITY**
enables residents to meet their needs within a short distance, fostering social cohesion, local economies, and reducing urban mobility's carbon footprint.

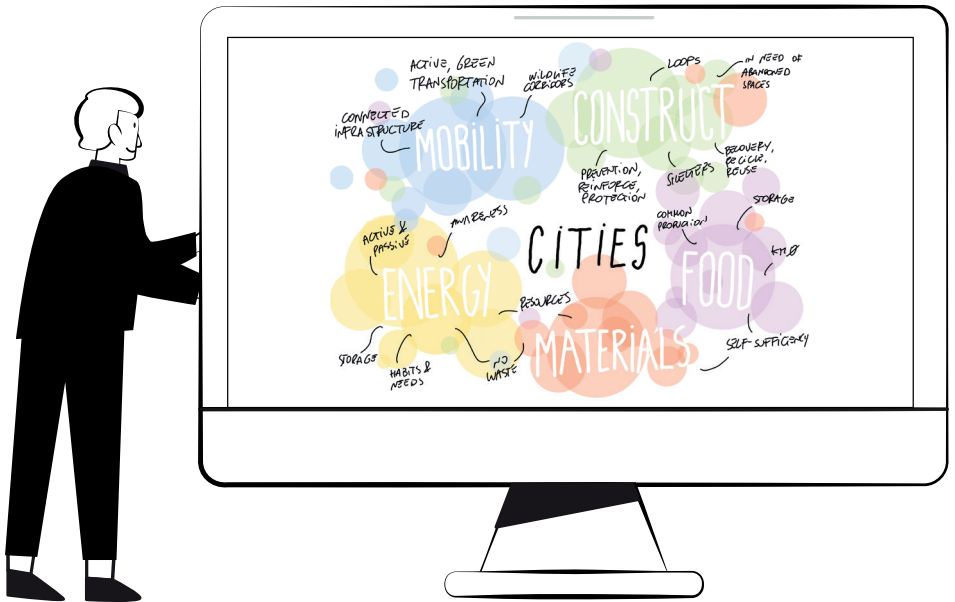
city visions and local need matching | how to


# FOCUS GROUP

In this session, we aim to gather valuable insights and perspectives from community members to better understand the needs and aspirations of the local area.
Each team could reflect on a specific city vision or navigate through all of them. A facilitator guides the focus group and directs the discussion to define potential solutions for the city. The team is asked to place the proposed solutions on a backcasting matrix (timespan representation) or on the city visions canva.

## MATERIALS

- A1 printed diagram with city visions (PDF file shaerd by facilitators)
- Sticky notes
- Canvas Matrix
- Markers
- Framework presentation (PPT, PDF)



# a day in the life

## 20 - 60m

*depending on the size of the focus group and the number of the analyzed end-user personas (about 20 minutes per personas). The timing can depend on UCDCW formats and to the target participant*

## OBJECTIVES

- Envision desirable outcomes for specific end-user personas within a city vision context
- Simulate a day in the life of the persona to understand their needs and challenges
- Tailor urban design and planning solutions to meet the specific requirements of different user groups

## DESCRIPTION

This tool immerses participants in a visionary exploration of future cities by adopting different personas associated with specific city visions. Experts guide the process as participants envision a day in the life of these personas, considering their unique needs, characteristics, and daily routines. Through collaborative brainstorming and dialogue, participants delve into potential sustainability and urban design options that can support these personas' everyday practices

## OUTCOMES

Day in the life stories of a number of personas. Journey maps (to be developed afterwards by project team with the support of facilitators) illustrating the link between design proposal and personas life

## FACILITATORS

The exercise needs to be guided and facilitated by experts.  At least four facilitators, one per city vision, are recommended for this tool

## TARGET GROUP

Communities, decision makers, policy-makers, city officials, local experts, practitioners, students, community leaders, NGOs, Third Sector, private stakeholders

# a day in the life | how to

01

## BASELINE MATERIAL PREPARATION

At this stage, experts prepare presentations about city visions (Green and Blue city, Circular city, Zero-Carbon city, 15 minutes city, Disaster Resilient city), End-user persona profiles to be delivered in a printed format and personas canvas printed or filled in a digital version. Baseline material also includes printed posters and cards for each city visions, post-its, markers and flipchart paper

02

## PRESENTATION OF THE CITY VISIONS

The activity begins, if not already done, with a presentation of city visions such as the Green and Blue city, Circular city, Zero-Carbon city, all framed within the Metadesign framework.

03

## VISIONING EXERCISE

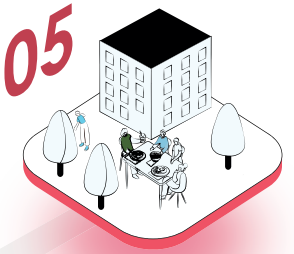
Each group embarks on a visioning exercise, envisioning the persona and their city in the year 2050. They delve into a typical day in the life of their persona, taking into account their unique needs, characteristics, and daily journeys.

04

## POTENTIAL URBAN SOLUTIONS

Participants brainstorm with experts and discuss potential sustainability and urban design options that can support the persona's daily practices and needs

05



## ENHANCED CITY VISIONS

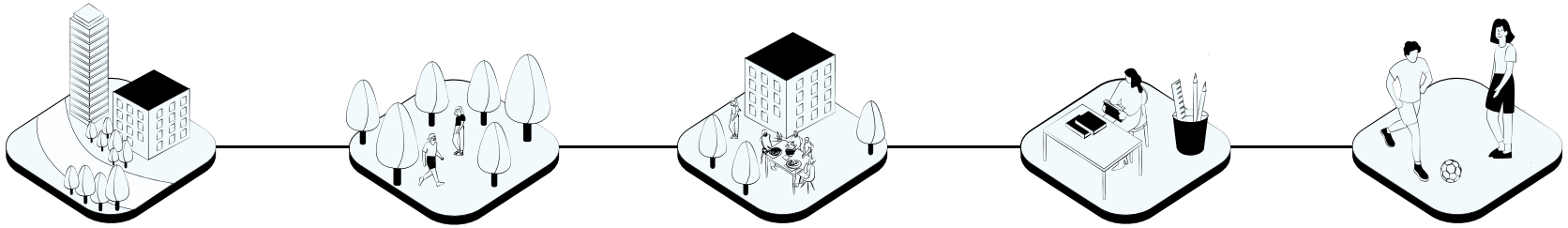
It results in a visual representation of the imagined day in the life of the persona, showcasing the identified interventions and solutions required to enhance their daily routines in city visions

