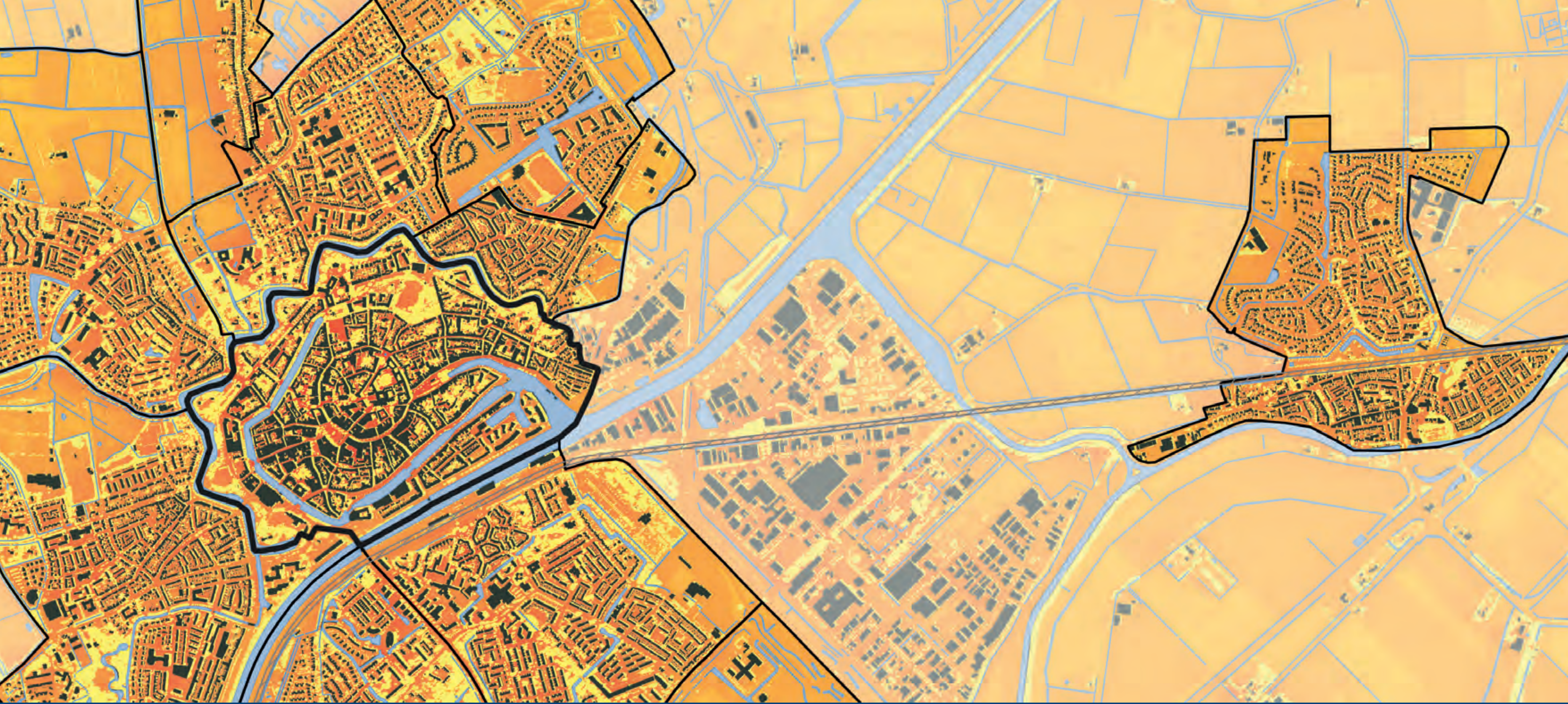

Cool Towns Heat Stress Model and Mapping Tool

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in close collaboration with the scientific partners Debbie Bartlett from Greenwich

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Cool Towns

output 1

Amsterdam University of Applied Sciences
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Faculty of Technology

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Cover image: Heat stress map of Middelburg developed by Cool Towns

CONTENTS

1. Results Output 1

The climate is changing, global warming is real, the effects are being felt and urgent action is required. The Intergovernmental Panel on Climate Change (IPCC) have issued increasingly stark warnings. Many groups, from professional organisations to local councils and municipalities, have made declarations recognising the climate emergency. Adaptive measures to prevent damage to people and property from surface water flooding are well established with sustainable drainage. However, the need to mitigate heat stress has only recently come onto the agenda as the potential impact on health and productivity, have become apparent.

The Cool Towns project, funded under the INTERREG 2Seas programme was initiated in response to the growing concerns about the impacts of climate change, and particularly hot weather, on the residents and visitors to small towns and cities in Northern Europe. Municipalities are aware of their responsibilities, and that they need to develop strategies for resilience in the face of the anticipated increase in severity of climate related events. Most have flood resilience plans but much less has been done to mitigate the impact of heatwaves and hotter summers. This project aims to address this by providing cities and municipalities a heat stress model and tool to become heat-resistant. In line with the Cool Towns application form, the heat stress model with specifications has been developed (A1.1 + A1.3), a comparative analysis of existing heat mapping tools was conducted (A1.2), and the model is further advanced to identify heat stress vulnerabilities in (Cool Towns partners') urban areas. In total 7 heat maps were foreseen (according to the application form) but in close collaboration with the members of the Scientific Committee and other partners, 54 maps were made.

In 2021, the pilot partners requested in a consortium meeting additional and more advanced heat stress vulnerability maps on neighbourhood level to inform their greening and urban renewal programmes. Advanced vulnerability maps gain more insight into the heat vulnerable routes, spaces, and functions for different user groups. For example, for visitors of a shopping area, it provides answers to what the intensively used routes for walking and cycling are that suffer severely from heat stress and the level of accessibility of shops during heat waves.

AUAS used the extra Interreg funding, as agreed on in the consortium meeting for making these maps (and coordinating the measurements in wp4). In individual meetings between AUAS and experts from the pilot partners, the 54 generated maps were analysed and the neighbourhood with the highest priority was identified and selected for a further investigation (see Chapter 5 for a full overview of developed maps). Based on these meetings and the extra information the partners provided regarding these neighbourhoods (data sets, reports, etc.), a total of 9 advanced vulnerability maps on neighbourhood level were made: one for each partner and three for the observatory partners of East Flanders.

The collection of maps to identify heat stress in the Cool Towns pilot partners urban areas cover up to a total of almost 44.000. Breda 10.000 ha, East-Flanders observatory partners Eeklo 1350 ha, Merelbeke 2800 ha, Zelzate 700 ha, Kent 3323 ha, Middelburg 4900 ha, Ostend 3934 ha, Saint-Omer 10350 ha and Southend 6619 ha (in total 43976 ha).

1.1 Progress of Activities & Deliverables

Act	Deliverable Title	Status	Describe Progress	Evidence
A1.1	Specifications heat stress model	Completed	Reported in APR 2019	Yes
A1.2	Analysis mapping tools	Completed	Reported in APR 2019	Yes
A1.3	Build heat stress model	Completed	Reported in APR 2019	Yes
A1.4	Finalise heat stress model	Completed	In 2021 the accuracy of the simulated heat stress model was tested. This was done by comparing the measured PET to the modelled PET (maps) (see section 2.4 Model Validation). For the comparison, 5 different types of urban areas in Cool Towns partners' territories were selected. The baseline measurements in areas without any cooling features and with existing features such as trees in comparison with the model-based heat maps gave similar PET results. The model has on average less than 4 °C lower values than the measurement taken with mobile weather stations in the field. Some variables are more challenging to capture entirely in models such as wind speed (urban canyon effect) and infrared. It can be concluded that the model gives in general a good representation of PET as part of a Thermal Comfort Assessments (TCA) at city level for identifying the areas that suffer the most from heat stress for prioritization. Thus, the model has been validated. This was the last step of work package 1 (A1.4) where we finalised the Cool Towns Heat Stress model by validation.	Yes

1.2 Heat Stress Mapping & Modelling tool (Output 1)

With this tool, cities can map geographic heat stress patterns in present and future climate conditions and model the effects of different heat stress-reduction measures.

a) In the partner territories, this results in at least 40.000 hectares of urban territory mapped and analysed for heat stress risk and most appropriate adaptation measures.

Result category	Governance & policy
Result Type	Improved governance quality and capacity
Modality of measurement	Heat stress maps of all partner territories has been generated using this model. The actual achievement of this part of the result is calculated as the cumulative area covered by the heat stress maps of all partner territories.
Description of the measured specific result	The actual achievement of this part of the result is a total of Cool Towns urban area covered by heat maps adds up to a total of almost 44000 ha. Achieving the target of 40 ha according to the application form of urban territory mapped and analysed for conducting appropriate adaptation measures.
	Additionally, to the PET maps and basic vulnerability on city level maps described above also 9 advanced vulnerability maps on neighbourhood level have been developed: one for each partner and three for the observatory partners of East Flanders (see Chapter 5 for an example).

b) In the wider 2 Seas area this results in improved capacity of local authorities in small and medium sized cities to understand the extent geographic distribution of heat stress in their area and for modelling effects of different heat resilience measures to support selectin of appropriate measures. We will directly transfer this output to at least 80 cities through our partner and observer network.

Result category	Knowledge
Result Type	Increase skills & capacity
Modality of measurement	The (use of the) model is covered in our capacity building programme (WP3) & communication work (WP6). This part of the specific result can be quantified based on the numbers of participants in the respective training sessions (WP3) & comms events (WP6).
Description of the measured specific result	Definitive result can only be calculated when the capacity building programme (WP3) & dissemination work (WP6) has been delivered (2020 – 2022).
	We delivered several presentations on wp1 deliverables such as two keynote presentations at two large events (VMM & Annual Exchange) the use, value and application of the heat maps were demonstrated. A great number of experts from small and medium sized cities attended the events.

2. Modelling Heat Stress

In the last decades investigating the thermal comfort of places has resulted in the formulation of many indices (Nouri & Matzarakis, 2019). The widely used PET is an index that combines common parameters, such as air temperature and humidity, with non-temperature variables, such as solar radiation, wind speed, and thermo-physiological factors (e.g. clothing and body core temperature). It thereby describes best how people experience thermal comfort at 1.1. m height, referring to the relationship between meteorological conditions and the heat exchange between the human body and the environment, known as the human energy balance (Höppe, 1984, 1999).

PET is chosen over other indexes because it is set as the national standard for three of the partner countries (the Netherlands, the United Kingdom, and France). Also, it is displayed in degrees Celsius (°C), which makes it easy to interpret for policymakers and urban planners that are not familiar with more complex human-biometeorological units.

Other similar indices have disadvantages compared to PET. For instance, the Wet Bulb Globe Temperature (WBGT) is only based on single parameters (air temperature, solar radiation, humidity, and wind speed) and does not include the human energy balance. Similarly, the Universal Thermal Climate Index (UTCI) does not consider the effect of clothing (Elnabawi & Hamza, 2020).

The heat stress model is built-up from a combination of spatial data (elevation, orthophotos, buildings, water- and green infrastructure) with hourly meteorological data. It thereby estimates the hourly influence of urban geometry (i.e. trees, buildings, waterbodies) in relation with sun and wind, the radiation of green and hardened surfaces, and includes the effect of shadow of objects and spatial air temperature differences. The model is further advanced and connected to the use of the city by the development of a 'lunch-break' scenario, with the highest sun position when people go outside for lunch, come home from school, or are active in the public space, and by a 'rush hour' scenario when people travel from work to home and when the hard surface of pavement and buildings is heated up.

This means that on a city level the derived maps identify where public spaces are vulnerable to heat stress at what time of the day. Thus, the heat stress maps based on the heat stress model show the PET distributed within a certain extent of each Cool Towns partner city. The output of the model shows particularly the effect of shadow caused by trees and buildings, with a smaller effect for green locations that have no shadow (e.g. hardened pavement and green surfaces).

On neighbourhood-level building, density determines the cooling effect caused by wind. A higher density results in a higher PET. All together the derived maps based on the heat stress model, provide a clear 'stress-test' for a typical hot day during the lunch break and rush hour that can help to identify locations that need adaptation.

