UCDL
URBAN CLIMATE DESIGN LAB

Microclimate Digital Platform (MDP)

A digital model for urban microclimate visualization, modelling and implementation in urban planning

User guides | Apr 2026

NUS National University of Singapore | Department of Architecture
College of Design and Engineering

(FRS) FUTURE RESILIENT SYSTEMS

Scan me to access the MDP ☺

http://mdp.ucdl.sg/

(Yuan, et al., 2025)

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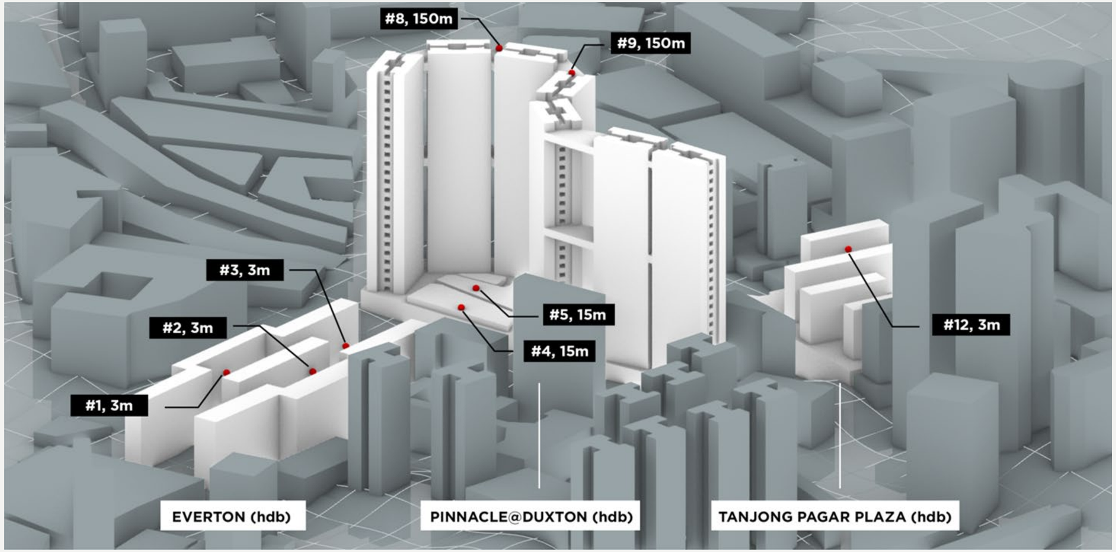
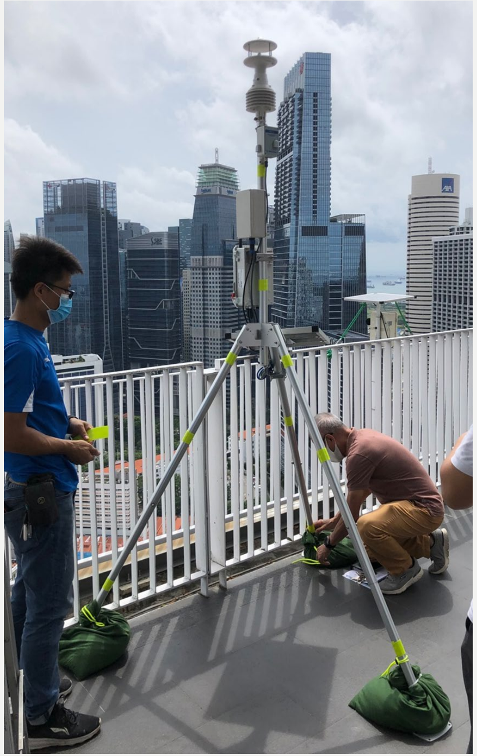
01 Real-Time Field Measurement



UCDL measurement in Tanjong Pagar, Singapore

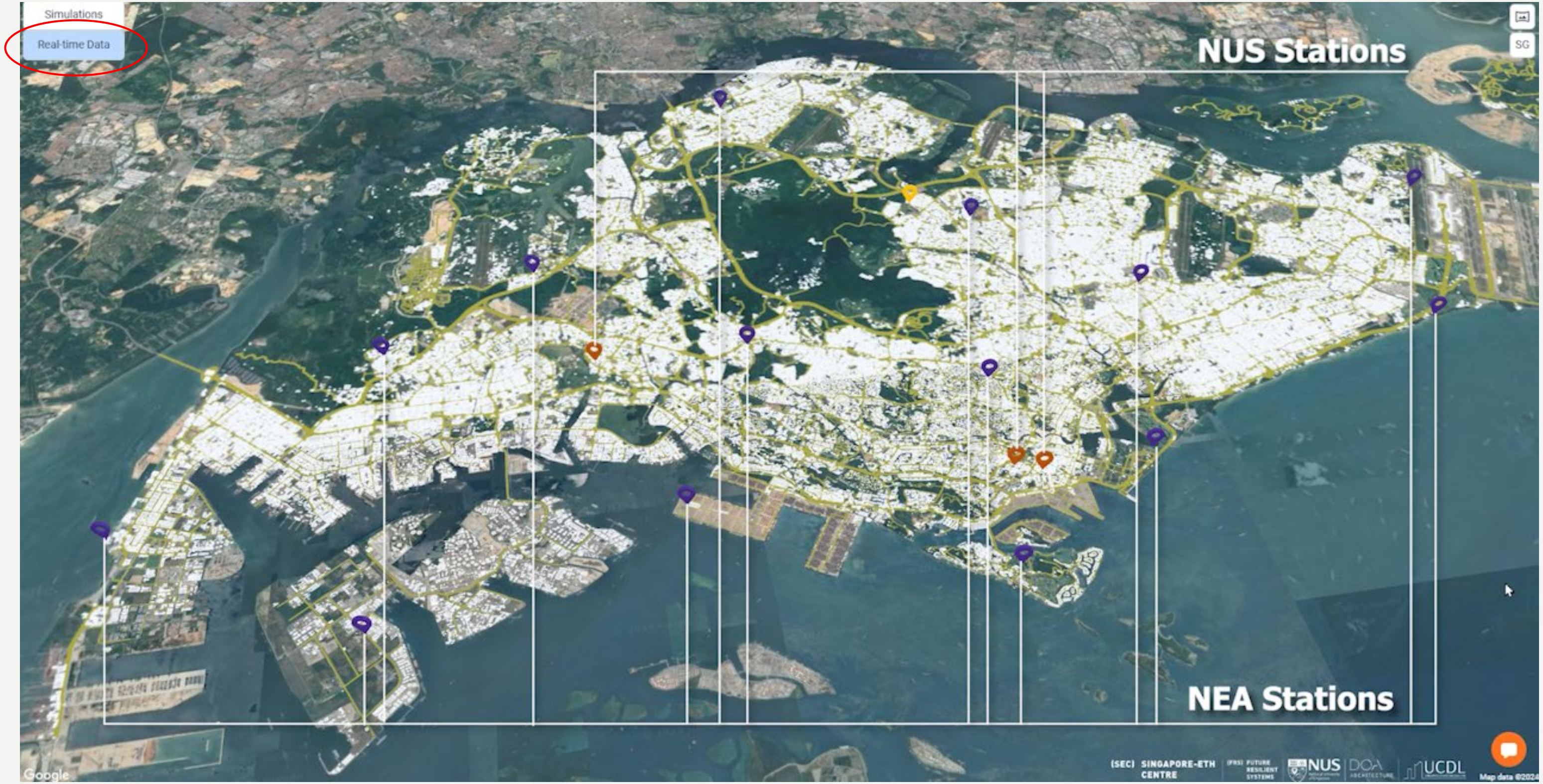


Environment sensors:

- Air temperature
- Wind velocity
- Solar radiation
- Relative humidity
- Air Quality: PM 1.0, PM 2.5; PM 10
  (PM 1.0, 2.5 and 10 refer to inhalable particles with diameters typically 1 .0, 2.5, 10 micrometers or smaller)

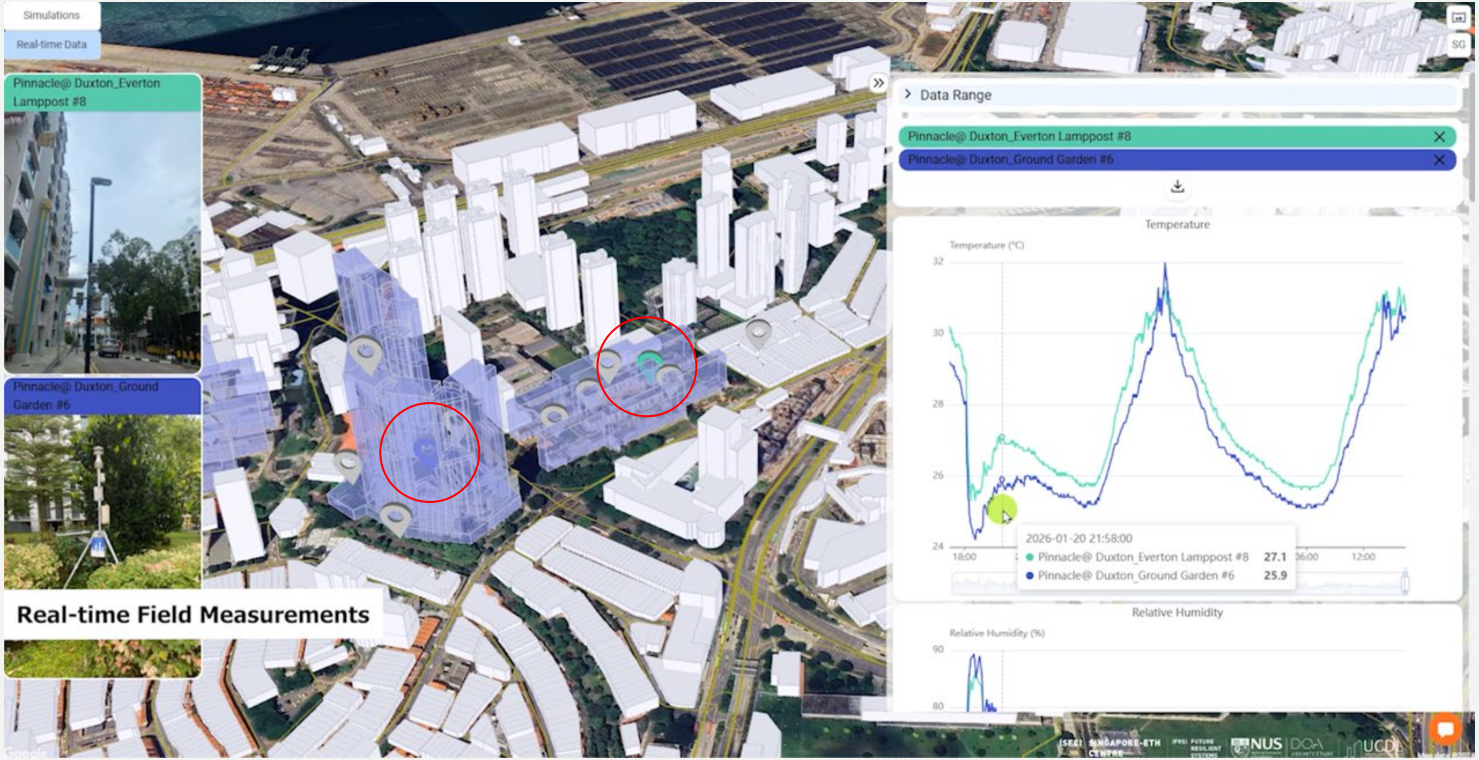
01 Real-Time Field Measurement

Click "Real-time Data" to view the available station options, including NUS Stations (red) and NEA Stations (purple).



01 Real-Time Field Measurement

For example, users can zoom in to the stations near Pinnacle@Duxton
and select stations (by clicking on icons) located in areas with different densities for comparison.



MDP records air temperature, relative humidity, wind speed and direction, and pollutant particles, for recent 6 months.

01 Real-Time Field Measurement

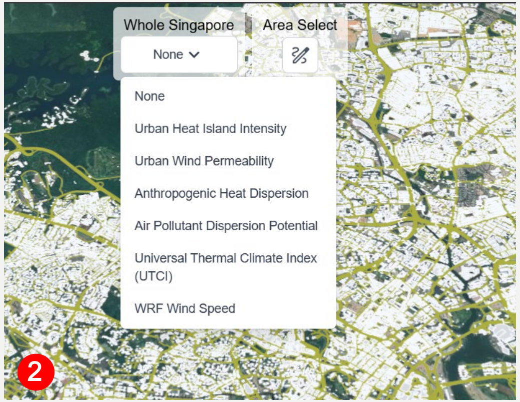
Beyond this, we predict real -time fine-scale air temperature for a specific chosen time (Simulations - AI Temperature Prection).

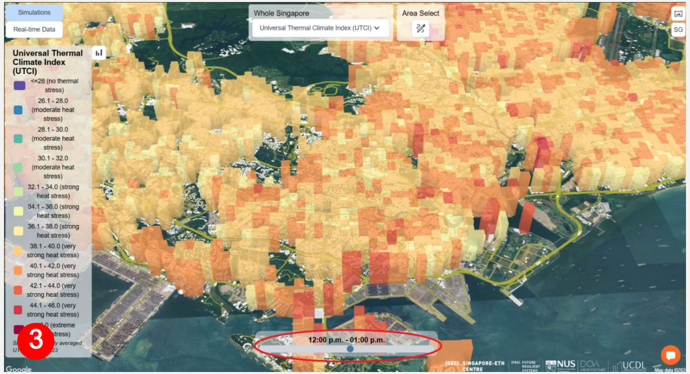
Data from the nearest stations are used.