# 03 VISIONING EXERCISE

## MATERIALS

- End user persona profiles (PDF file provided by facilitators)
- Personas Canvas (PPT or PDF file provided by facilitators)
- Sticky Notes
- Markers

*A Day In the Life in Porte de Montreuil 2050*
*Marie is 12 years old and lives in Montreuil*



Marie walks from her home in Montreuil to her school on the other side of Porte de Montreuil. Green pedestrian paths make the journey pleasant and safe

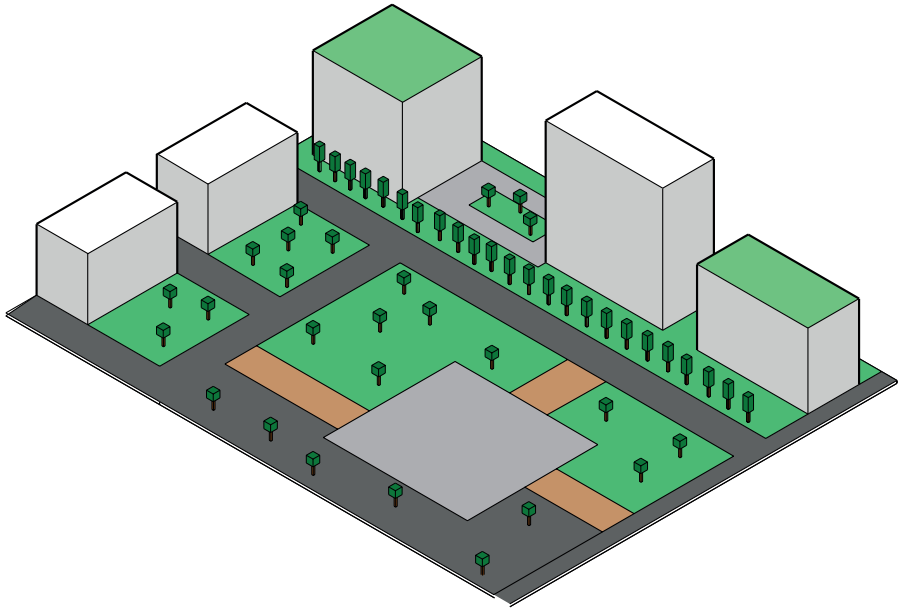
At school, Marie and her classmates go on a field trip to a nearby urbam forest to learn about the importance of urban biodiversity

During lunch, Marie plays with her friends in the schoolyard which has been transformed into a green oasis

In the afternoon, Marie has math class. Even though her school is located in a very noisy area, she is able to focus thanks to the recent acoustic insulation of the school building.

After school, Marie enjoys football practice at the newly renovated sports facilities near Porte de Montreuil

# 3d neighbourhood configurator



**6h**

*Training Format: 4 hours*
*Focus Group Format: 2 hours*

## OBJECTIVES

- Optimise and simplify the district-scale modelling phase integrating key performance indicators related to climate benefits (mitigation, adaptation) and co-benefits (social, economic, environmental) of different design solutions at the earliest design stages (e.g. concept phase, massing)

## DESCRIPTION

The tool aims to create a simple and intuitive modelling environment that allows, through the management of simple 3D objects and a few parameters, to generate urban scenarios and verify their behaviour in relation to various indicators, both qualitative and quantitative. This tool is intended to simplify the processes of comprehension of climate modelling and consequently climate resilient planning and design, enabling the assessment of key performance indicators for climate-resilience already at the conceptual stage of design (e.g. massing)

## OUTCOMES

3D visualisation of current city conditions and proposed design concepts, with assessment of key indicators related to climate-benefits (mitigation and adaptation) and co-benefits (social, economic and environmental)

## FACILITATORS

Experts trained in IT and urban climate and basic Rhino user

Focus Group Format: one expert capable to facilitate the focus groups and one expert to run the configurator

## TARGET GROUP

- Technical training format: experts/practitioners in architecture, planning and engineering with basic knowledge of the Rhinoceros software
- Focus groups co-design format: Communities, decision makers, policy-makers, city officials, local experts, practitioners, students, community leaders, NGOs, Third Sector, private stakeholders

# 3D neighbourhood configurator | how to

01

## BASELINE MATERIAL PREPARATION

The tool consists of five components programmed in Grasshopper, which enables the users to generate simplified and blocky 3D objects representing some of the typical elements that characterise the urban environment and influence its microclimate (e.g.) grounds, roads, buildings, trees and canopies.
Once generated, the user can assembly those elements to make a conceptual mass model of a urban space

02

## TRAINING SESSION

Training/educational format addressed to practitioners or architectural/ planning students (one day workshop). The expert manages a training of 6 hours in which the functioning of the tool is explained to allow the participants to generate potential design solutions verifying different configurations and simulating their effects on urban micro-climate

03

## FOCUS GROUP

Focus groups/co-design with non experts (city officials, decision makers, community): An expert gives a PPT/PDF presentation to introduce the focus-group. The focus is to deliver to participants basic knowledge on urban micro-climate and potential design solutions that can be configured through the tool..