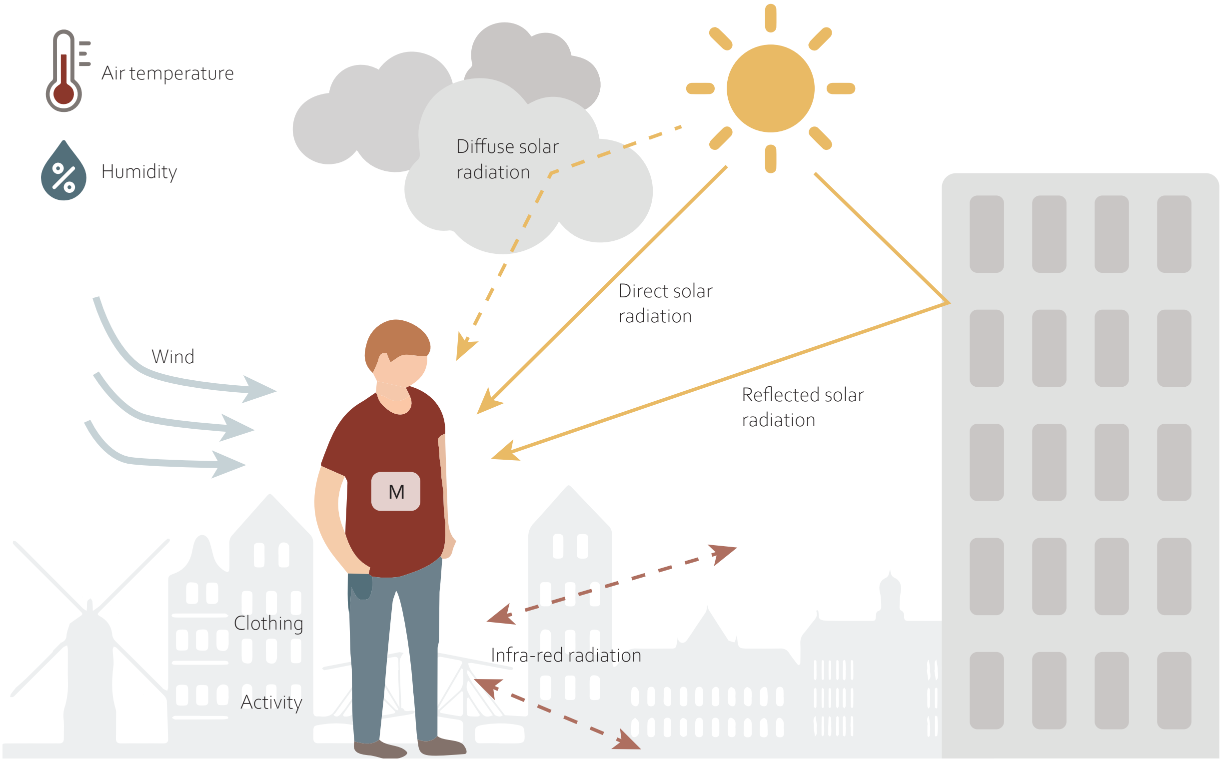


Figure 1: *Schematic representation of the different factors that influence the energy balance of the human body. Air temperature, humidity and wind speed can be modelled or are directly measured by a mobile weather station. The influence of direct, diffuse and reflected solar radiation and infra-red radiation from the environment are combined in the globe temperature measurement. Clothing insulation and activity are recorded by the questionnaire. Adapted from Havenith (1999).*

PET (°C)	Physiological Stress Grade
<18	Slight Cold Stress
18-23	No Thermal Stress
23-29	Slight Heat Stress
29-35	Moderate Heat Stress
35-41	Strong Heat Stress
41-46	Extreme Heat Stress (LV1)
46-51	Extreme Heat Stress (LV2)
51-56	Extreme Heat Stress (LV3)
>56	Extreme Heat Stress (LV4)

Figure 2: *The different grades of thermal perception and physiological stress on human beings expressed as the Physiological Equivalent Temperature (PET) thermal index. After Nouri et al. (2018), adapted from Matzarakis et al. (1999).*

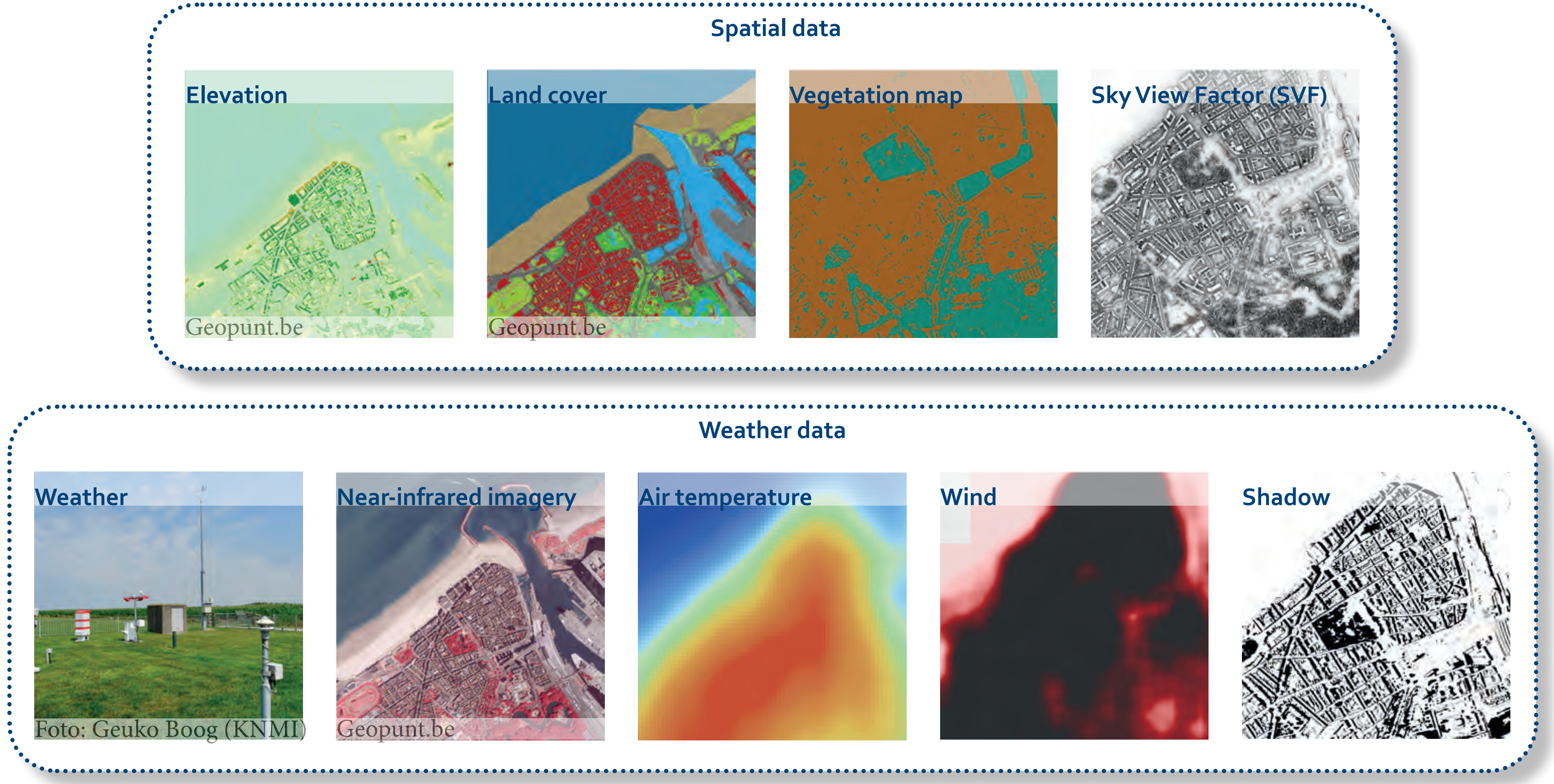


Figure 3: *Spatial and meterological input data used in the heat stress model*

2.1 Input Data

For input data, both spatial and meteorological data were used. For meteorological data, a predefined dataset for two scenarios (lunch break and rush hour) was formulated. Each dataset includes the following parameters: wind direction (°), wind speed (m/s), air temperature (°C), global irradiation (W/m2), and relative humidity (%). In addition to this, for calibration purposes also hourly data from a nearby weather station adjacent to the relevant Cool Towns partner municipality was used per Cool Towns partner city.

Spatial data includes (colour-infrared) orthophotos describing vegetation density, elevation (DSM or DTM), and allocation of trees, buildings, and water surfaces. In order to estimate the spatial effect of shade on wind, the effect of obstacles, and surface elevation data were converted to estimate the building and tree height.

In certain cases, data was converted per Cool Towns partner country, because of different data infrastructure, availability, format type, and accessibility. Due to the spatial dependence of microclimate computations (e.g. wind behaviour), a spatial input data extent of a 1.1 km buffer around each partner city was needed. Therefore, datasets were sometimes transformed or merged in order to include the 1.1 km buffer. For instance, several orthophotos for the British partner cities came from different data sources and were merged into one orthophoto.

Figure 4: *Example heat stress map of the lunchtime scenario in Breda.*

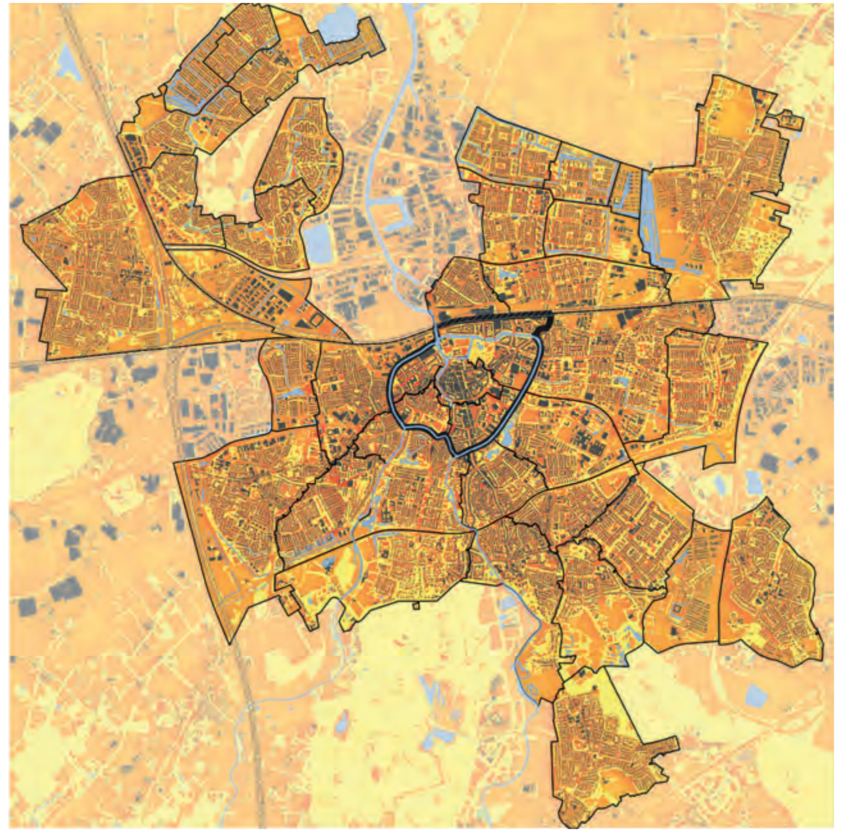


Figure 5: *Example heat stress map of the rush hour scenario in Breda.*

Scenario	Date YYYYMMDD	Hour (UTC)	Wind direction °	Wind strength m/s	Air temperature °C	Solar radiation W/m2	Humidity %
Lunchtime	20190728	12 (14 CEST)	90	4.0	28	750	49
Rush hour	20190728	15 (17 CEST)	0	1.0	33	600	29

Figure 6: *Table of the two heat stress scenario parameters*

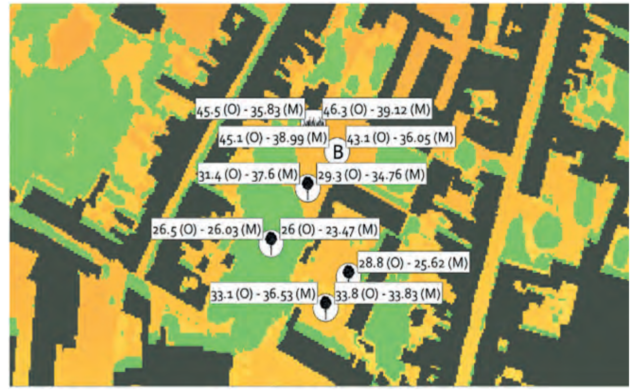
2.2 Heat Stress Scenarios

The urban areas within the Cool Towns 2 Seas region experience a relatively strong variability in coastal microclimate, which makes the comparison of model output challenging when local-varying weather station data is used as meteorological input. Therefore, two heat-stress scenarios were developed with specific meteorological conditions representative of all Cool Towns partner municipalities. These scenarios take up the differences in the use of outdoor public spaces depending on the time of the day.

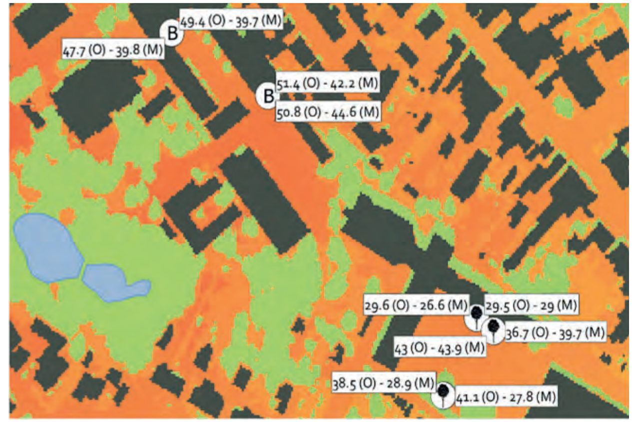
The two scenarios are based on a period of persistent heat: three consecutive days with an average day temperature of > 20 oC (HKV, 2019). For corresponding meteorological input that matches this condition, thirty-year datasets of four KNMI meteorological stations (Vlissingen, Westdorpe, Wilheminadorp, and Gilze-Rijen) were analysed. The heat stress locations on the PET maps display a specific time on the second day and describe thermal conditions regarding specific social activities and outdoor spaces at that time. Two important periods for the social use of the city during the second day were defined as a scenario (see Figure 6. for parameter values):

'Lunch break' scenario, refers to the time of the day when people go outside for a lunch break or are generally active in the public space, for example, they are. shopping in the city centres. It represents the moment with the highest position of the sun and the most radiation (12 UTC). There is relatively low wind speed and an air temperature of 28 °C. Output generally results in lower than 29 °C PET in the shade and PET values of 42-44 °C in the sun.

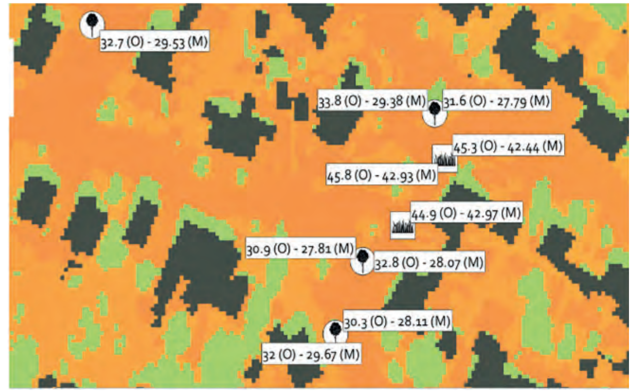
'Rush hour' scenario, refers to the time of the day when people leave work and travel home or children play outside after school. The urban context plays a more important role in the rush hour scenario than in the lunch-break scenario, due to the heat stress built up by infrared radiation emitted by buildings and hard surfaces during the afternoon hours(15 UTC). Hence, there is a higher air temperature of 33 °C, slightly more wind from the east, and less solar radiation. Model output resulted in PET values lower than 35°C in the shade and PET values of 39-47 °C in the sun.