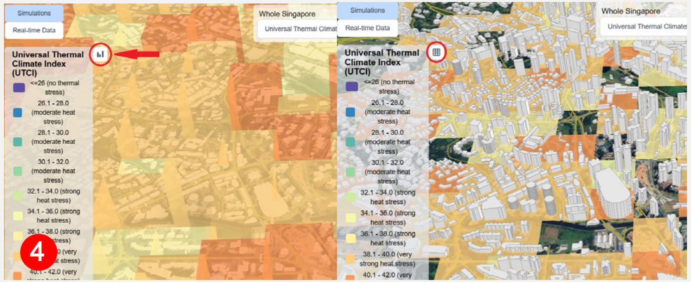
(Luo et al., 2026)

02 Urban Scale Microclimate Evaluation

1. Ensure that the "Simulations" option is highlighted.
2. From the city-wide selection, choose an urban-scale simulation under "Whole Singapore".
3. Certain simulations include a slider that allows switching between different time ranges.
4. Simulation results can be viewed, by clicking on corresponding icons, in either 3D or 2D to illustrate urban morphology.

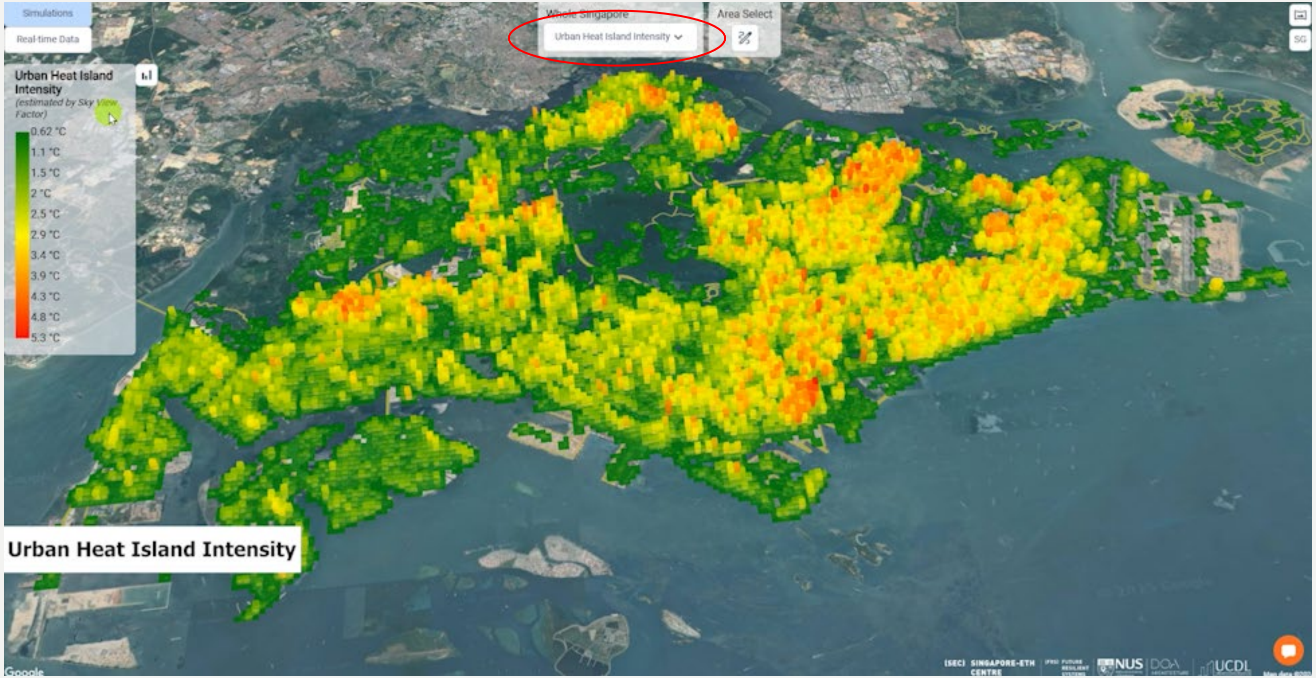






02 Urban Scale Microclimate Evaluation

Urban Heat Island (UHI) Intensity



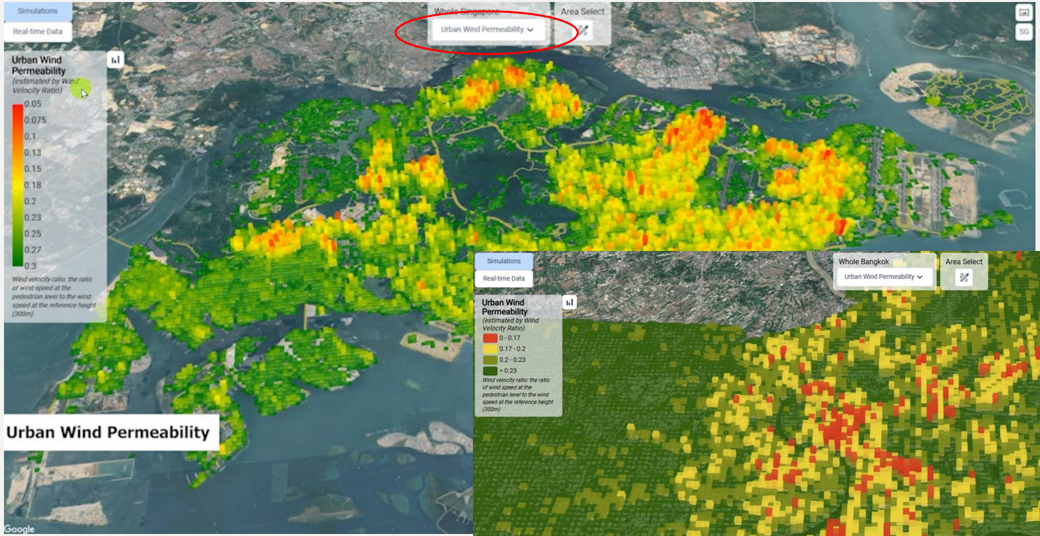
Fisheye photos to measure SVF in Singapore

- Urban Heat Island Intensity (°C), air temperature difference between urban and rural reference at a typical hottest day selected from the annual meteorological data , is estimated by local Sky View Factor (SVF: 200m x 200m), which is fraction of sky visible from the ground.
- Corresponding Urban Heat Island Intensity is shown in the legend on the left.

(Yuan et al., 2011; Zhang and Yuan, 2023)

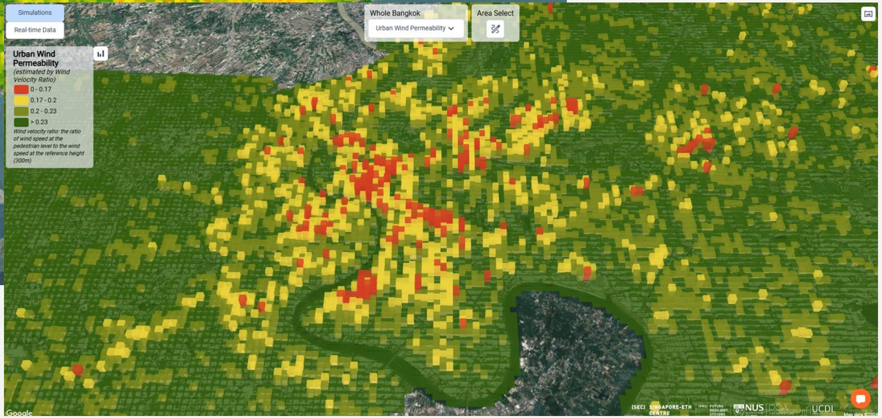
02 Urban Scale Microclimate Evaluation

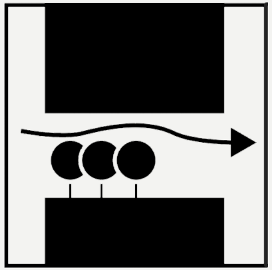
Urban Wind Permeability



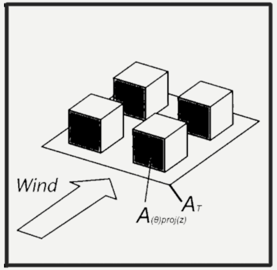
Singapore

Bangkok





Building permeability (Zhang and Yuan, 2023)