04

## RUNNING THE CONFIGURATOR

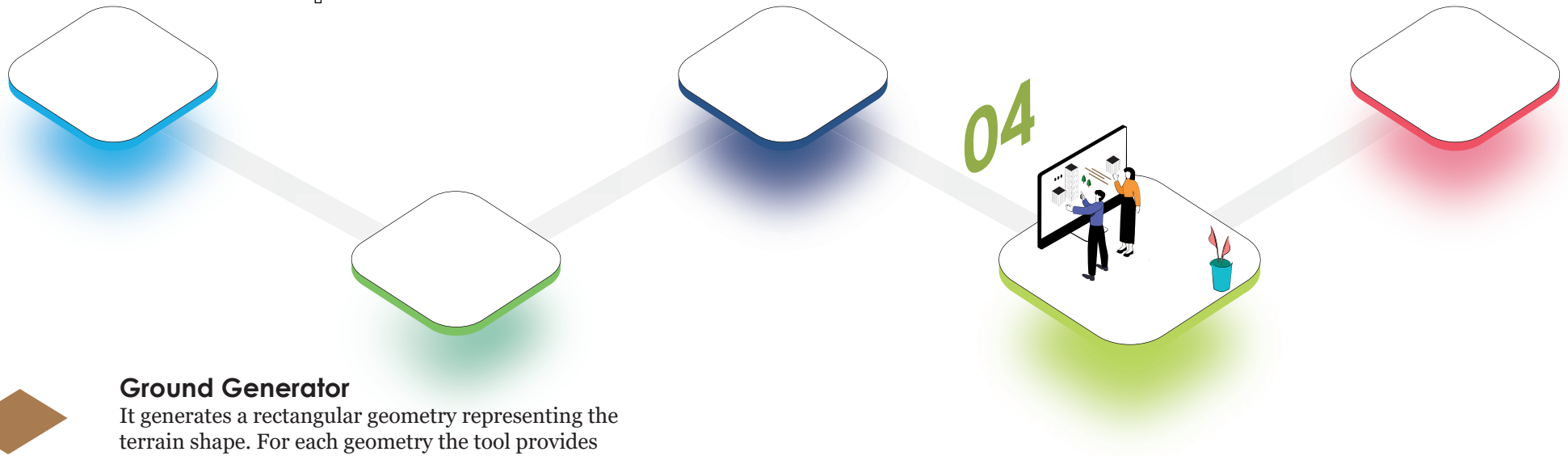
In the second phase while one expert guides the focus group for a co-design exercise the second expert simultaneously runs the configurator to generate and simulate the co-designed solutions

05

## USING THE 3D MODEL

The generated 3D model automatically provides all the input data useful for running energy consumption and outdoor comfort simulations with AAD tools and thus can be directly embedded in the simulation models without additional post-processing steps. It also provides other useful information for further assessment, such as social, economic and environmental co-benefits of the modeled solutions

3D neighbourhood configurator | focus on




## Ground Generator

It generates a rectangular geometry representing the terrain shape. For each geometry the tool provides quantitative and qualitative informations (e.g. albedo, emissivity, co-benefits)

## Road Generator

It generates a solid representing the shape of the road according to the given polyline and width. The tool provides quantitative and qualitative informations (e.g. albedo, emissivity, co-benefits)

## Building Generator

It generates a box geometry of the specified dimensions, which represents the building shape. According to the parameters the tool proves with information useful to outdoor comfort and energy simulations

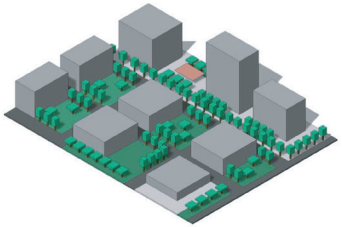
## Tree Generator

It generates a box geometry of the specified dimensions, which represents the tree canopy, providing the following informations: and: tree and co-benefits

## Canopy Generator

It generates a rectangular geometry of the specified dimensions, which represents the canopy and co-benefits

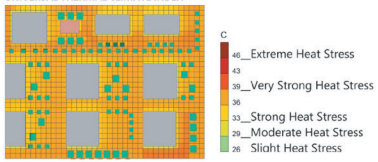
# RUNNING THE CONFIGURATOR



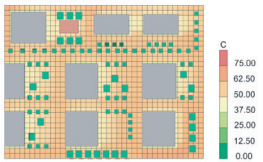
| Dotazione Funzionale | | |
|---|---|---|
| Area | m² | % |
| Total Surface | 29802 | 100 |
| *Partial surfaces* | | |
| Paved surfaces | 14482 | 48,6 |
| Green surfaces (lawn, ground, etc...) | 6815 | 22,9 |
| Tree covered area | 1108 | 3,7 |
| Building footprint | 8505 | 28,5 |
| Area covered by canopies | 247 | 0,8 |
| *Soil permeability* | | |
| Permeable surfaces | 6815 | 22,9 |
| Non permeable surfaces | 22987 | 77,1 |

**- OUTDOOR COMFORT SIMULATION (hottest day of the year)**

UNIVERSAL THERMAL CLIMATE INDEX




MEAN RADIANT TEMPERATURE



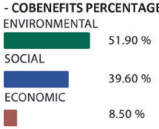

**- CO2 STORED BY TREES**

SPECIES:

| | |
|---|---|
| QUERCUS ILEX (Leccio) | 45 % |
| POPULUS TREMULA (PIOPPO TREMULO) | 12 % |
| FAGUS SYLVATICA (FAGGIO EUROPEO) | 43 % |

CO2 STORED: 0,48 Tons of CO2 equivalent/year

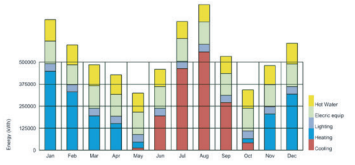
**- COBENEFITS PERCENTAGE**



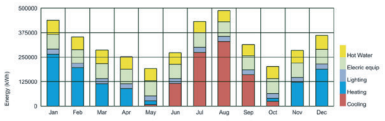

**- ENERGY CONSUMPTION** *RESIDENTIAL AREA*

| | |
|---|---|
| Energy Use Intensity (EUI) (kWh/m²) | 140,77 |
| PV energy production (Kwh/year) | 2670300 |
| PV panel Total surfaces (m²) | 8126 |
| Energy saved percentage % | 40,74 |
| Energy Use Intensity (EUI) with PV panel (kWh/m²) | 83,43 |