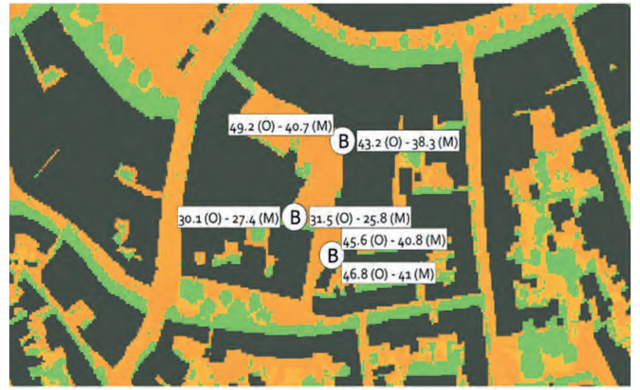
Eeklo (BE), De Zuidkaai



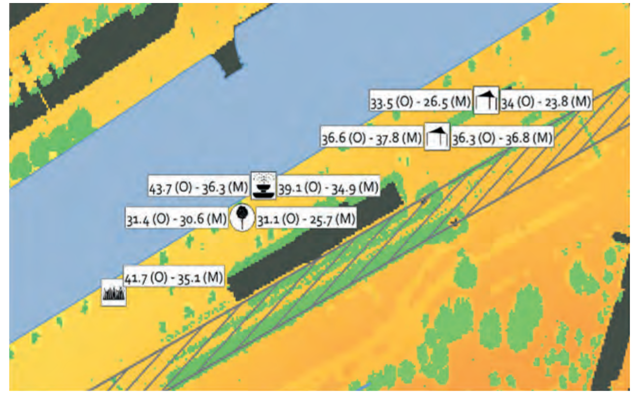
Zelzate (BE), School "de Reigers"



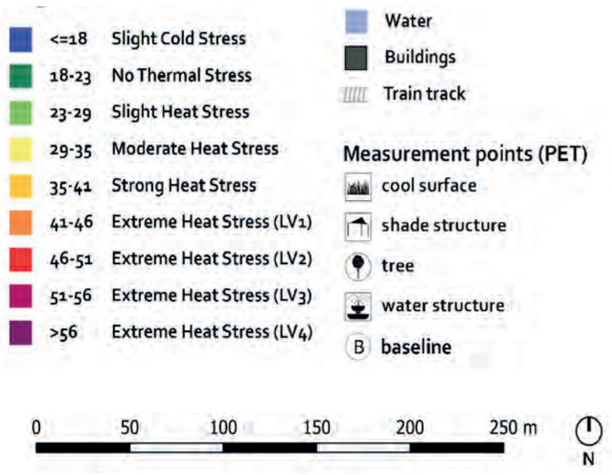
Merelbeke (BE), Tuinwijk Jan Verhaegen



Middelburg (NL), Zusterplein



Middelburg (NL), Kanaalweg & Station



2.3 Model Validation

The conducted model validation aimed to examine the accuracy of the model by comparing the model PET-value with PET measurements on the ground using mobile weather stations.

In the comparative analysis, the PET value differences are analysed by using the collected measurements in four different partner municipalities. Model runs are on the same date and hour when the measurements were performed and do not use scenario meteorological data, but data from a nearby weather station and corresponds to meteorological conditions at the time of the TCA at street level was conducted.

The validation results show that on average PET values are 4 °C degrees lower compared to the measurement locations, implicating that the model gives a generally good representation of PET although slightly lower PET than measured. Areas that provide shade (e.g. trees) generally show the most representative results, whereas baseline measurements (exposed to full sun) show the least representation. For instance, at the 'Zusterplein' in Middelburg where only baseline measurements were conducted, the highest PET difference was found. Or the baseline measurements at 'Zelzate' also showed a relatively large PET difference, (see figure, the two northernmost measurement locations).

These PET differences at the 'Zusterplein' and 'Zelzate' could be explained by that the stony appearance results in relatively high emission of longwave radiation (infrared). The 'Zusterplein' is a square enclosed by buildings and no vegetation, and the two measurements at 'Zelzate' were taken near a stone wall also enclosed by buildings. Within the model solar radiation is only determined by two surface factors (vegetation or non-vegetation) which thereby possibly lowers the actual radiative emissivity of certain surface types and thus reduces the PET. Also, the wind is not always clearly represented in the model and can be overestimated reducing the PET. Especially in (partly) enclosed squares like the 'Zusterplein' that possibly have higher windspeed modeled than measured.

	Average PET Observed (°C)	Average PET Modelled (°C)	PET Difference (°C)
Location			
Middelburg (NL) – Zusterplein	41.1	35.7	+5.4
Middelburg (NL) – Kanaalweg/station	36.4	31.9	+4.5
Eeklo (BE) – De Zuidkaai	35.4	33.4	+1.9
Zelzate (BE) – School "de Reigers"	39.7	37.6	+2.2
Merelbeke (BE) – Tuinwijk Jan Verhaegen	36.0	32.9	+3.1
Existing cooling featurer (intervention types)			
Baseline (no intervention)	41.9	36.1	+5.8
Cool surfaces (grass, vegetated/reflective pavement)	44.7	39.2	+5.6
Trees	32.5	30.6	+1.8
Water Features (canal sidewalk)	41.4	35.6	+5.8
Total	37.8	34.0	+3.9

3. Modelling Heat Vulnerabilities

The vulnerability maps visualise physical, socio-economic and demographic heat stress vulnerabilities per neighbourhood. They provide insight into the underlying causes and risks of heat stress. Examples of the dominant physical characteristics are the high PET values, the vegetated percentage, or the amount of available cool ground-level area per inhabitant. Potential heat stress risks for residents are explained under the socio-economic score (SES), population density and age distribution section. These socioeconomic and demographic characteristics are indicators that refer to the presence of certain vulnerable groups and vulnerable functions in each neighbourhood. For instance, the percentage of children or elderly in a certain neighbourhood may indicate a higher number of elderly homes, schools, and childcare facilities. Groups that are particularly vulnerable to heat stress.

The four vulnerability maps complement the Cool Towns PET maps and assist decision-makers in identifying focus areas for heat resilient interventions in the city. In other words, not only does the PET value inform decision-making on where interventions are the most needed, but also underlying issues such as a low vegetated percentage and socioeconomic score contribute to prioritizing areas for heat adaptation. The following sections explain in more detail how each map was created.

3.1 Vegetated Percentage

The vegetated percentage is calculated based on the Normalised Difference Vegetation Index (NDVI). Each pixel (i.e. square metre as seen from above) in a colour-infrared aerial photograph is assessed to be 'green' above a value of 0.16 and 'not green' below that value. More 'green' pixels indicate a higher vegetated percentage. The NDVI analysis was based on the colour-infrared orthophotos already provided for the spatial PET model input. The NDVI analysis means that grasslands, trees, shrubs, and other vegetation types are all taken into account and contribute to a higher vegetated percentage. A higher vegetated percentage also means more trees that can provide shade but it is important to remember that other vegetation types that do not give shade are also included.

The vegetated percentage is an indication of a cooling transpiration mechanism caused by plants and prevents that great infrastructure heat up for also comfortable night temperatures. Night-time heat stress exacerbates the impact of daytime heat on the human body.

Green representing the presence of transpiring vegetation, is the simplest indicator for the absence or reduction of night-time heat stress. The more transpiring vegetation the less a neighbourhood stores solar radiation that raises night-time temperatures.

Figure 8: Vegetated percentage map of Breda.

3.2 Population Density & Age Distribution

The population density and age distribution map represent two demographic neighbourhood characteristics: population density (purple shades) and age distribution (pie charts). Population density is visualised as the number of square metres per inhabitant per neighbourhood. Higher population density indicates that more residents can benefit from heat adaptive measures in the given neighbourhood. People living in dense urban often have smaller homes and a limited amount of private cool space. Higher population densities also mean more residents sharing public parks and outdoor spaces where they can potentially escape the heat. A densified context also relates to more anthropogenic heat from cars and air conditioning systems increasing heat stress even further.

The age distribution is visualised per neighbourhood and is subdivided into three age groups: i) children (0 -17 years) who are often less aware of the threat of heat stress and whose centre of gravity is closer to the ground exposing them more to the infrared radiation reflected by the ground; ii) adults (18-64 year) who, if healthy, are physiologically the least vulnerable group but are nevertheless strongly affected by heat stress, for example in their productivity and concentration capacity; and iii) elderly (> 65 year) who suffer more from heat-stress due to generally poorer medical condition and a lower ability to transpire. Also, age distribution can indicate the number of vulnerable functions related to the elderly (e.g. elderly homes) or children (e.g. schools, childcare, and playgrounds).

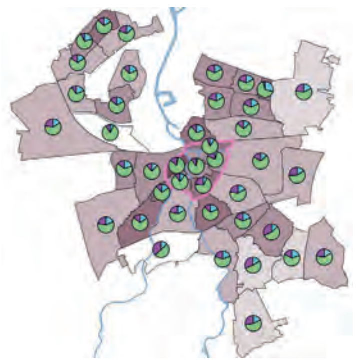


Figure 9: Population density and age distribution map of Breda.

Population density and age distribution are is assessed based on data from governmental funded organisations: Centraal Bureau voor de Statistiek (Breda, Middelburg); de provincie in cijfers – databank province (East-Flanders); Institute nation de la Statistique (Saint-Omer) and Office of National statistics (Southend, Kent). Each dataset is converted to an average per neighbourhood.

3.3 Socio-economic Score & PET Grade

The socio-economic score map shows per neighbourhood the socio-economic score (purple and orange shades) and the percentage of PET class based on the Physiological stress grade classes from Nouri et al. (2018) (pie-charts).

SES scores are composed of three frequently used socio-economic indicators: i) percentage low income; ii) percentage low education and iii) percentage unemployment. These scores also indicate the ability of residents to cope with heat stress. Neighbourhoods with a low SES-score seemed to be more vulnerable to heat stress. For example, residents with lower socio-economic status may live in poorly insulated homes and have limited economic means to cool their homes. They may spend extended periods indoors and have limited options to travel to city parks and nature reserves further away.

PET grades, presented in the pie-charts on the map, indicate the average heat stress per neighbourhood, based on the 'rush-hour' scenario. Each part of the pie-chart displays a class of the Physiological stress grade index. By displaying it per neighbourhood it is easier to detect which neighbourhood suffers more from heat stress than others and which neighbourhoods suffer from the compounding effects of low SES scores and high heat stress levels.

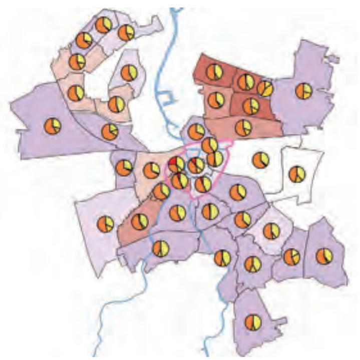


Figure 10: *Socio-economic score and PET grade map of Breda.*

3.4 Cool Area Per Inhabitant

The cool outdoor ground-level area per inhabitant map depicts the number of square metres (m2) per inhabitant that fall below the 'strong heat stress' (< 35 °C) grade as defined by Nouri et al., considering the 'rush-hour' scenario PET values. The map takes both public and private outdoor ground-level spaces into account; both public parks and private gardens may contribute to more cool space. Spaces that are located above ground level, such as balconies, elevated gardens, or rooftops, are not considered. A high amount of cool outdoor ground-level area per inhabitant indicates that the PET values and/or the population density in the neighbourhood are low. Conversely, a low amount of cool area per inhabitant indicates that the neighbourhood is densely populated and/ or PET values are high. A high amount of cool outdoor ground-level area points to a high probability of available cool spots in the neighbourhood residents can rely on during periods of extreme heat. At the same time, the map makes no indication of the spatial quality and accessibility of these cool spots, their usability, and whether they create cool routes through the neighbourhood. A low amount of cool outdoor ground-level area per inhabitant means insufficient cool spots to benefit the entire neighbourhood. It may indicate that all neighbourhood residents suffer from a lack of cool spaces, but may also indicate that opportunities are unevenly distributed. These insights in turn can help decision-makers to prioritise neighbourhoods where the most people benefit from heat adaptation measures.

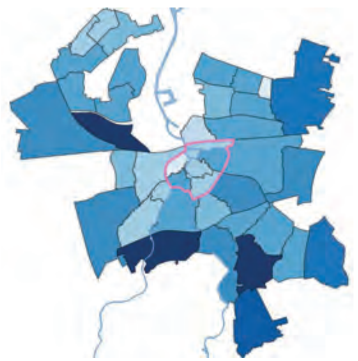


Figure 11: *Cool outdoor ground level area per inhabitant map of Breda..*

4. Advanced Vulnerability Maps

European cities face increasing heat stress risks with detrimental effects for the liveability of public spaces. Heat stress puts vital urban functions (Böcker and Thorsson 2014) at risk in multiple ways, for example, it can negatively impact the local economy (Evers et al. 2020), and threaten citizens' health (Ebi et al. 2021). To identify vulnerable heat-stress locations suitable for adaptation, climate comfort models, akin to the Cool Towns heat stress model, are used. These models often lack integration with other vulnerabilities such as heat vulnerable spaces, slow traffic routes, urban functions, or specific user groups. Taking such socio-environmental vulnerabilities into account is crucial for policy and decision-makers to allocate funds and prioritise areas for climate adaptation.

The city-scale heat stress and vulnerability maps we developed for the Cool Towns Output 1 and discussed above, highlight where heat stress is located in the urban areas of partner cities and where socio-environmental vulnerabilities might contribute to an increased risk of heat stress. In a collaborative process with Cool Towns partners, these city-scale maps together with local urban planning and climate adaptation agendas formed the basis for prioritising neighbourhoods for the advanced vulnerability maps. Once a priority neighbourhood was chosen for each partner city, the advanced vulnerability maps were developed in GIS by intersecting one of the two discussed heat stress scenarios with community amenities and slow traffic routes to identify potential focus areas.

The results are 9 advanced neighbourhood level vulnerability maps: one for each partner and three for the observatory partners of East Flanders. The maps highlight that certain spatial typologies that fulfill vital urban functions in the city are especially vulnerable to heat stress. Examples are historic city centres with an abundance of cultural and shopping amenities, suburban shopping centres, mobility hubs, primary bicycle and pedestrian routes and schoolyards. The advanced vulnerability maps point beyond their singular use. They are instrumental in applying city-scale heat stress and vulnerability maps to prioritise urban areas for immediate action and strategically integrate heat adaptation into municipal and regional climate adaptation agendas. The maps will serve partner municipalities and a wide network of decision-makers who will be introduced to the maps during dissemination activities in 2022.