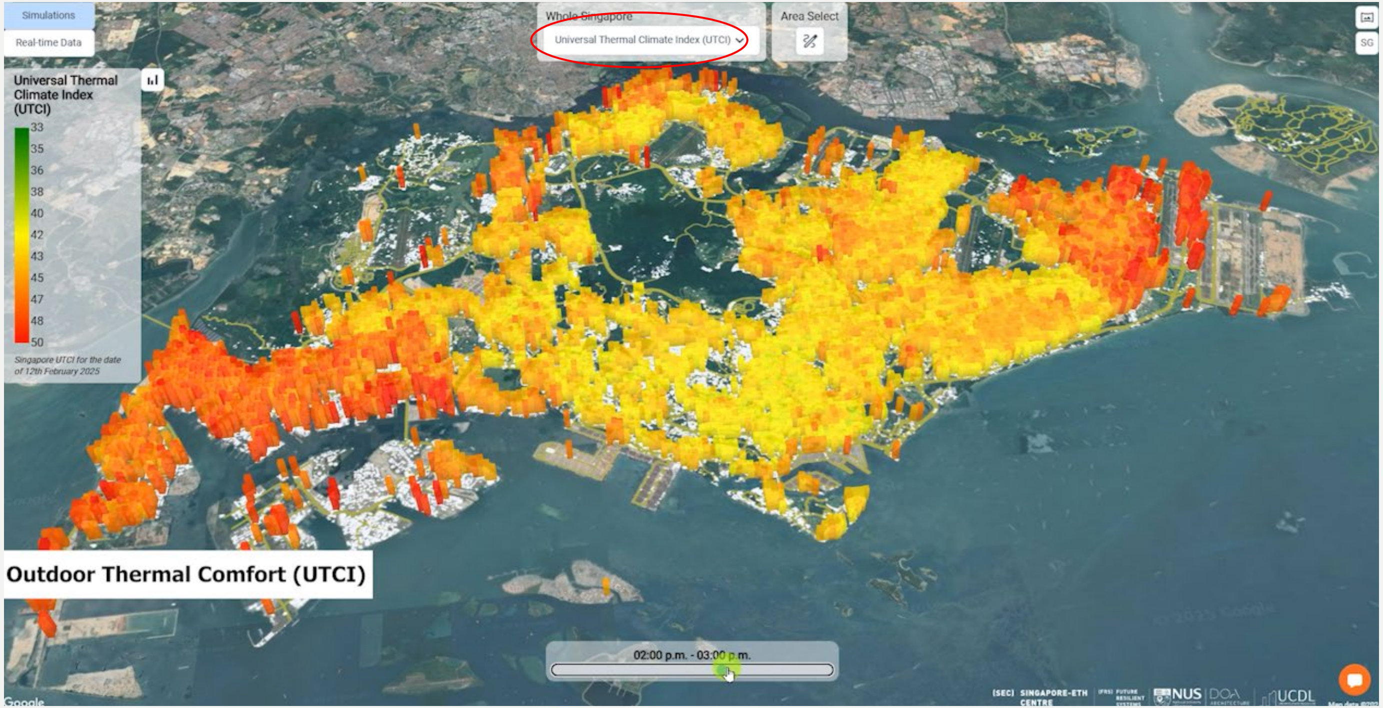


Frontal Area Density (FAD) (Oke et al., 2017)

- Urban wind permeability is evaluated using the wind velocity ratio, which indicates how easily wind can flow through the urban fabric.
- It is estimated based on frontal area density, defined as the ratio of the total building façade area exposed to the prevailing wind direction to the ground area within a neighborhood.
- Annually averaged wind velocity ratio is used, weighted by the annual wind frequency across 16 directions.
  (Ng, et al., 2011; Yuan, et al., 2014; Zhang and Yuan, 2023)

02 Urban Scale Microclimate Evaluation

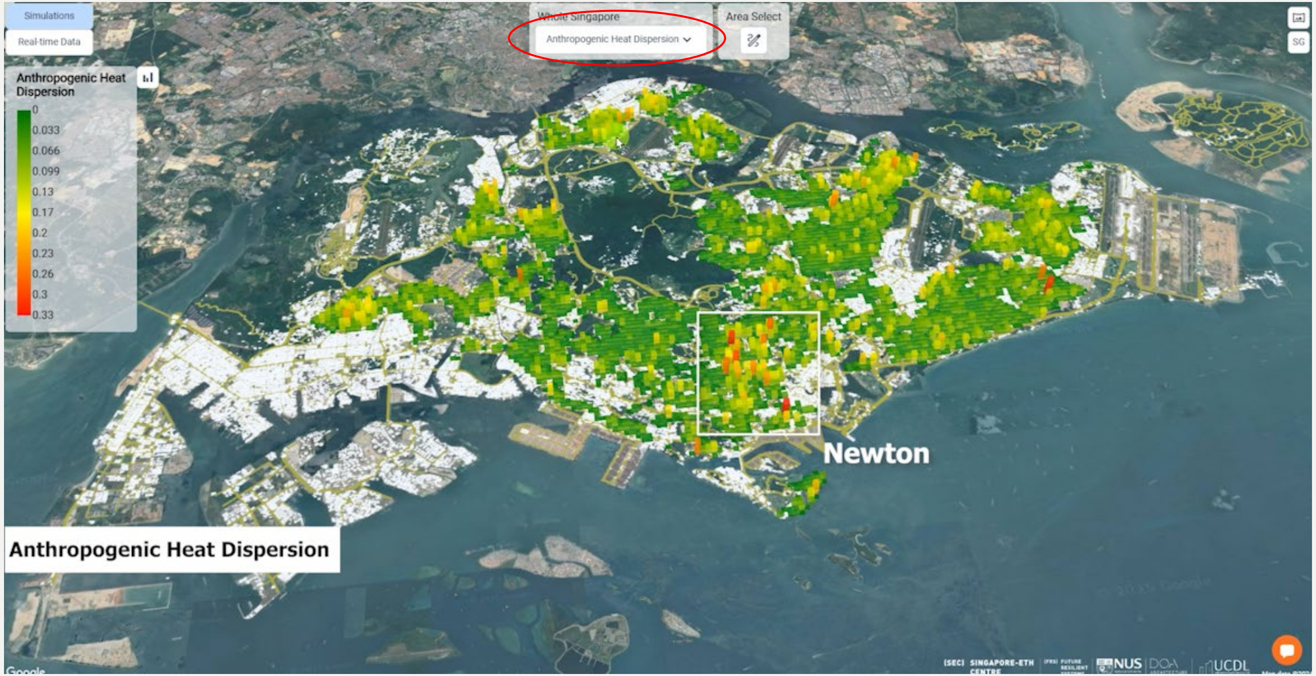
Universal Thermal Climate Index (UTCI)



Outdoor thermal comfort is directly quantified by Universal Thermal Climate Index (UTCI, °C) over a 24-hour period, explicitly accounting for the cooling effects of urban greenery (Chen, et al., 2025).