ENERGY CONSUMPTION

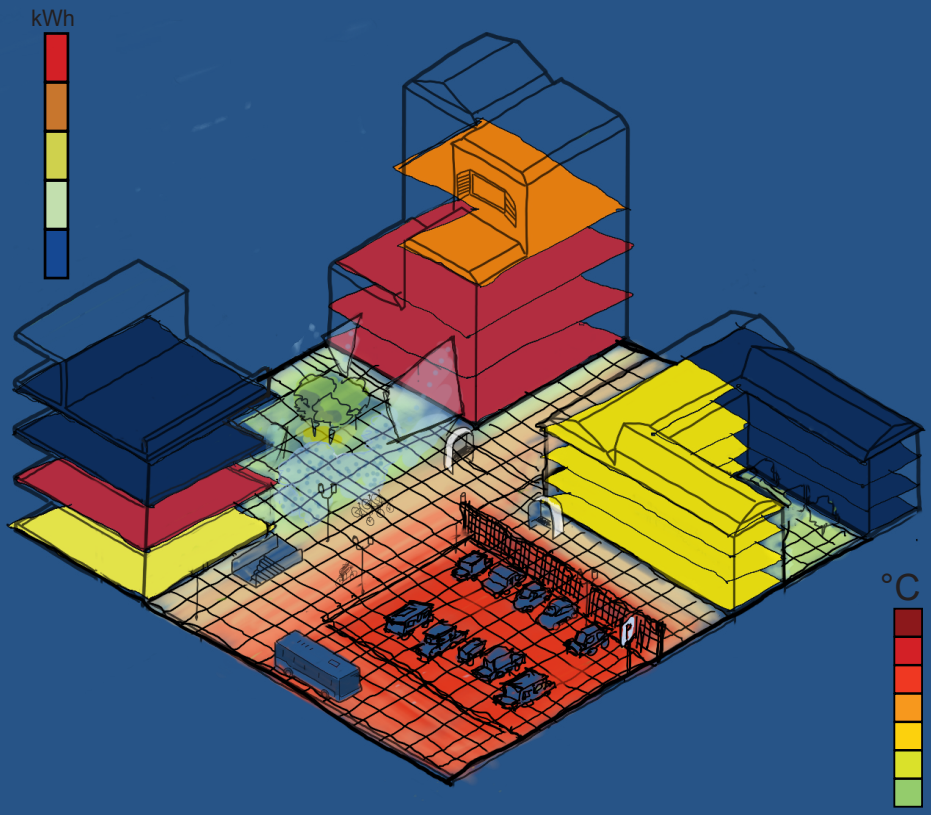



ENERGY CONSUMPTION (PV implementation)



# SIMULATION TOOLKIT

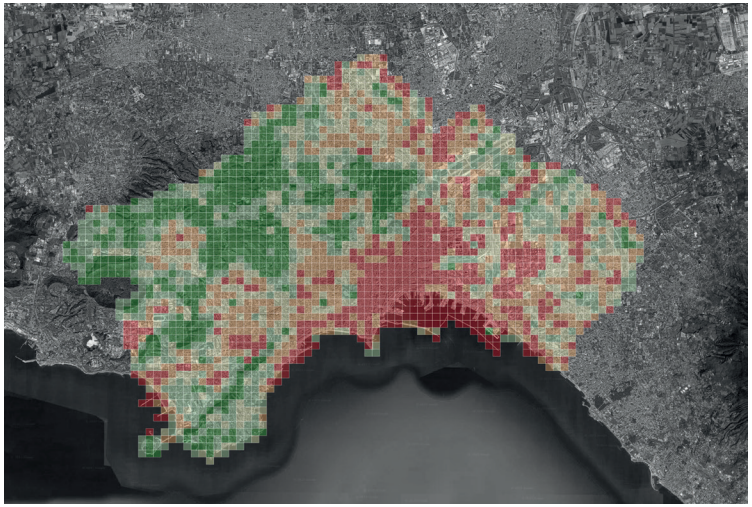
The toolkit comprises a set of IT tools (GIS tools and 3D Modelling tools) aimed at evaluating the impact of climate change in cities considering the effect of urban climate factors (linked to morphology, land use and cover, building features, etc.).
The toolkit operates at different scales and phase of the UDCW methodology workflow, with particular reference to the Climate Analysis Mapping and the Post Intervention Evaluation phases. It can be used as a standalone toolkit (and its tools as standalone components for partial analyses), but provide significant additional outcomes if used in synergy with the Facilitation toolkit.
The models are based on the elaboration of climate projections downscaled at city level to include urban microclimate conditions and simulate the impacts of heat waves on population, the effect of seasonal temperature trends variation on energy demand, and impacts of floods on buildings and open spaces.
The current version of the toolkit has been developed, tested and improved within several projects (UCCRN ARC3.2; UCCRN ARC3.3; H2020 CLARITY; H2020 ESPREssO; Erasmus+ UCCRN_edu, Horizon Europe KNOWING, Horizon Europe UP2030)




## Tools

_GIS tools
_3D modelling tools

# GIS tools





## OBJECTIVES

- The UDCW GIS Tool offers a comprehensive platform that enables stakeholders to visualize and evaluate the effects of climate change on a city-wide scale. This assessment encompasses various impacts, including heatwaves, flooding, and shifts in energy demand. It allows for the analysis of these impacts under different conditions, including the present conditions, business-as-usual projections, and post-intervention scenarios.

## DESCRIPTION

By drafting current city conditions and/or design scenarios in a GIS environment, a range of simulation models can be executed, enabling quantitative and spatial analysis of climate change impacts and the effect of climate-resilient planning and design solutions. In particular, the current version of the models allows the assessment of the health and economic impacts of heat waves and floods, the effect of slow-onset temperature and precipitation variations on energy consumption and production from renewable sources, and the $CO_2$ absorption potential from vegetation cover.

## OUTCOMES

- Heat Wave Hazard analysis
- Heat Wave Impact analysis
- Flood Hazard analysis
- Flood Impact analysis
- Energy analysis
- Carbon analysis

## FACILITATORS

Technically qualified experts with a medium level of expertise in GIS.

## TARGET GROUP

- Desision maker
- Technicians
- Civil society
- Other stakeholders

# GIS tools | how to

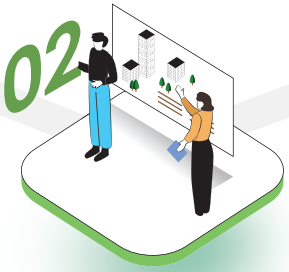
01

## DATA COLLECTION

1 to 7 days

Data is collected and organized in a coherent folder structure by the interested entity which usually requires the help of a GIS expert

02



## TRAINING SESSION

2 to 5 days

Preliminary analysis is performed, like future weather predictions, to establish the baseline of the models. In this phase, data is revised, imported, and organized into their respective layers with their respective attributes to characterize the GIS model

03

## RUN THE SIMULATION

1 to 5 hours

Different types of simulations are run for the performance of the following analyses:

- Heat Wave Hazard analysis
- Heat Wave Impact analysis
- Flood Hazard Analysis
- Flood Impact analysis
- Energy analysis
- Carbon analysis

04

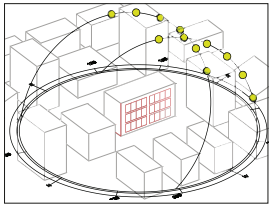
## RESULTS VISUALIZATION

All of the simulations generate city-wide GIS in which indicators are shown in a variable side length square grid