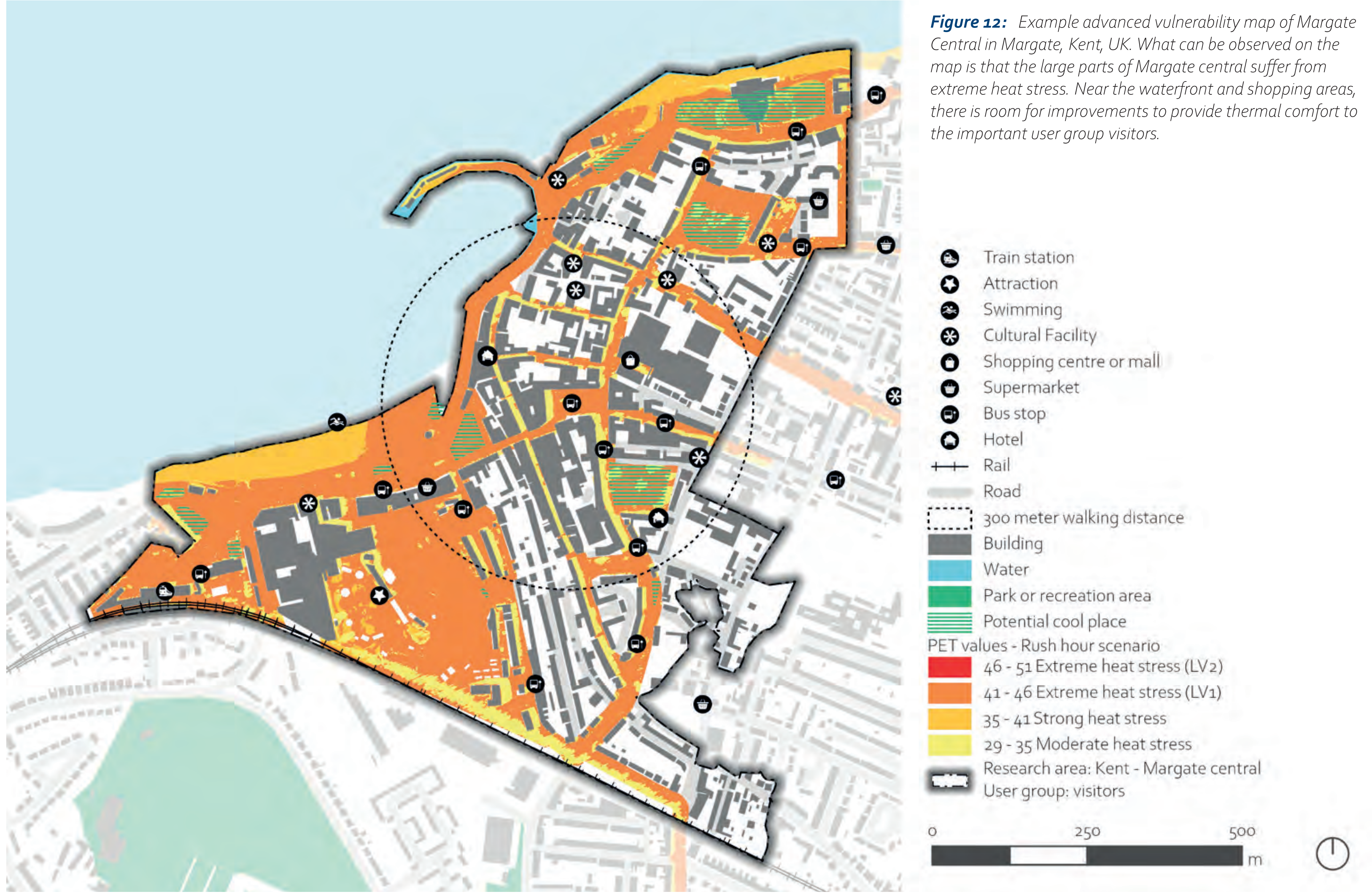


Figure 12: *Example advanced vulnerability map of Margate Central in Margate, Kent, UK. What can be observed on the map is that the large parts of Margate central suffer from extreme heat stress. Near the waterfront and shopping areas, there is room for improvements to provide thermal comfort to the important user group visitors.*

5. Heat Stress & (Advanced) Vulnerability Maps

5.1 Breda

Figure 13: *Breda PET Lunchtime scenario, 12 UTC (14 CEST), Tair: 28 °C*

Figure 14: *Breda PET Rush hour scenario, 15 UTC (17 CEST), Tair: 33 °C*

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress

- Building
- Water
- Train track
- City centre
- Neighbourhood

N

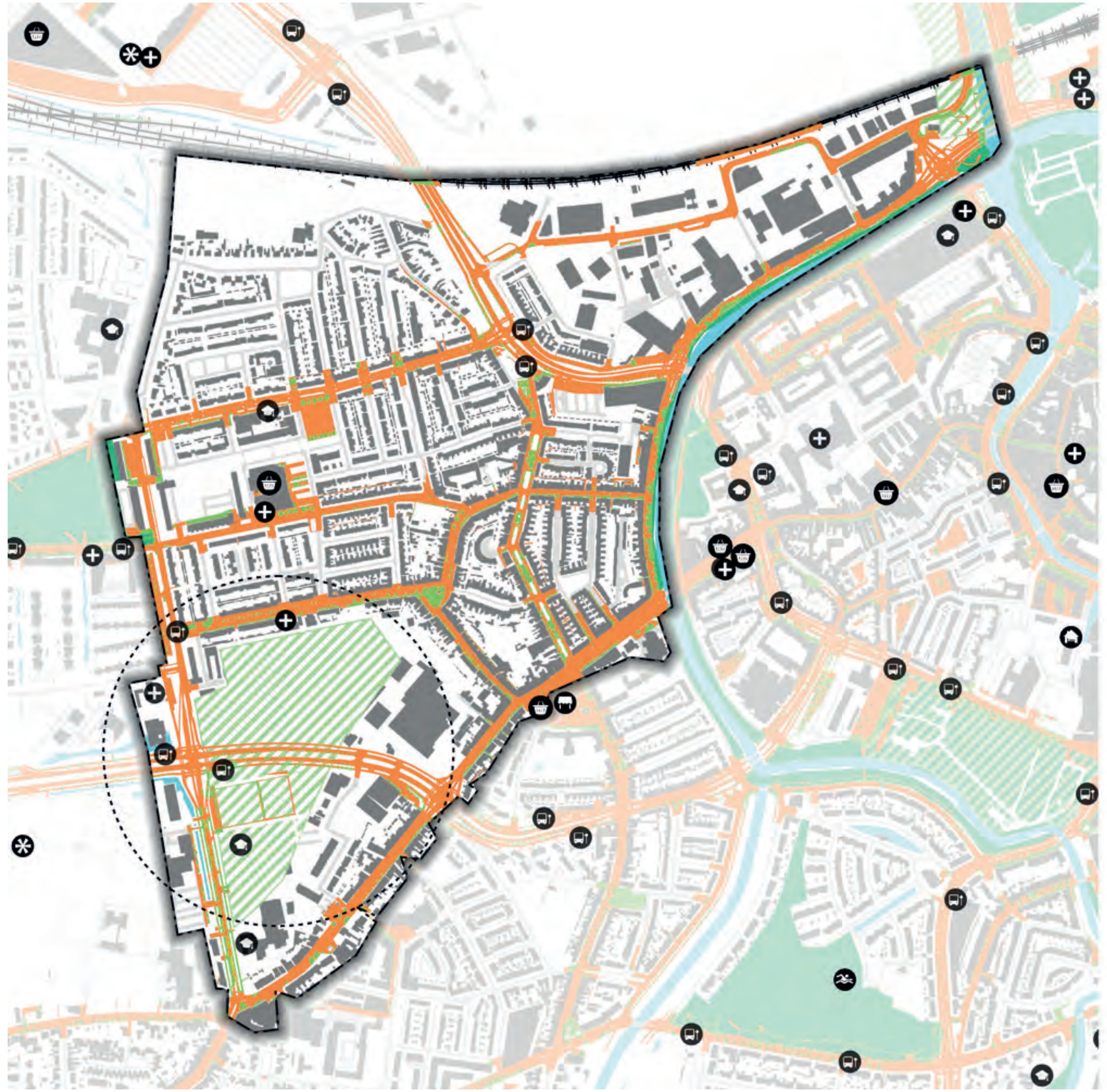


Figure 15: *Advanced vulnerability map of Tuinzigt neighbourhood in Breda, NL*

- Cultural facility
- Shopping center
- Hotel
- Market
- Supermarket
- Swimming
- Bus stop
- Healthcare related facility
- Education
- Train station
- Rail
- 300 meter walking distance
- Road
- Building
- Future park
- Park or recreation area
- Water

PET values - Lunchtime scenario

- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress
- 23 - 29 Slight heat stress
- Research area: Breda - Tuinzigt User group: Elderly

0 300 600 m

Breda vulnerability maps

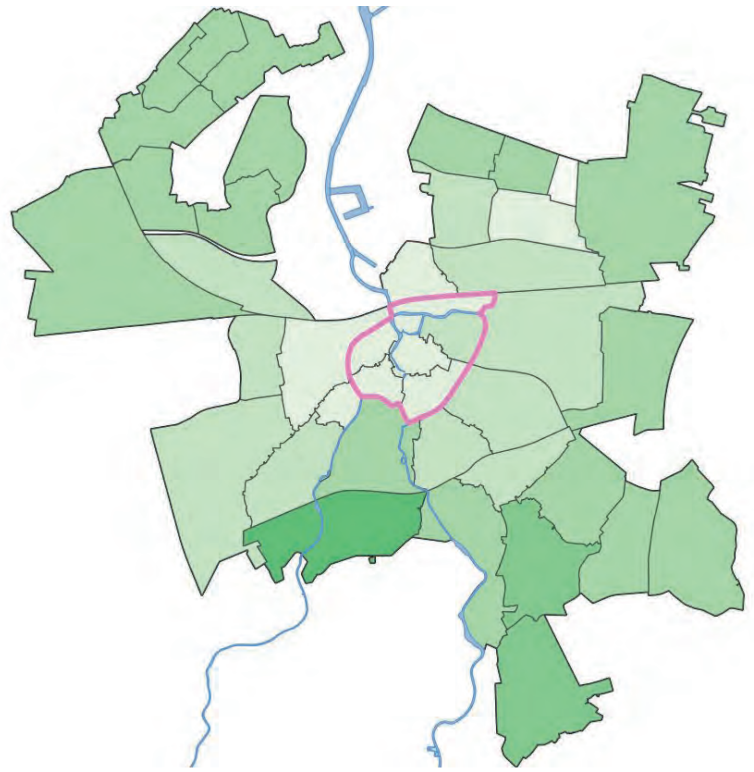


Figure 16: *Vegetated percentage*

0-10%
0-20%
20-30%
30-40%
40-50%

0-10%
0-20%
20-30%
30-40%
40-50%

Water
Train track

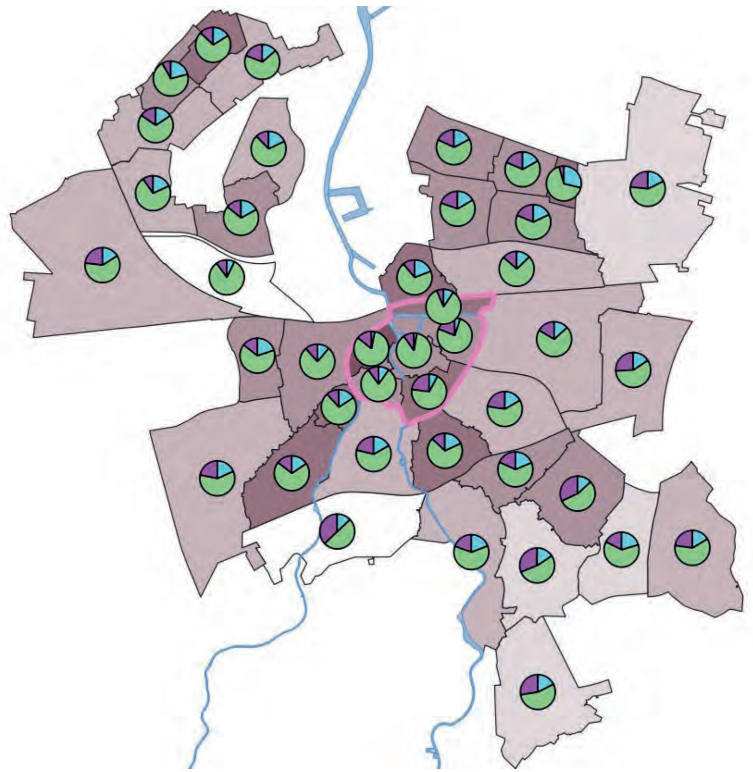


Figure 17: *Population density and age distribution*

Population density

0-50 m² per inhabitant
50-100 m² per inhabitant
100-150 m² per inhabitant
150-200 m² per inhabitant
200-350 m² per inhabitant
350-500 m² per inhabitant
>500 m² per inhabitant