02 Urban Scale Microclimate Evaluation

Anthropogenic Heat Dispersion

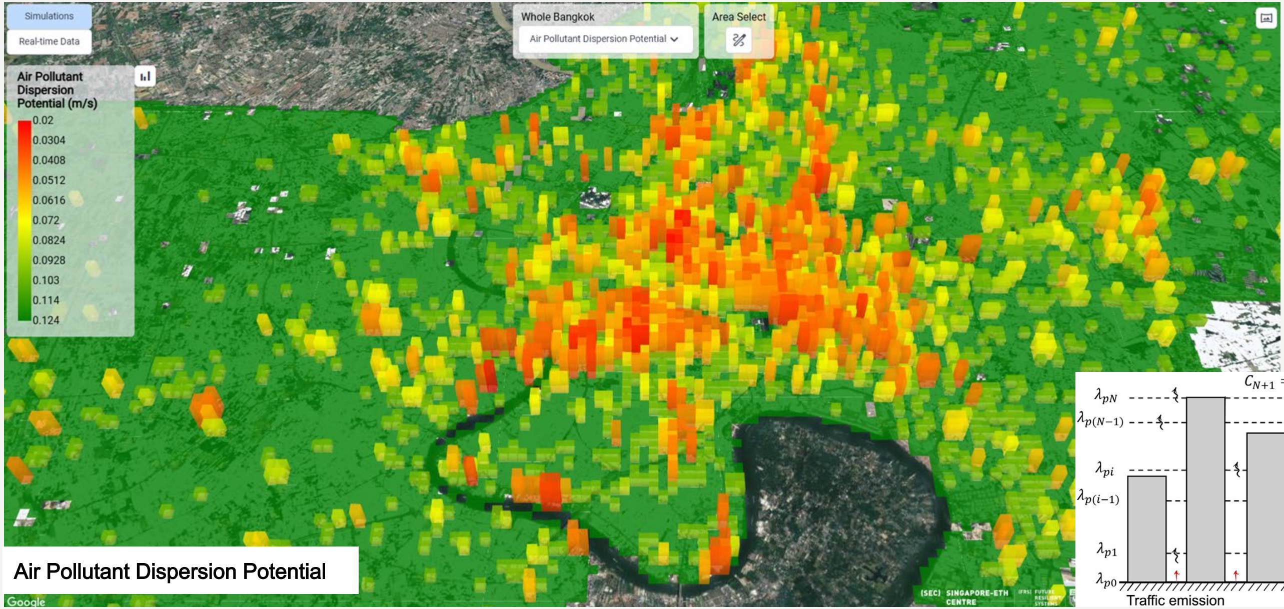


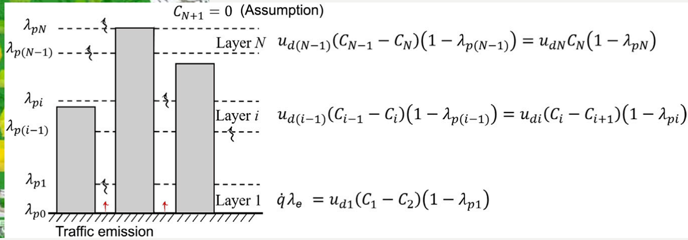
AC condensers in residential areas in Singapore

- Anthropogenic heat dispersion (°C) is estimated using site coverage ratio, frontal area density, based on heat conservation within urban canopy layers.
- Anthropogenic heat dispersion reflects the impact of heat emissions from air conditioning (AC) systems on air temperature in residential areas.
  (Yuan, et al., 2020)

02 Urban Scale Microclimate Evaluation

Air Pollutant Dispersion Potential



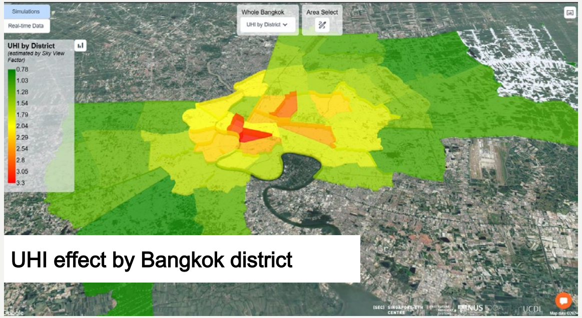


Schematic of the urban canopy layers and the governing equations per layer.

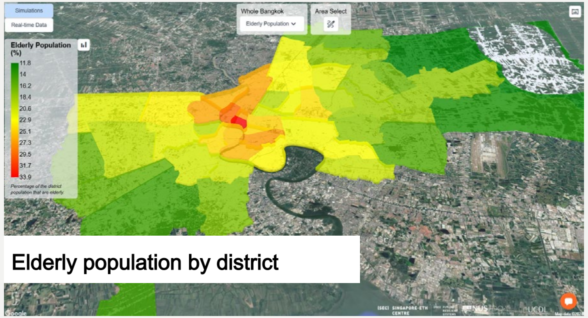
- Air pollutant dispersion potential (m/s) reflects how quickly traffic -related air pollutants are dispersed from the bottom of street canyons to the top.
- Air pollutant dispersion potential model incorporates various exchange velocities within the multiple urban canopy layers caused by building height variations.
  (Yuan et al., 2019)