# GIS tools | focus on

01

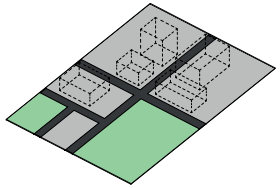
## DATA COLLECTION



**CLIMATE DATA**

- air temperature
- solar radiation and position
- rain amount

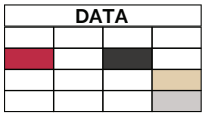
+



**LANDUSES FEATURES**

- building features
- open spaces
- vegetation features

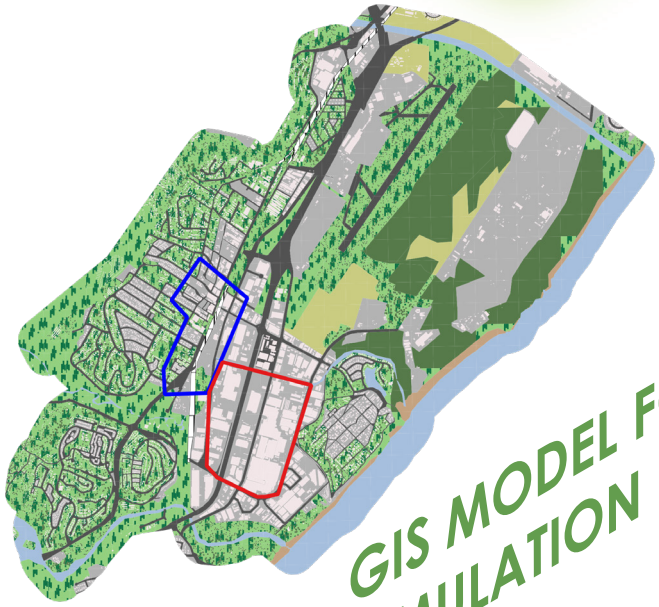
+




**POPULATION DISTRIBTION**

- number of people
- age of people

=



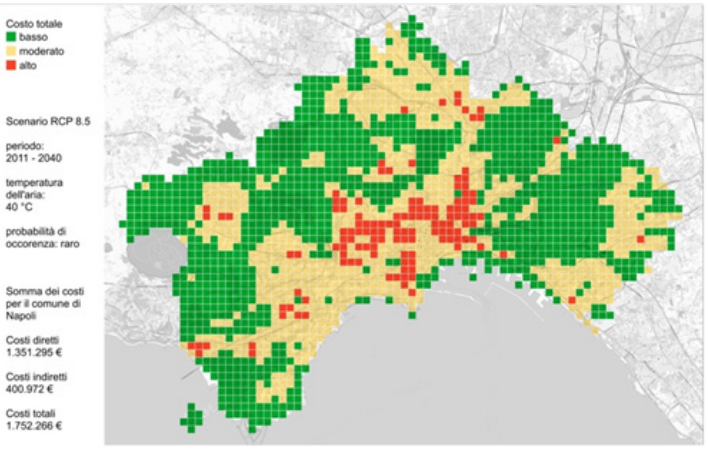
GIS MODEL FOR SIMULATION

GIS tools | focus on

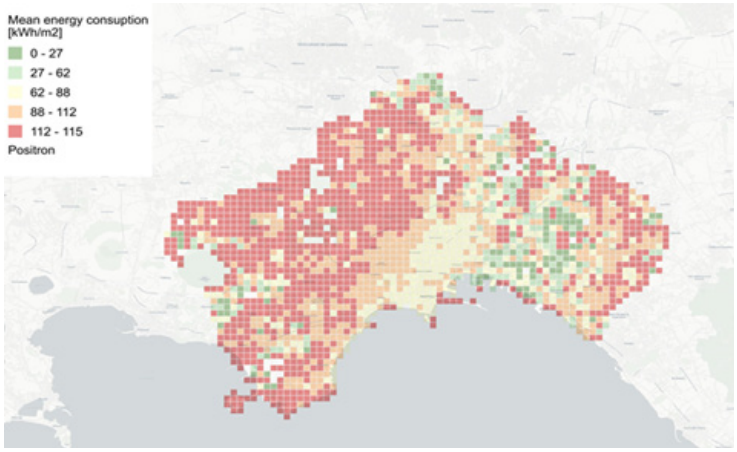
# RESULTS VISUALIZATION

04

## HOSPITALISATION COSTS DUE TO HEATWAVE




## BUILDING ENERGY CONSUMPTION




## OUTPUTS

Heat Wave Hazard analysis

- Mean Radiant Temperature (TMRT) [°C]
- Universal Thermal Climate Index (UTCI) [°C]
- Apparent Temperature [°C]
- Land Surface Temperature [°C]

Heat Wave Impact analysis

- Hospitalisation costs [€]
- Mortality rate [%]

Flood Hazard analysis

- Flood probability index [-]

Flood Impact analysis

- Building damage (structure and content) [€]
- Road infrastructure damage (cleaning and repairing) [€]

Energy analysis

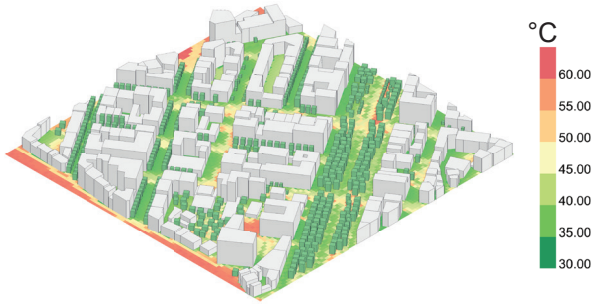
- Average building energy consumption [kWh/m2y]
- Renewable energy production potential [kWh/y]

Carbon analysis

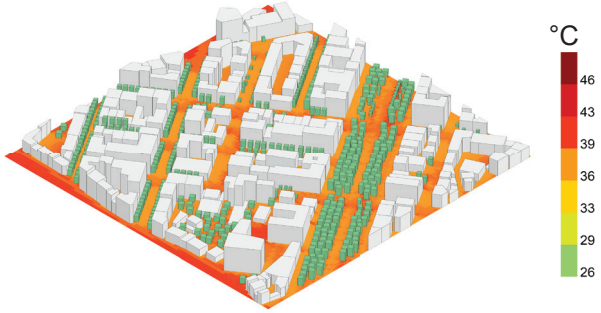
- Carbon storage potential from vegetation [tCO2/y]