Age distribution

> 65
18 - 64
0 - 17

Water
Train track

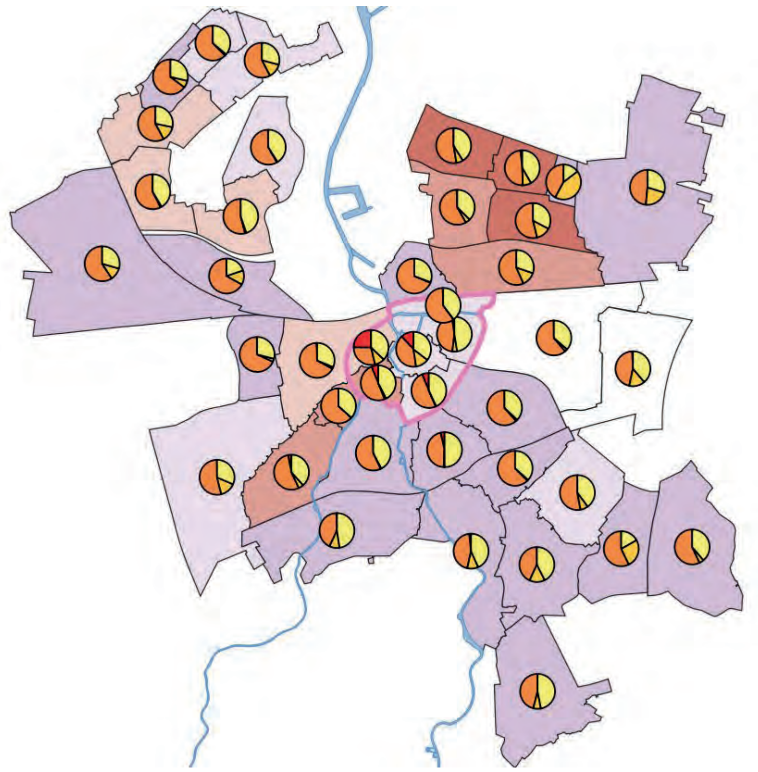


Figure 18: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

Extremely below city average
Strongly below city average
Moderately below city average
Slightly below city average
Slightly above city average
Moderately above city average
Strongly above city average

Heat stress levels

46-51 Extreme Heat Stress (LV2)
41-46 Extreme Heat Stress (LV1)
35-41 Strong Heat Stress
29-35 Moderate Heat Stress
23-29 Slight Heat Stress

Water
Train track
No data

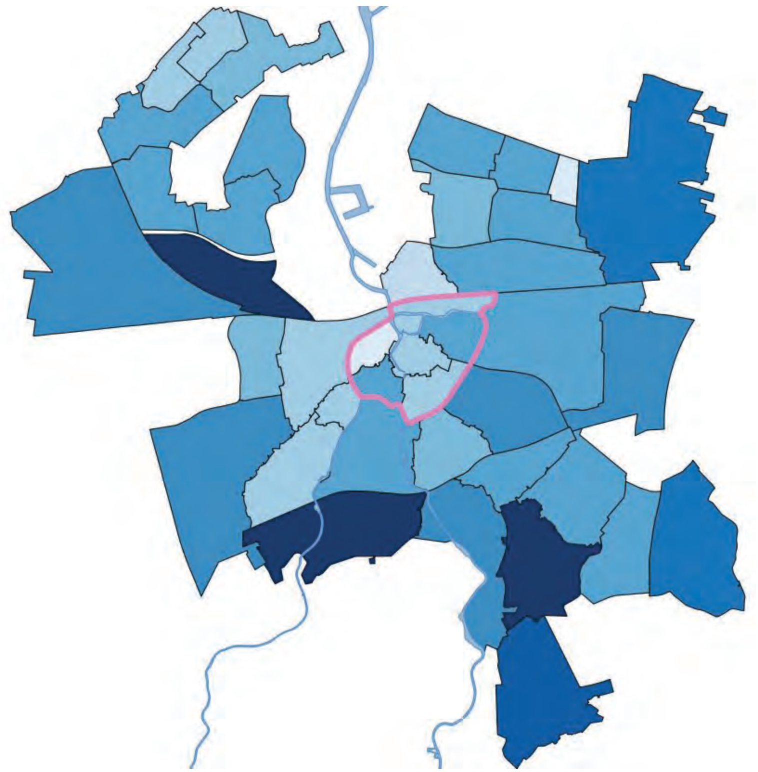


Figure 19: *Cool outdoor ground level area per inhabitant*

0-10 m² [PET < 35 °C] / inhabitant
10-20 m² [PET < 35 °C] / inhabitant
20-30 m² [PET < 35 °C] / inhabitant
30-40 m² [PET < 35 °C] / inhabitant
40-50 m² [PET < 35 °C] / inhabitant
50-75 m² [PET < 35 °C] / inhabitant
75-100 m² [PET < 35 °C] / inhabitant
100-125 m² [PET < 35 °C] / inhabitant
125-150 m² [PET < 35 °C] / inhabitant
>500 m² [PET < 35 °C] / inhabitant

Water
Train track

5.2 Middelburg

Figure 20: Middelburg lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C

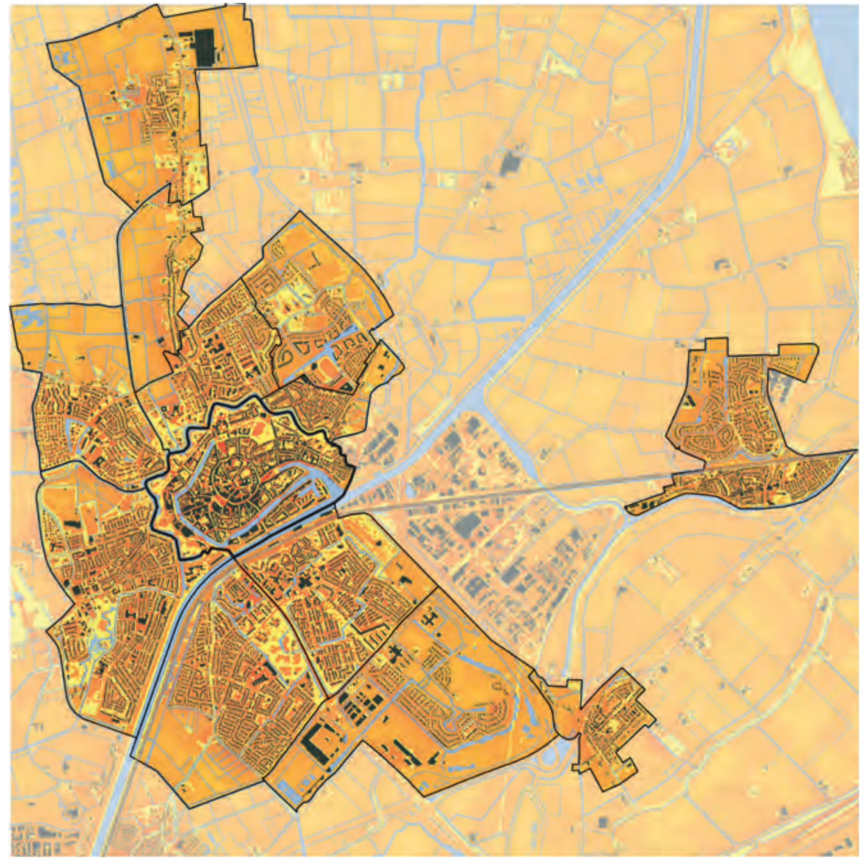


Figure 21: Middelburg rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Building
- Water
- Train track
- City centre
- Neighbourhood

N

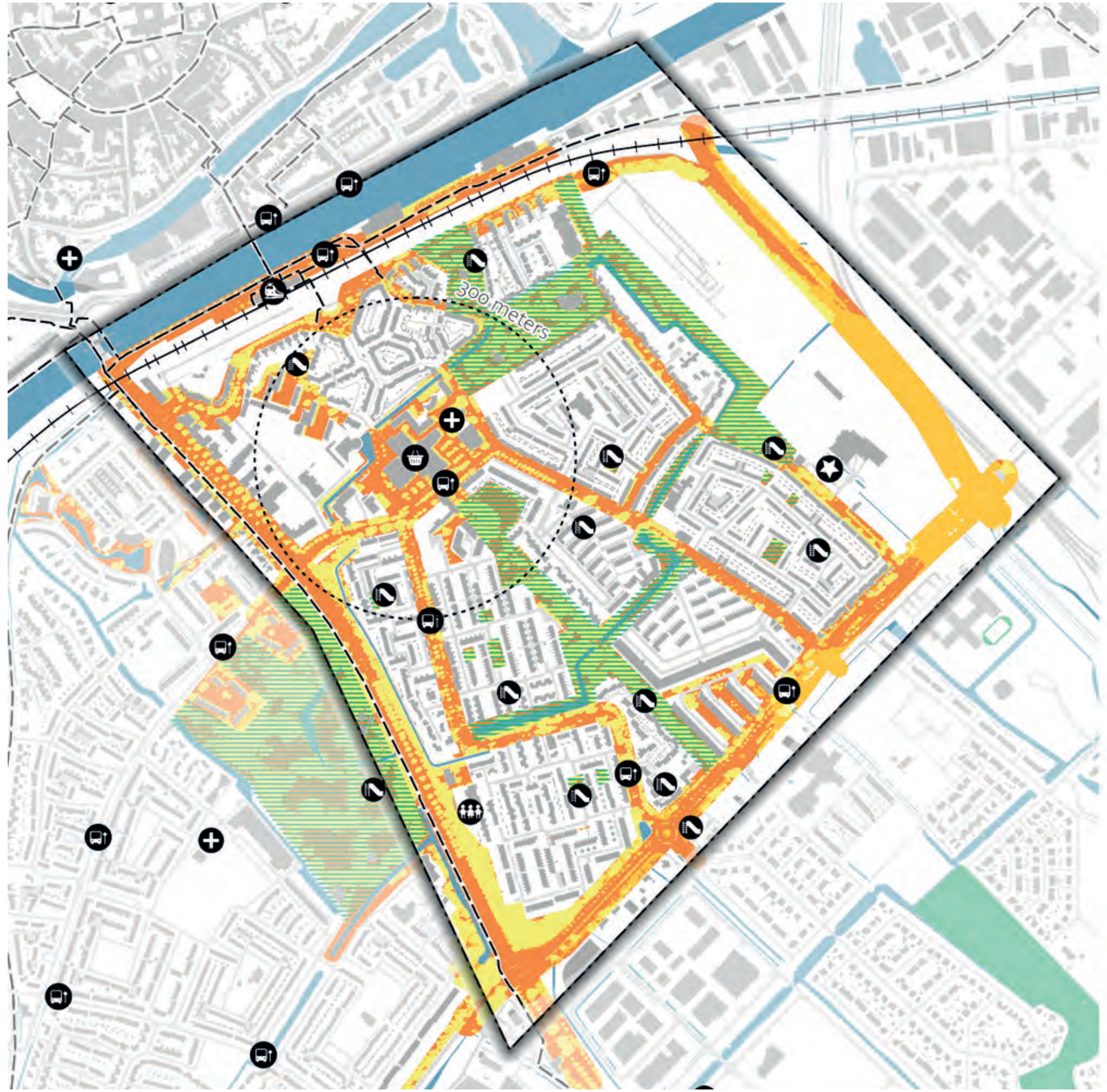


Figure 22: Advanced vulnerability map of Dauwendaele neighbourhood in Middelburg.

- Bus stop
- Healthcare related facility
- Community Center
- Childcare
- Train station
- Playground
- Supermarket
- Rail
- Regional cycling and walking routes
- 300 meter walking distance
- Potential cool place
- Park or recreation area
- Water
- Road
- Building

PET values - Rush hour scenario

- 46 - 51 Extreme heat stress (LV2)
- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress
- Research area: Middelburg - Dauwendaele
- User group: visitors

0 250 500 m

Middelburg vulnerability maps

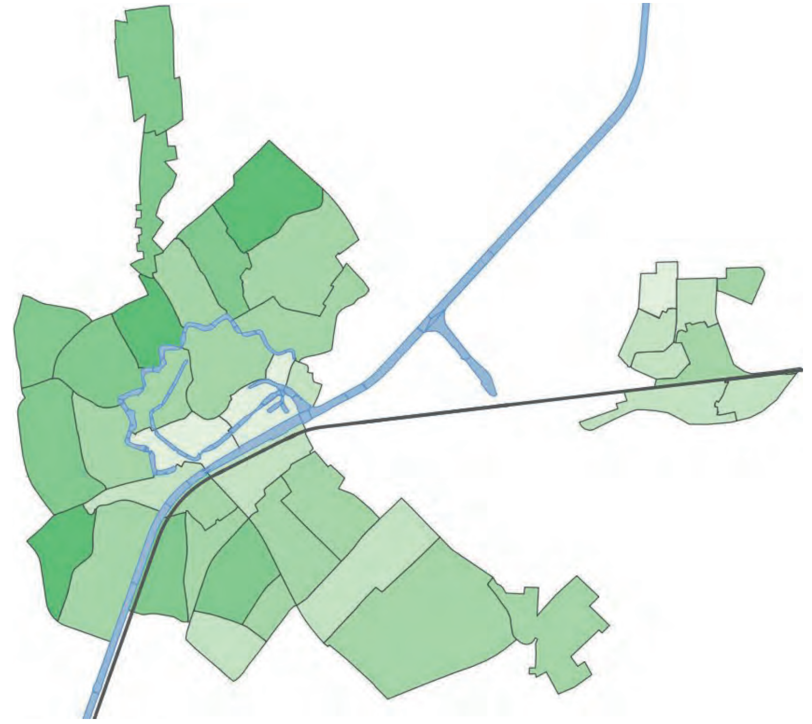


Figure 23: *Vegetated percentage*

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- Water
- Train track

Figure 24: *Population density and age distribution*

Population density

- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17

- Water
- Train track

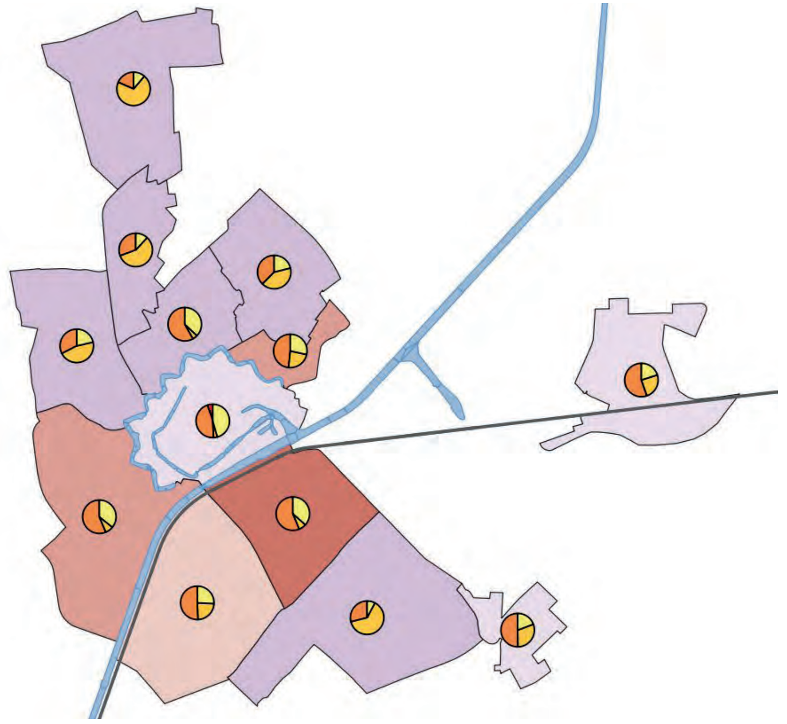


Figure 25: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress

- Water
- Train track
- No data

Figure 26: *Cool outdoor ground level area per inhabitant*

- 0-10 m^2 [PET < 35 °C] / inhabitant
- 10-20 m^2 [PET < 35 °C] / inhabitant
- 20-30 m^2 [PET < 35 °C] / inhabitant
- 30-40 m^2 [PET < 35 °C] / inhabitant
- 40-50 m^2 [PET < 35 °C] / inhabitant
- 50-75 m^2 [PET < 35 °C] / inhabitant
- 75-100 m^2 [PET < 35 °C] / inhabitant
- 100-125 m^2 [PET < 35 °C] / inhabitant
- 125-150 m^2 [PET < 35 °C] / inhabitant
- >500 m^2 [PET < 35 °C] / inhabitant