02 Urban Scale Microclimate Evaluation

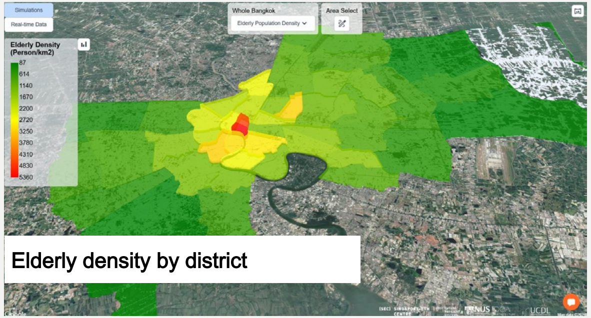
Elderly Heat Risk Assessment



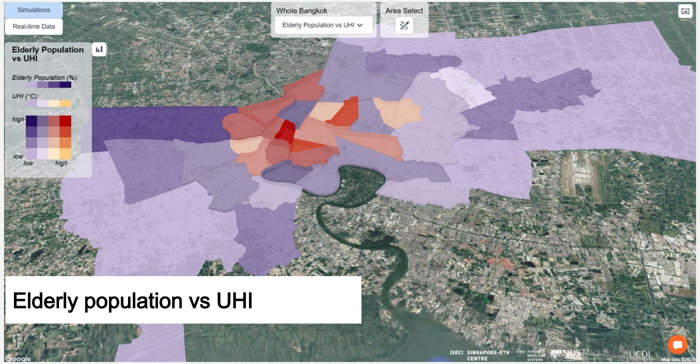
UHI effect by Bangkok district



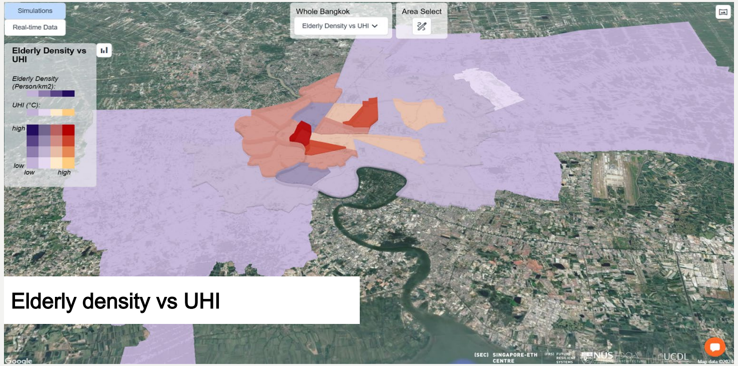
Elderly population by district



Elderly density by district



Elderly population vs UHI

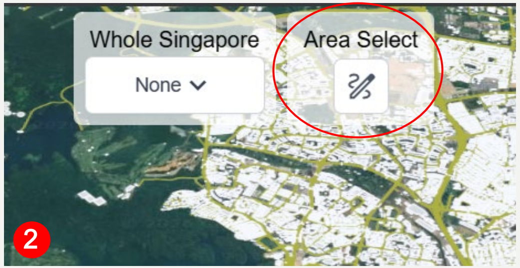


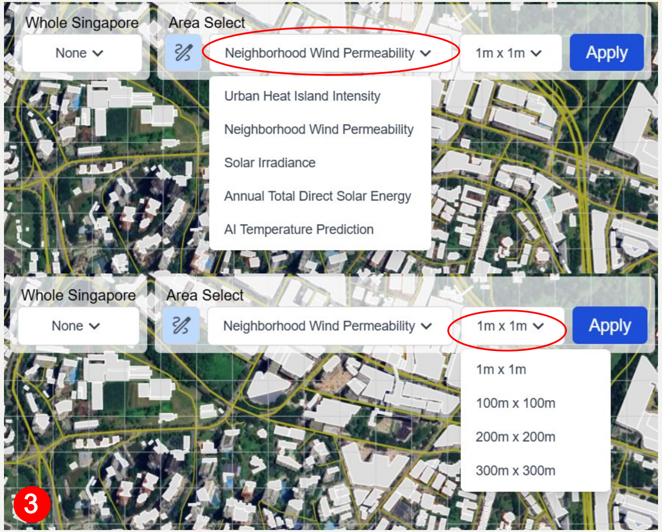
Elderly density vs UHI

Risk level assessment by integrating urban heat (exposure) and the elderly distribution (vulnerability) by districts within city (Zhu and Yuan, 2023).

03 Neighbourhood Scale Microclimate Evaluation

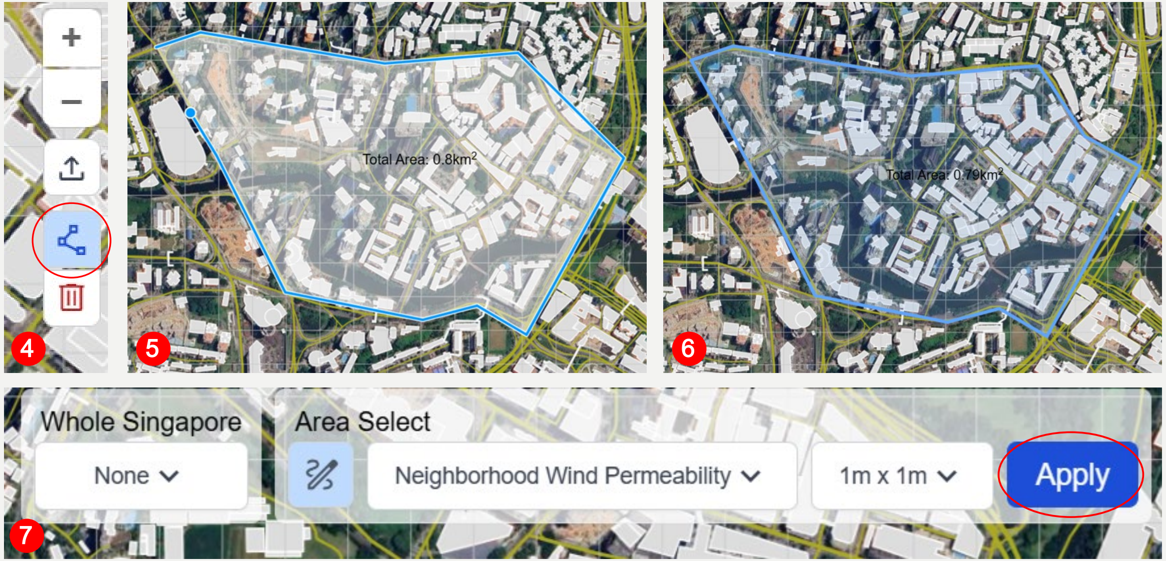
1. Ensure that the Simulations option is highlighted.
2. From the top panel, toggle on "Area Select".
3. From the drop downs, choose a neighbourhood scale simulation and simulation resolution.





03 Neighbourhood Scale Microclimate Evaluation

4. Make sure area drawing tool is activated.
5. Draw simulation boundary by left clicking (mouse) or tapping on the map (touch screen).
6. Connect to the first starting point to complete the simulation boundary.
7. Click on "Apply" to start retrieving simulation result from the MDP server.



03 Neighbourhood Scale Microclimate Evaluation

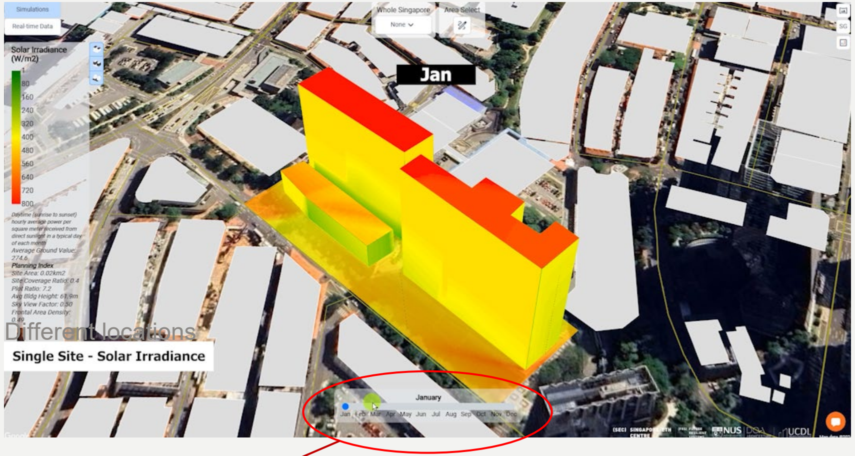
Neighborhood Wind Permeability

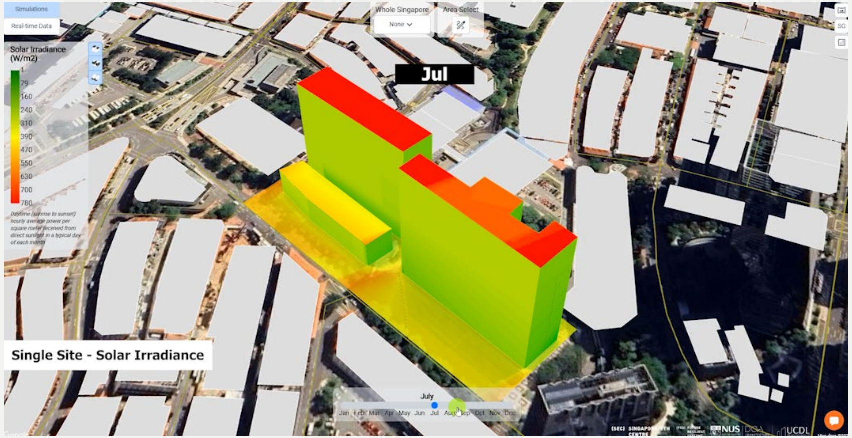
(Yuan, et al., 2016)