# 3D modelling tools

## 1 outdoor thermal comfort tool

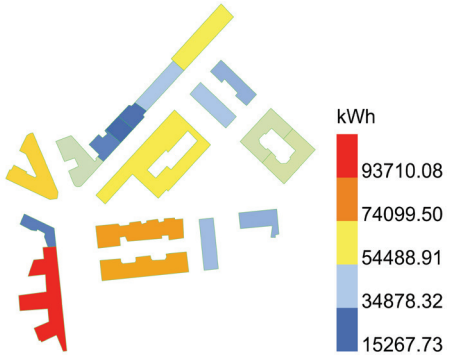



MEAN RADIANT TEMPERATURE

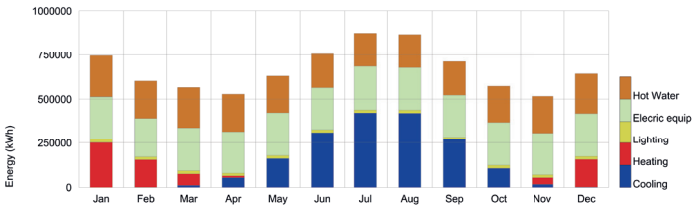



UNIVERSAL THERMAL CLIMATE INDEX

## 2 energy consumption analysis tool




Total Zone Electric Equipment Electricity Energy (kWh)
1/1 to 12/31 between 0 and 23




ENERGY USE

### OBJECTIVES

- The 3D modeling tools aim to analyze climate benefits of urban designs at the neighborhood scale, validated against historical data, requiring detailed building and environmental specifics.

### DESCRIPTION

The 3D modelling tools offer a comprehensive, quantitative, and spatial analysis of the climate benefits associated with planning and design scenarios at the neighbourhood scale. The effectiveness of these tools is evaluated by comparing the outcomes against observed historical data and available statistics. Their application requires more detailed information about building envelope and HVAC solutions (both for existing buildings and targeted designs for new or retrofitted buildings), as well as technical specification for outdoor paving materials and vegetation types.

### OUTCOMES

- Thermal comfort analysis
- Energy consumption analysis
- Carbon analysis

### FACILITATORS

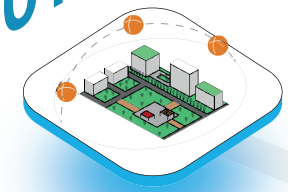
Technically qualified experts with a high level of expertise in algorithm aided design (AAD)

### TARGET GROUP

- Desision maker
- Technicians
- Civil society
- Other stakeholders

# 3D modelling tools | 1 | outdoor thermal comfort tool | how to

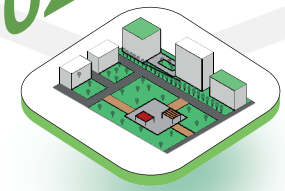
01



## CLIMATE DATA COLLECTION

Provide weather data using EPW files to set the geographic position of the model and to characterise its climate features

02



## TRAINING SESSION

Model the geometries into the respective layers (landuse, road, buildings, trees and canopies) assigning the essential thermal properties that characterise the model using object “keys and values” in Rhino.

03

## RUN THE SIMULATION

Set the analysis period on the hottest day of the year (using the data in the epw file) or on another specific date;

Name the file and choose the folder directory;

Run the simulation.

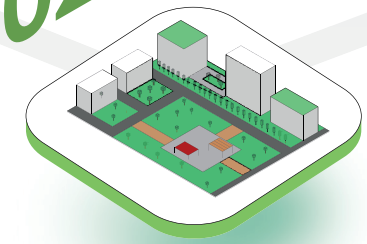
04

## RESULTS VISUALIZATION

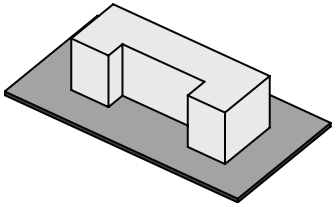
All the end of the simulation, the tool generates microclimate maps in the Rhino, view showing, for the selected analysis period, the level of different outdoor comfort indicators such us UTCI and TMRT

# 3D modelling tools | 1 | outdoor thermal comfort tool | focus on

02

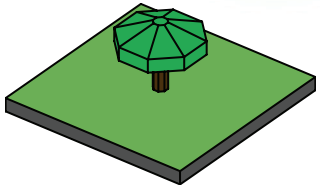


## MODELLING PHASE



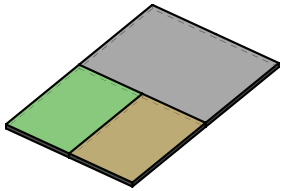
### BUILDING MASSES

Context buildings have to modeled as solid geometries. The tool assesses their contribution to outdoor thermal comfort by calculating the amount of shade they can cast during the day



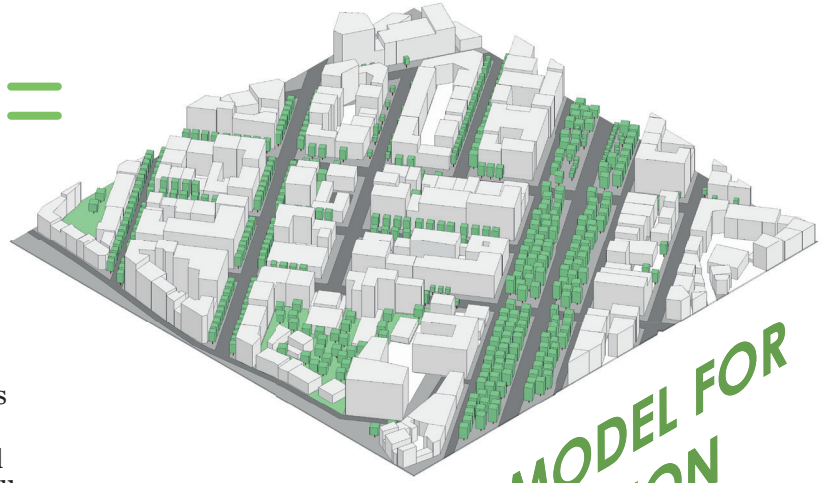
### TREES AND CANOPIES

Canopies and trees can be modeled as surfaces or solid geometries. The tool calculates the amount of shade they can cast and applies different coefficients to trees according to the season