- Water
- Train track

5.3 Ostend

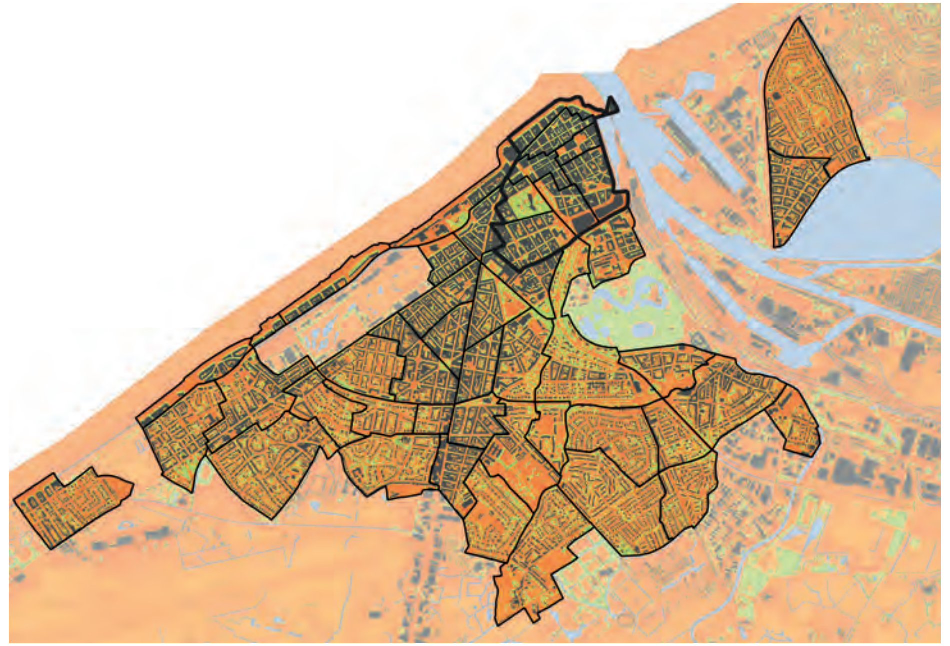


Figure 27: *Ostend lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C*

Figure 28: *Ostend rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C*

Heat stress level (PET)

46-51 Extreme Heat Stress (LV2)
41-46 Extreme Heat Stress (LV1)
35-41 Strong Heat Stress
29-35 Moderate Heat Stress
23-29 Slight Heat Stress

Building
Water
Train track
City centre
Neighbourhood

N

Figure 29: *Advanced vulnerability map of Nijverheidsstraat, H.Hartplein, and Nieuwlandstraat neighbourhoods in Ostend.*

Childcare
Library
Playground
Supermarket
Cultural facility
Bus stop
Education
Tram
Road
300 meter walking distance
Potential cool place
Future park
Park or recreation area
Water
Building

PET values - Lunchtime scenario
41 - 46 Extreme heat stress (LV1)
35 - 41 Strong heat stress
29 - 35 Moderate heat stress
22 - 29 Slight heat stress

Research areas: Ostend - Nijverheidsstraat, H.Hartplein, and Nieuwlandstraat
User group: children

0 250 500 m

Ostend vulnerability maps

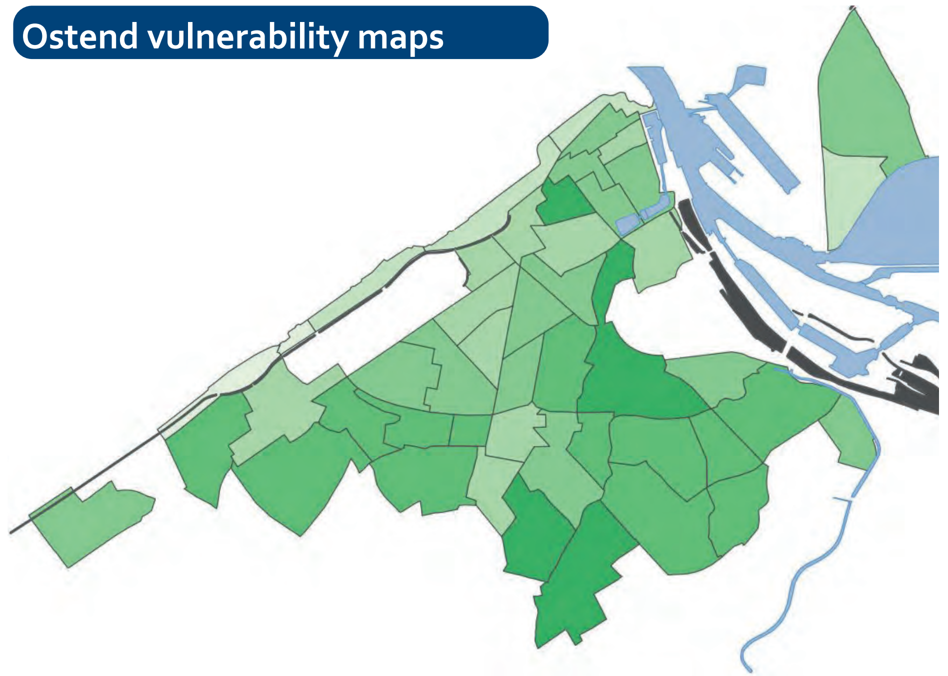


Figure 30: Vegetated percentage

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%
- Water
- Train track

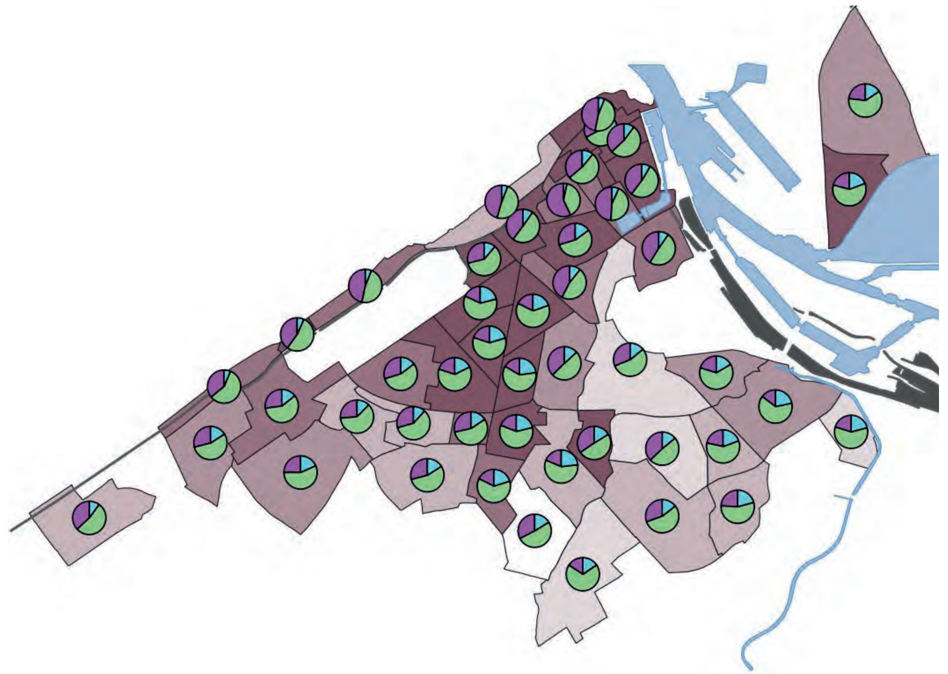


Figure 31: Population density and age distribution

Population density

- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17
- Water
- Train track

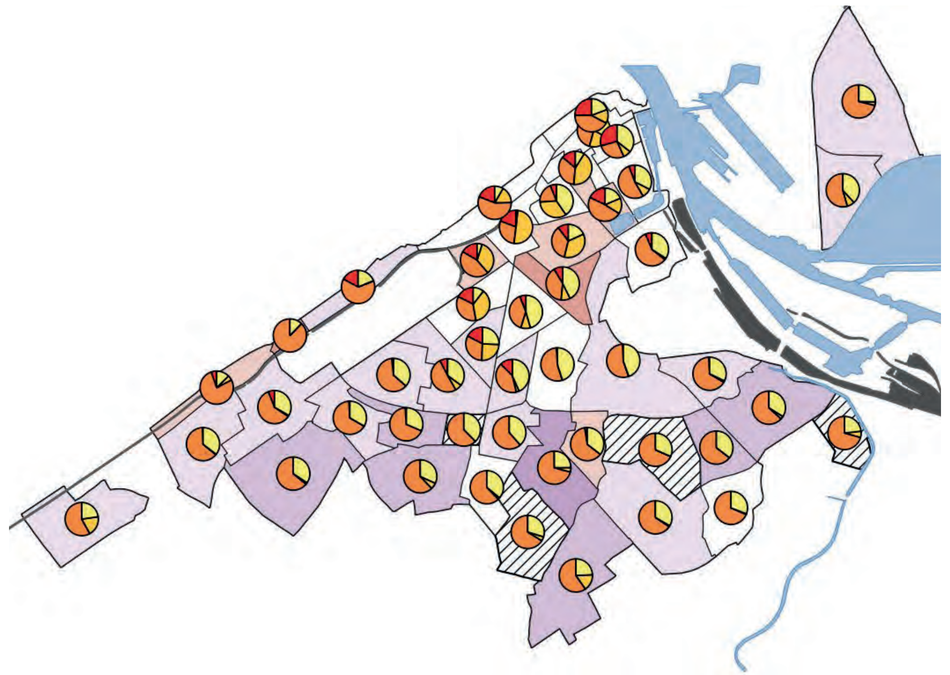


Figure 32: Socioeconomic status (SES) and heat stress levels (PET)

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Water
- Train track
- No data

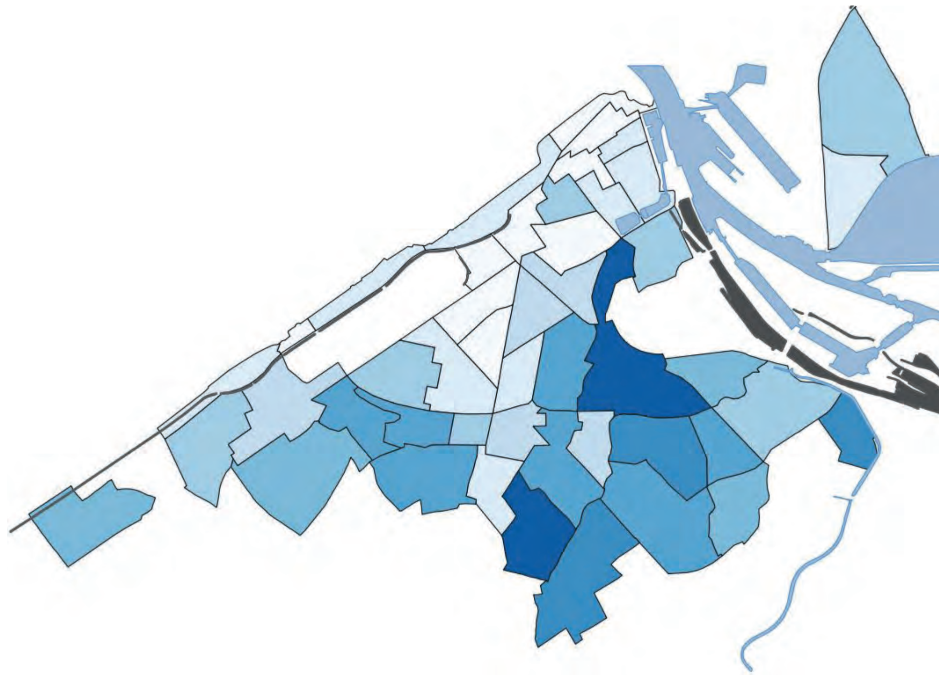


Figure 33: Cool outdoor ground level area per inhabitant

- 0-10 m^2 [PET < 35 °C] / inhabitant
- 10-20 m^2 [PET < 35 °C] / inhabitant
- 20-30 m^2 [PET < 35 °C] / inhabitant
- 30-40 m^2 [PET < 35 °C] / inhabitant
- 40-50 m^2 [PET < 35 °C] / inhabitant
- 50-75 m^2 [PET < 35 °C] / inhabitant
- 75-100 m^2 [PET < 35 °C] / inhabitant
- 100-125 m^2 [PET < 35 °C] / inhabitant
- 125-150 m^2 [PET < 35 °C] / inhabitant
- >500 m^2 [PET < 35 °C] / inhabitant