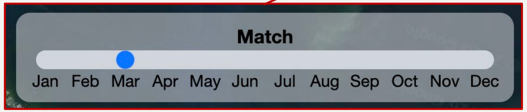
- Neighborhood wind permeability is measured by annually averaged wind velocity ratio in 1m x 1m resolution, weighted by annual wind frequencies in 16 wind directions.
- Wind frequency data from the nearest weather station are automatically selected and used in the calculation.
- Planning indices for the site, which are automatically calculated, are presented alongside microclimate evaluations to demonstrate the impact of urban morphology on the microclimate.

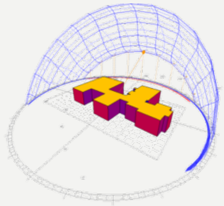
03 Neighbourhood Scale Microclimate Evaluation

Solar Irradiance







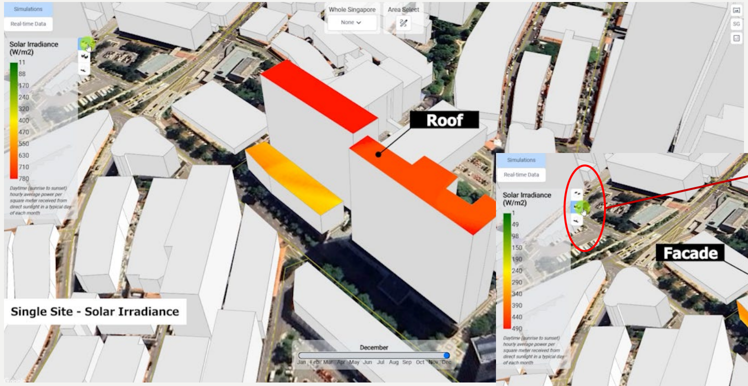


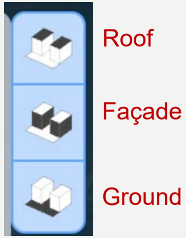
Solar irradiance
(Lassandro & Tundo, 2014)

- Solar irradiance (w/m^2) is modeled as the hourly average solar energy per square meter from direct sunlight on a typical day of each month.
- Use the slider to switch between different time ranges.

03 Neighbourhood Scale Microclimate Evaluation

Solar Irradiance





- The roof, façade, and ground components can be toggled on and off to inform various decisions.

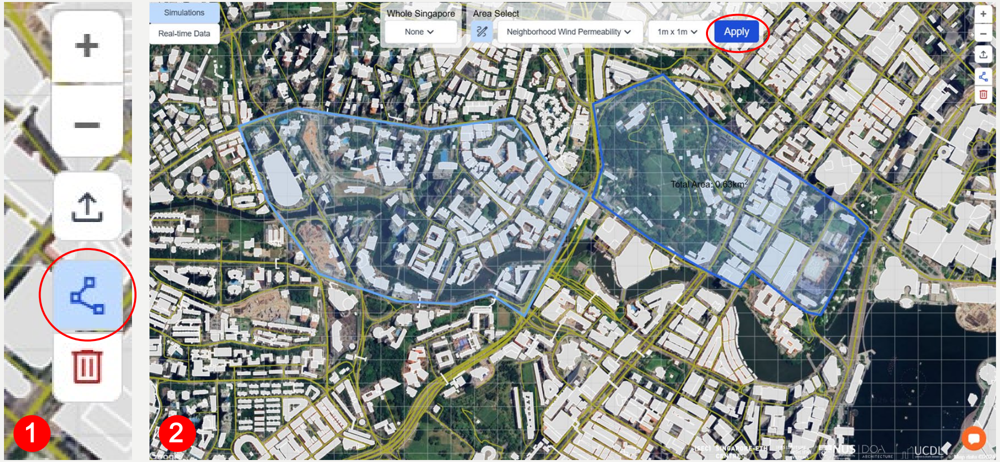
03 Neighbourhood Scale Microclimate Evaluation

Annual Total Direct Solar Energy

Annual total direct solar energy (w/m^2) on building roof, building fa çade, and ground surfaces is provided.

03 Neighbourhood Scale Microclimate Evaluation - Multiple Sites Selection

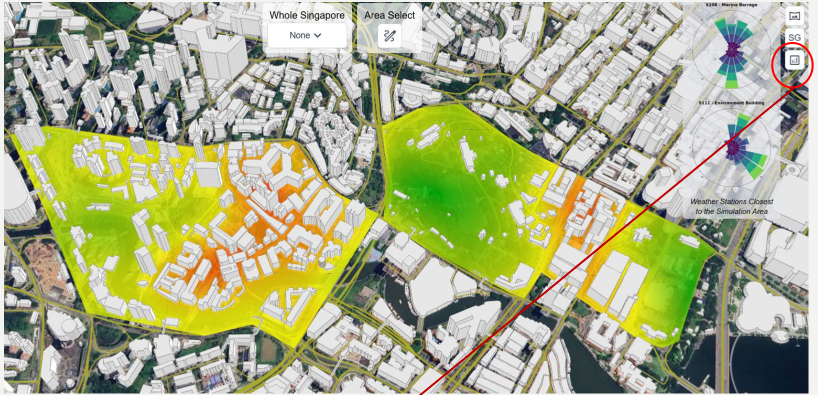
1. In neighbourhood scale simulations, multiple sites can be selected for simulation and comparison of results by retoggling area drawing tool.
2. Select "Apply" to retrieve simulation result for all selected sites



03 Neighbourhood Scale Microclimate Evaluation - Multiple Sites Selection

Comparison of neighborhood wind permeability distribution between two sites.