### LAND COVER

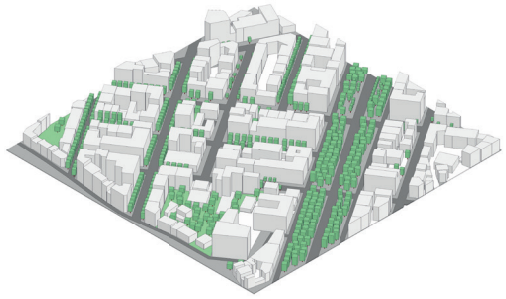
Ground surfaces have to be modelled as solids.
According to the land cover typology, thermal properties have to be assigned to the geometries (albedo, thermal emissivity, etc.). The tool will use these information to calculate the land surface temperature and, consequentely, their contrimution to the outdoor thermal comfort



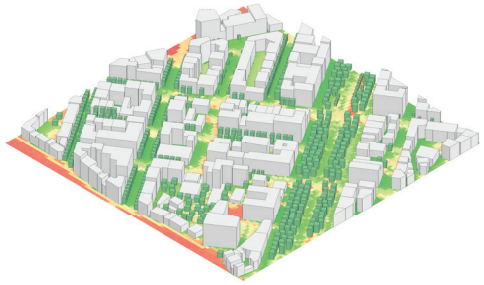
## 3D MODEL FOR SIMULATION

# 3D modelling tools | 1 | outdoor thermal comfort tool | focus on

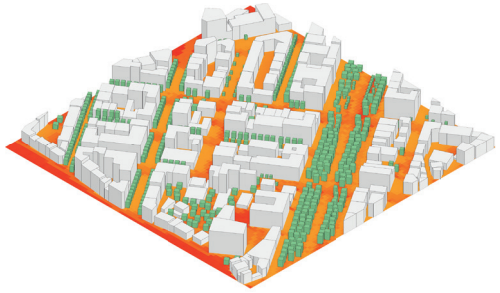

## 3D MODEL



## MEAN RADIANT TEMPERATURE




## UNIVERSAL THERMAL CLIMATE INDEX




## RESULTS VISUALIZATION

The tool uses the data provided by the simulation to produce 2D and 3D maps representing the climate behavior of the modeled area according to different indicators.
To assess the comfort levels of the area, in UDCW, the Universal Thermal Climate Index (UTCI) and Mean Radiant Temperature (TMRT) are most used indicators. The maps can report both average values over the 24 hours of the day and values calculated at a specific time of day.

# 3D modelling tools | 2 | energy consumption analysis tool | how to

01

## CLIMATE DATA COLLECTION

Provide weather data using EPW files to set the geographic position of the model and to characterise its climate features

02

## CONTEXT MODELING

Model, under the proper layers, all the geometries that cast shadows on the analysed buildings (eg. trees, canopies, other buildings that do not need to be analysed)

03

## BUILDING MODELING

Model the shape and set the building feature affective buildings' energy performances: envelope and roof construction, HVAC, Window to Wall ratio, building program, ecc.

04

## SIMULATION

Assembly the model merging all the components of the scene: context and buildings

Name the file and choose the folder directory

Run the simulation

05

## RESULT VISUALIZATION

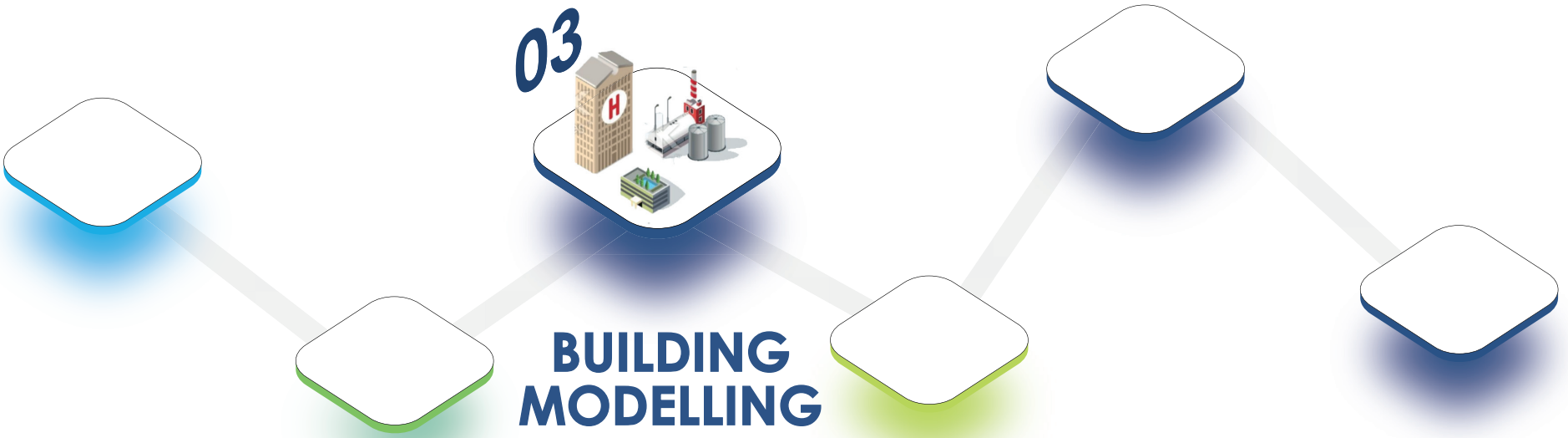
At the end of the simulation , the result will be reported on abar graph with different colors and values representing the amount of energy consumption for each end use

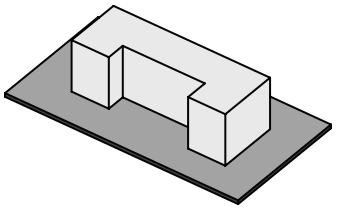
06

## PV INTEGRATION

If needed, calculate the amount of energy produced by Photovoltaic systems using the dedicated component

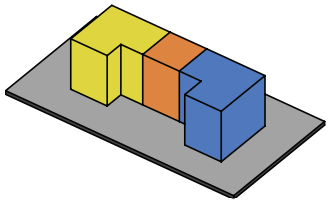
# 3D modelling tools | 2 | energy consumption analysis tool | focus on



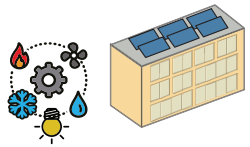
**BUILDING MASSES**

The building to simulate must be modelled as solid geometries



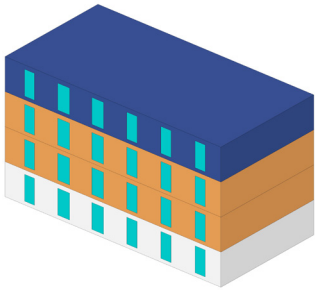
**PROGRAM, ENVELOPE AND ROOF FEATURES**

The geometry must be fed with infirmation related to the building program (residential, office, ecc) and envelope and roof features