- Water
- Train track

5.4 Eeklo

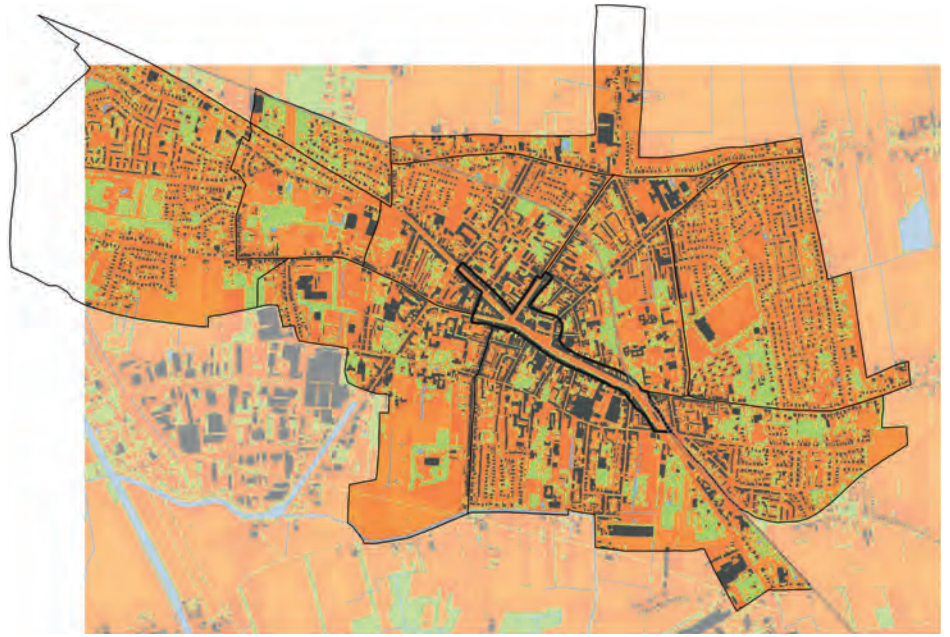


Figure 34: Eeklo lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C

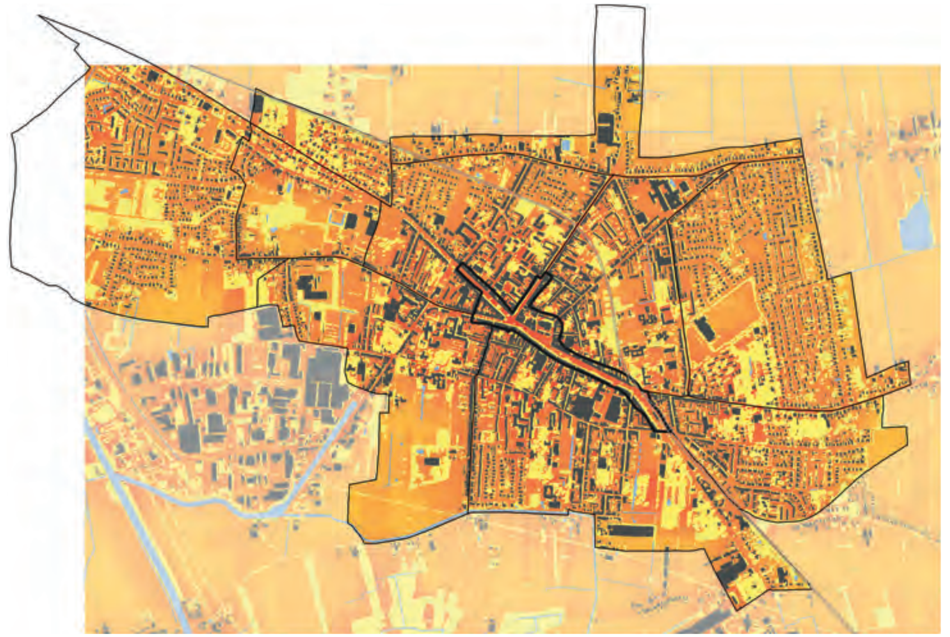


Figure 35: Eeklo rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Building
- Water
- Train track
- City centre
- Neighbourhood

N

Figure 36: Advanced vulnerability map of the Centrum area in Eeklo.

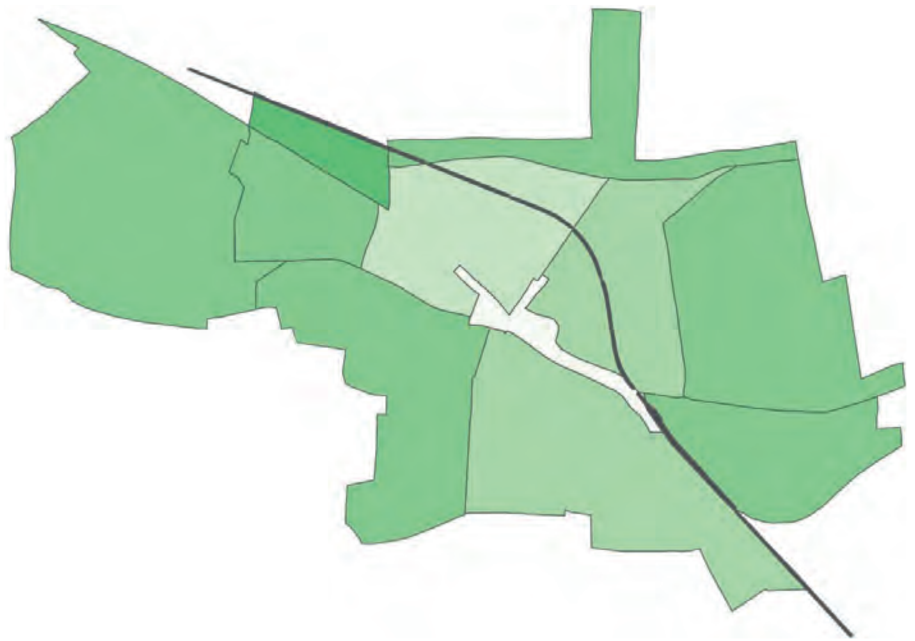
- Library
- Hotel
- Education
- Childcare
- Market
- Supermarket
- Cultural institution
- Healthcare related facility
- Shopping centre or mall
- Train station
- Bus stop
- Regional cycling and walking routes
- Rail
- Road
- 300 meter walking distance
- Park and recreational area
- Potential cool place
- Building

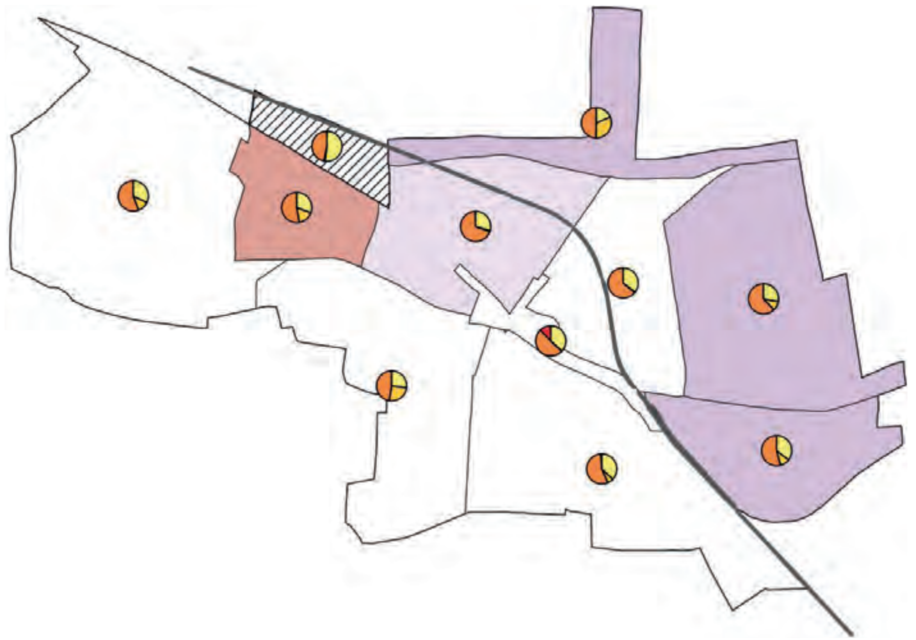
PET values - Rush hour scenario
- 46 - 51 Extreme heat stress (LV2)
- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress

Research area: Eeklo - Centrum
User group: visitors

0 250 500 m

Eeklo vulnerability maps





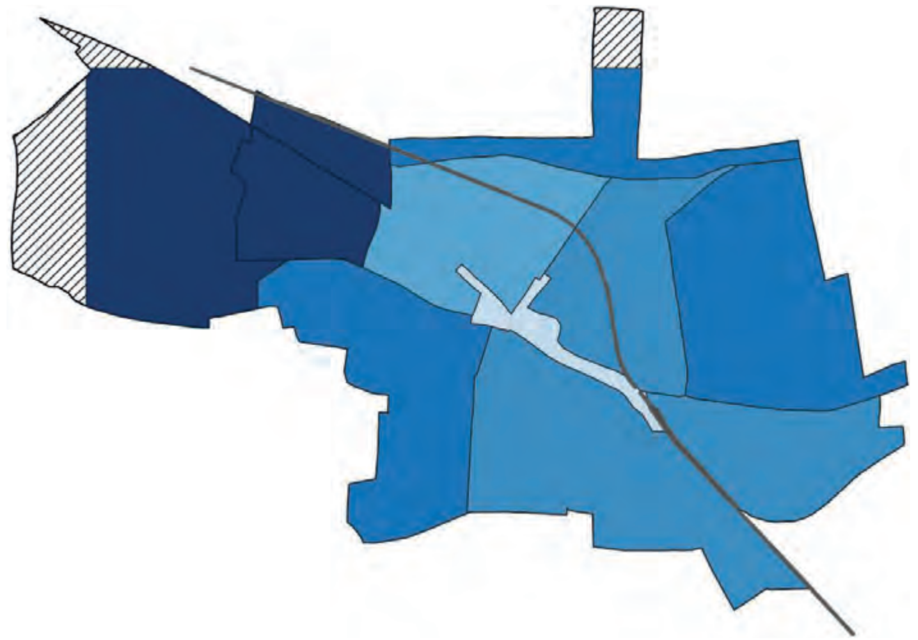


Figure 37: *Vegetated percentage*

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%
- Water
- Train track

Figure 38: *Population density and age distribution*

Population density

- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17
- Water
- Train track

Figure 39: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Water
- Train track
- No data

Figure 40: *Cool outdoor ground level area per inhabitant*

- 0-10 m^2 [PET < 35 °C] / inhabitant
- 10-20 m^2 [PET < 35 °C] / inhabitant
- 20-30 m^2 [PET < 35 °C] / inhabitant
- 30-40 m^2 [PET < 35 °C] / inhabitant
- 40-50 m^2 [PET < 35 °C] / inhabitant
- 50-75 m^2 [PET < 35 °C] / inhabitant
- 75-100 m^2 [PET < 35 °C] / inhabitant
- 100-125 m^2 [PET < 35 °C] / inhabitant
- 125-150 m^2 [PET < 35 °C] / inhabitant
- >500 m^2 [PET < 35 °C] / inhabitant

- Water
- Train track
- No data

5.5 Zelzate

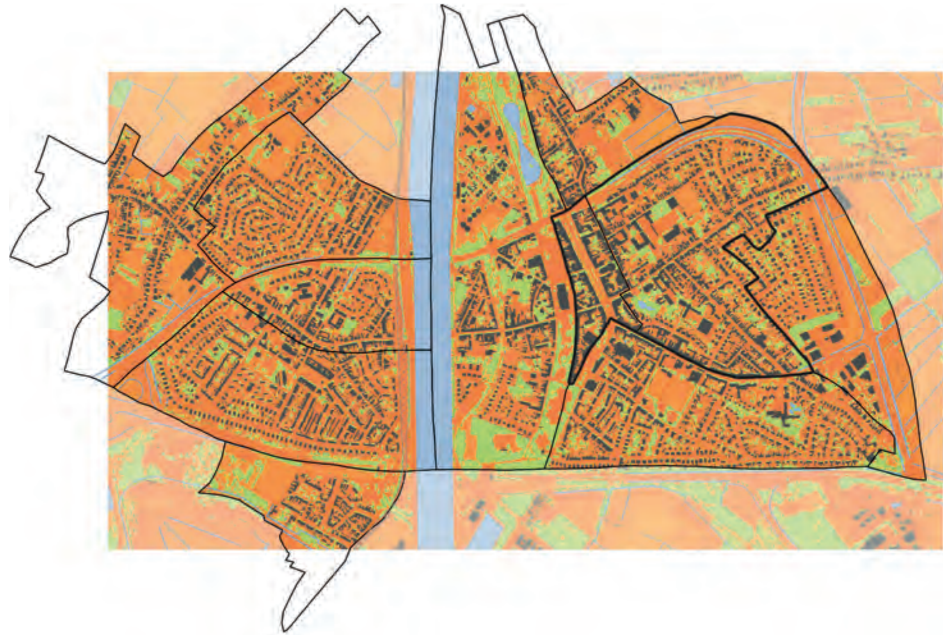


Figure 41: Zelzate lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C

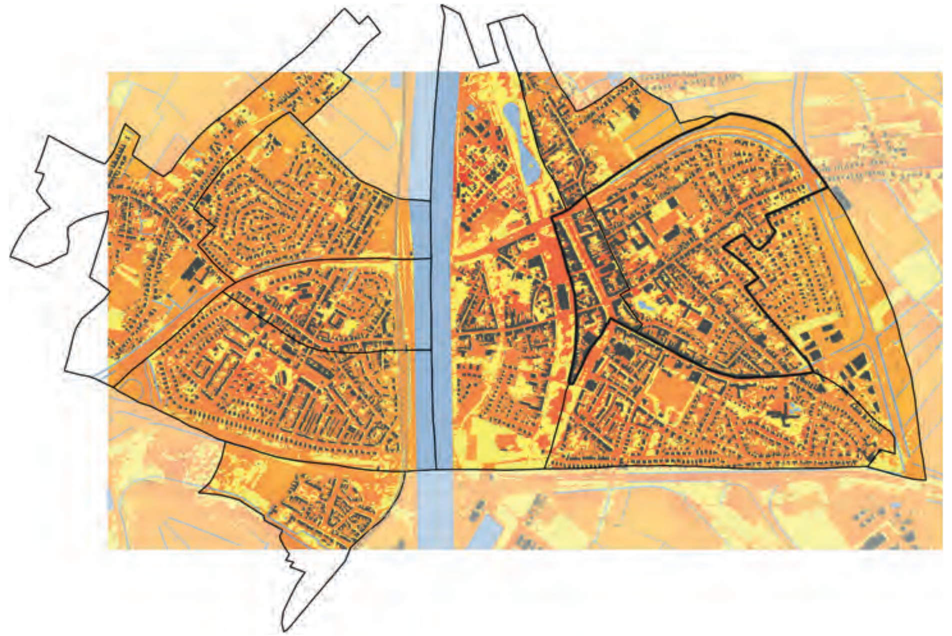


Figure 42: Zelzate rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Building
- Water
- Train track
- City centre
- Neighbourhood

N

Figure 43: Advanced vulnerability map of the Centrum area in Zelzate.