03 Neighbourhood Scale Microclimate Evaluation - Multiple Sites Selection



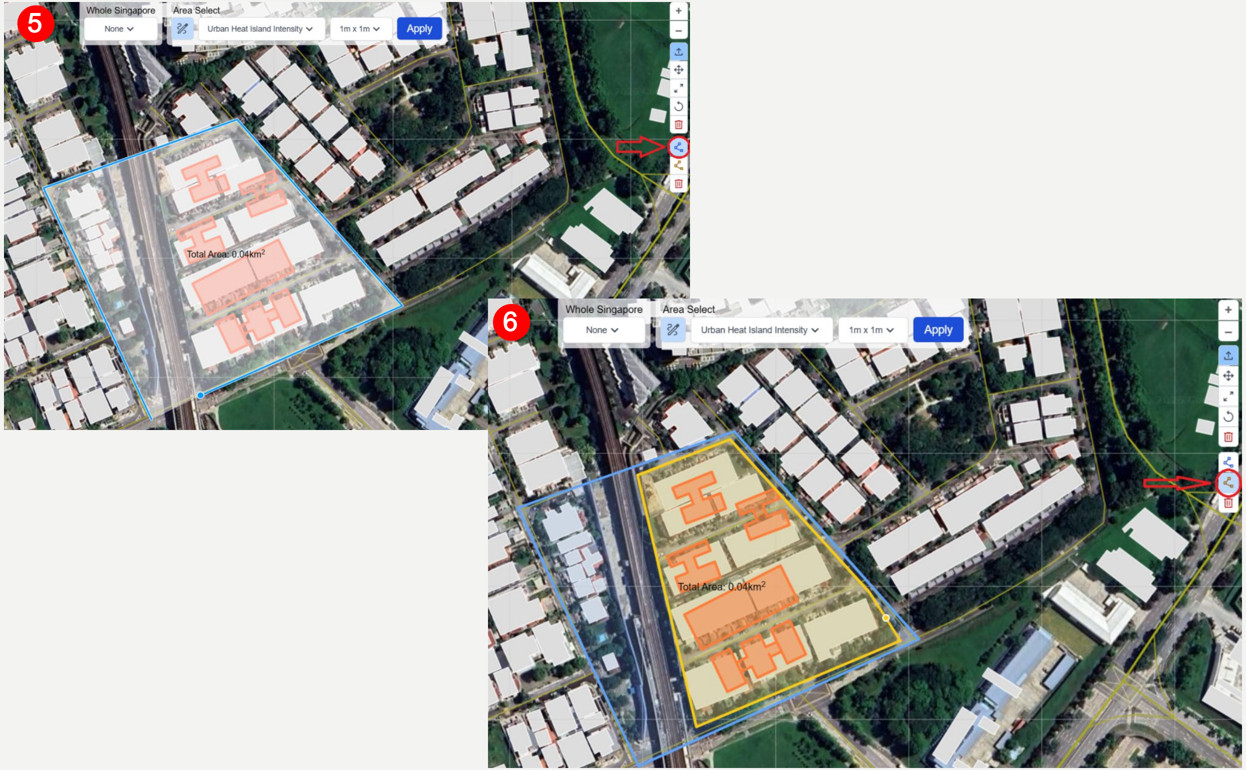
- Each selected site's specific planning index are displayed in the legend.
- Both qualitative and quantitative analyses, along with the distribution of result values, can be explored.
- Click the icon to access quantitative results.

04 User Uploaded Design (Neighborhood scale)

1. From neighbourhood simulation, select “Upload Model”.
2. Select a 3D model file to upload. Only *.dae and *.fbx file are currently supported.
3. Place the model in the desired location by moving to and left-clicking on the location.
4. Model can be further adjusted with the respective tools.

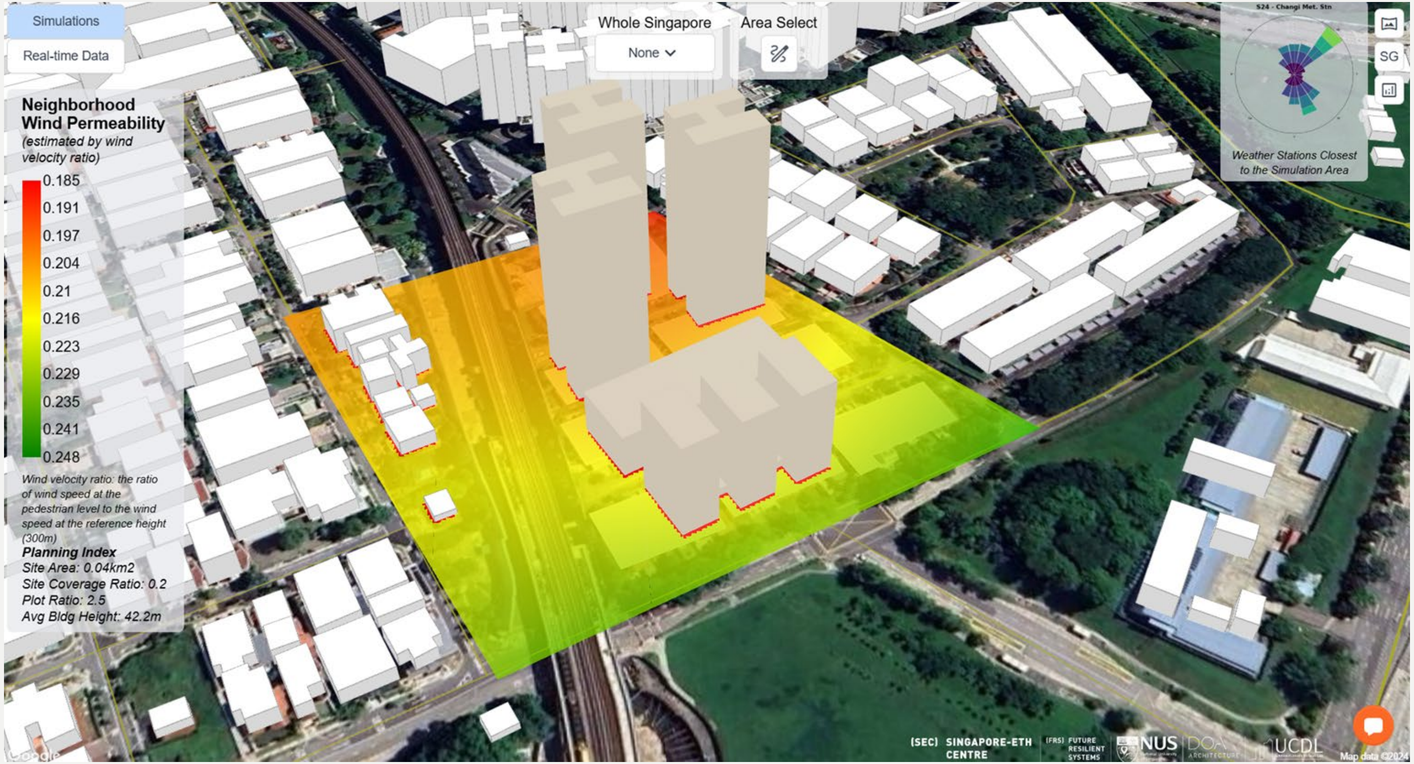
04 User Uploaded Design (Neighborhood scale)

5. Draw simulation area.
6. Draw replacement area where existing buildings are to be replaced.



04 User Uploaded Design (Neighborhood scale)

We are prepared for before-and-after comparison.



05 More Cities on MDP

We are now extending the city coverage from Singapore to cities across Asia and Europe. The model features vary partially across different cities and will be locally calibrated to reflect regional urban and climatic conditions.

05 More Cities on MDP

Click here to switch the cities.

06 References

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