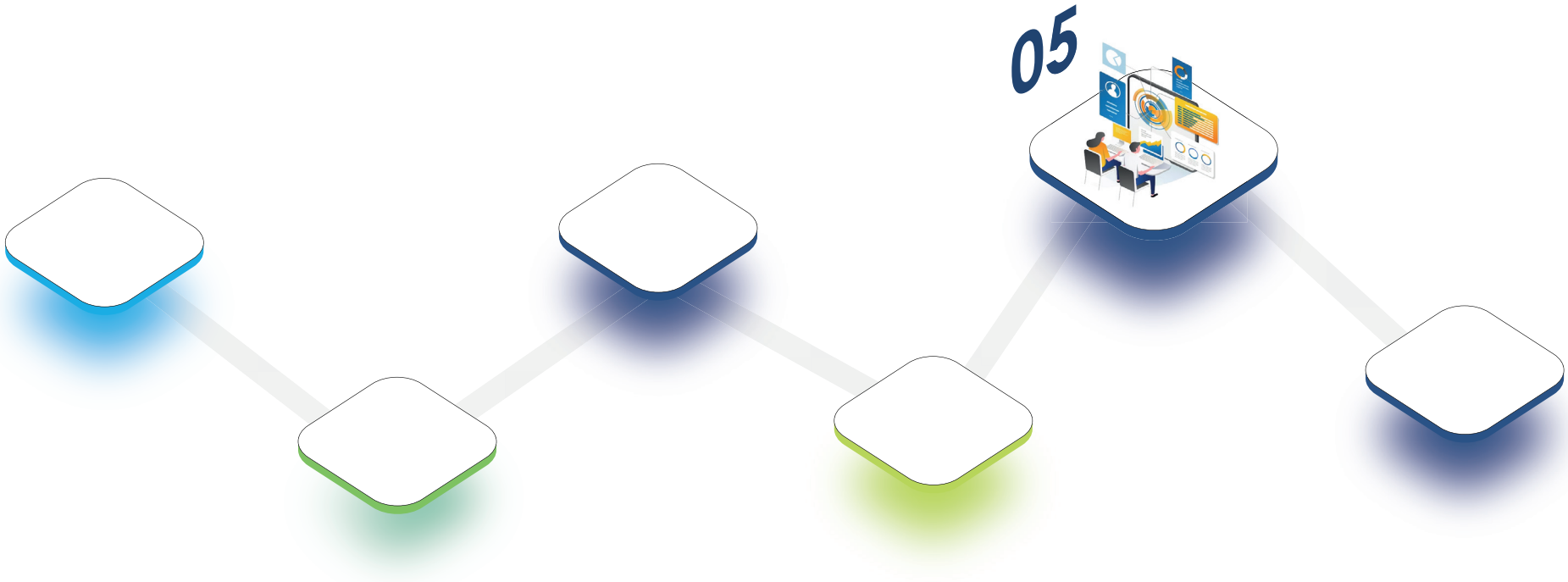
**HVAC TEMPLATE AND PV SETTINGS**

Other (optional) information concerns the typology of HVAC, which can be set according to specific presets. If needed, is it possible to add PV panels to the model

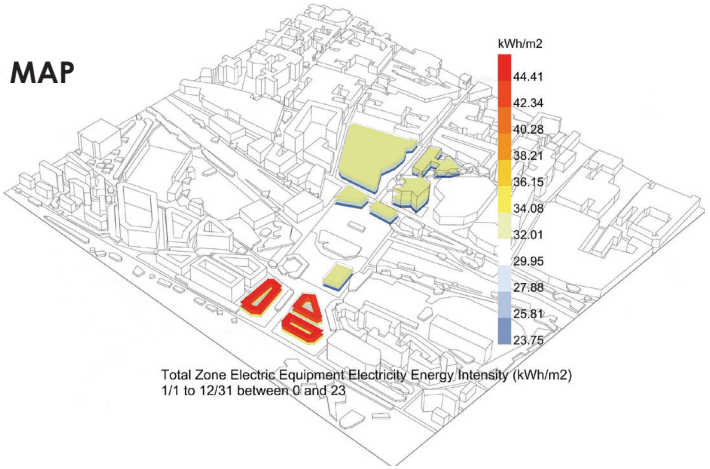


**3D MODEL FOR SIMULATION**

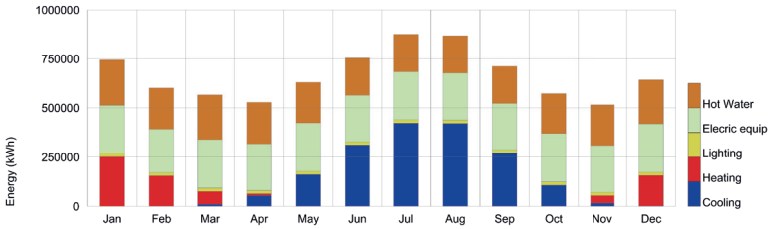
3D modelling tools | 2 | energy consumption analysis tool | focus on




## 3D MAP




## ENERGY USE GRAPH




# RESULTS VISUALIZATION

At the end of the simulation, the tool allows to visualize the results generating 2D/3D maps and bar graphs. The possible outputs are: Total energy consumption [kWh]; Energy Use Intensity (EUI) [kWh/m2]; EUI for single uses (Heating, Cooling, Lighting, etc.); Energy saved through the implementation of PVs (%)

# credits

## CONCEPTUALIZATION AND METHODOLOGY
Jeffrey Raven and Mattia Leone

## SIMULATION TOOLKIT
Giovanni Nocerino and Nicola Addabbo

## FACILITATION TOOLKIT
Cristina Visconti

## LAYOUT AND DESIGN
Anna Baldassarre

## SKETCHES
Hossein Ghandi and Antonio Sferratore

## CONTACTS
uccrneuropeanhub@gmail.com

UCCRN

**WEBSITE**
www.uccrn-europe.org
www.uccrn.education
www.uccrn.org

**LINKEDIN**
UCCRN Education

**INSTAGRAM**
@uccrneducation