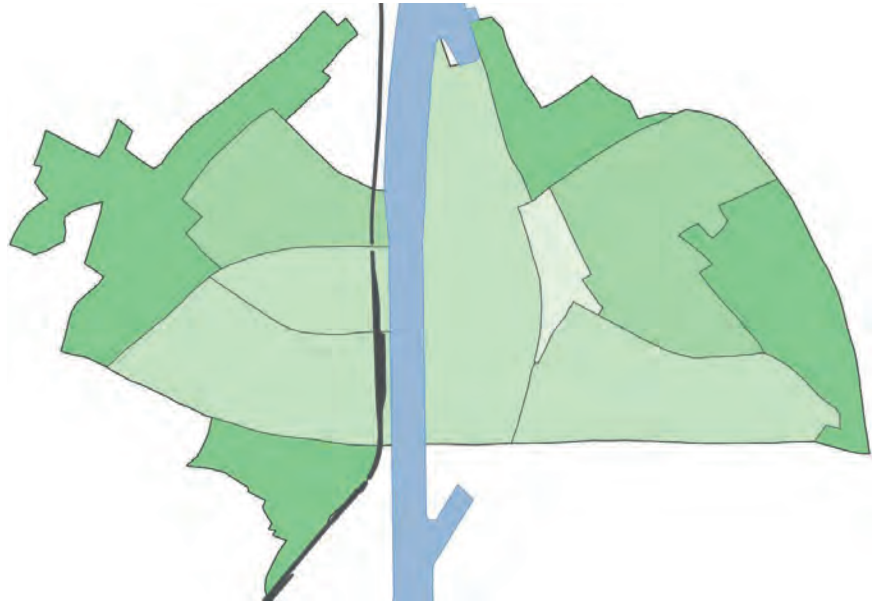
- Library
- Bus stop
- Healthcare related facilities
- Playground
- Supermarket
- Market
- Hotel
- Education
- Childcare
- Swimming pool
- Regional cycling and walking route
- Rail
- Road
- 300 meter walking distance
- Park or recreation area
- Potential cool place
- Water
- Building

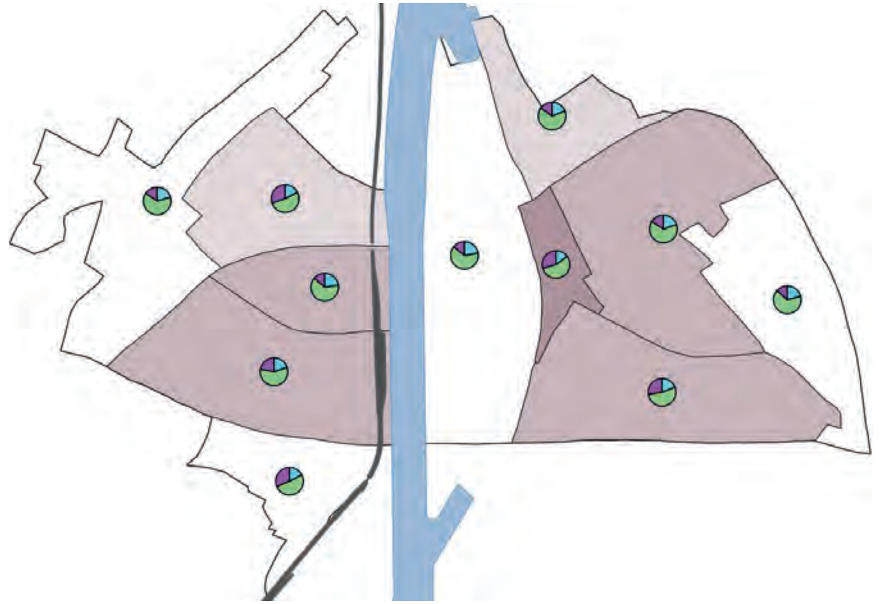
PET values - Rush hour scenario

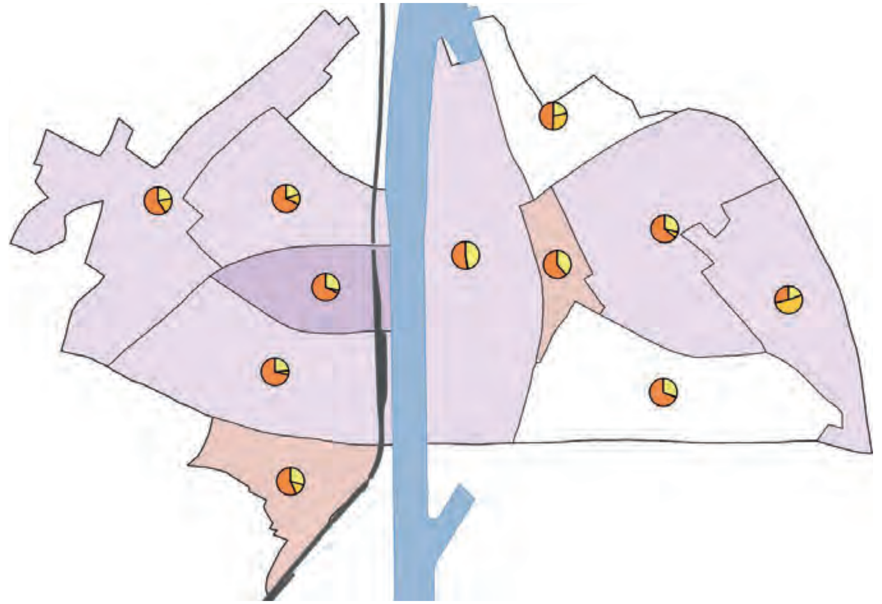
- 46 - 51 Extreme heat stress (LV2)
- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress
- Research areas: Zelzate - Centrum
- User group: visitors

0 350 700 m

Zelzate vulnerability maps







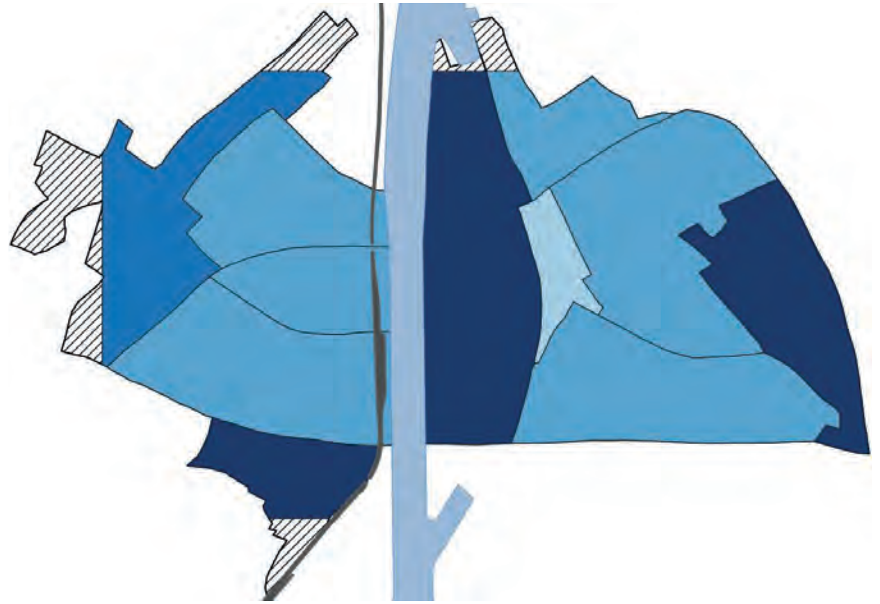


Figure 44: *Vegetated percentage*

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%
- Water
- Train track

Figure 45: *Population density and age distribution*

Population density

- 0-50 m² per inhabitant
- 50-100 m² per inhabitant
- 100-150 m² per inhabitant
- 150-200 m² per inhabitant
- 200-350 m² per inhabitant
- 350-500 m² per inhabitant
- >500 m² per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17
- Water
- Train track

Figure 46: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Water
- Train track
- No data

Figure 47: *Cool outdoor ground level area per inhabitant*

- 0-10 m² [PET < 35 °C] / inhabitant
- 10-20 m² [PET < 35 °C] / inhabitant
- 20-30 m² [PET < 35 °C] / inhabitant
- 30-40 m² [PET < 35 °C] / inhabitant
- 40-50 m² [PET < 35 °C] / inhabitant
- 50-75 m² [PET < 35 °C] / inhabitant
- 75-100 m² [PET < 35 °C] / inhabitant
- 100-125 m² [PET < 35 °C] / inhabitant
- 125-150 m² [PET < 35 °C] / inhabitant
- >500 m² [PET < 35 °C] / inhabitant

- Water
- Train track
- No data

5.6 Merelbeke

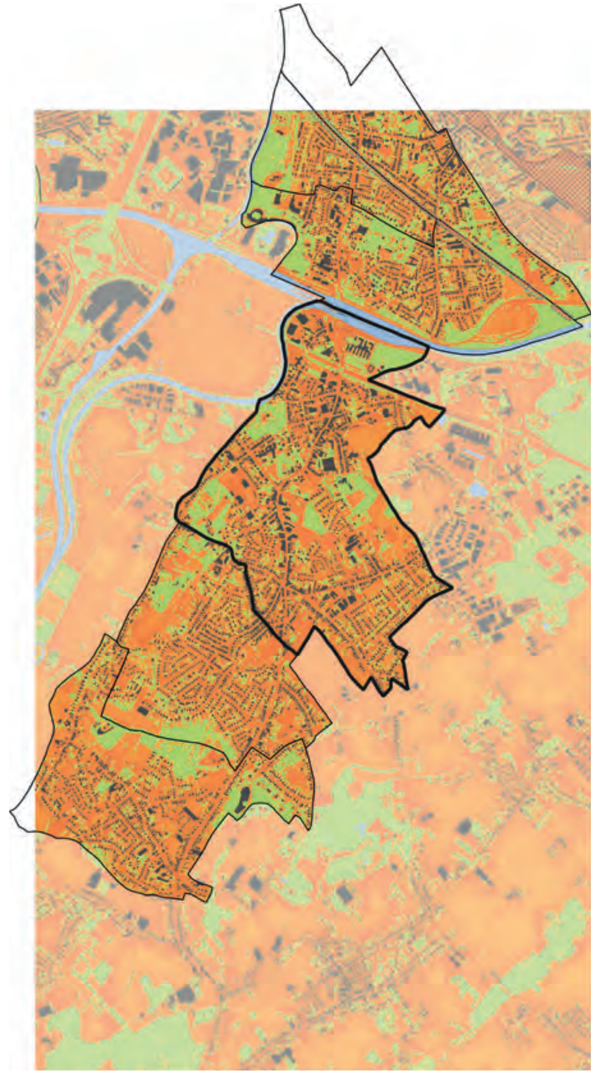


Figure 48: Merelbeke lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C

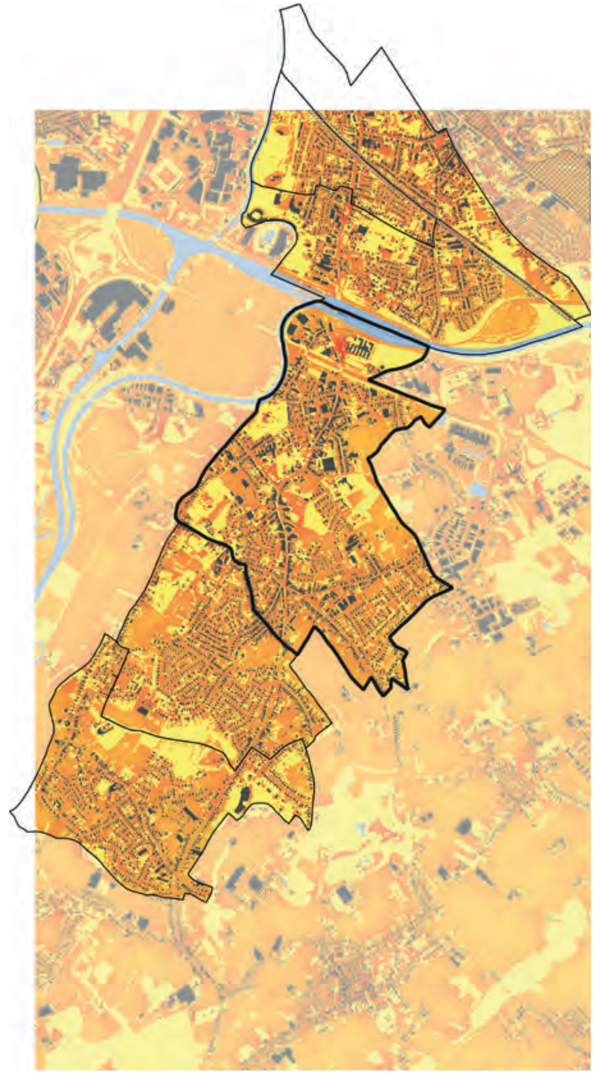


Figure 49: Merelbeke rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C

Heat stress level (PET)

46-51	Extreme Heat Stress (LV2)
41-46	Extreme Heat Stress (LV1)
35-41	Strong Heat Stress
29-35	Moderate Heat Stress
23-29	Slight Heat Stress

Building
Water
Train track
City centre
Neighbourhood

N

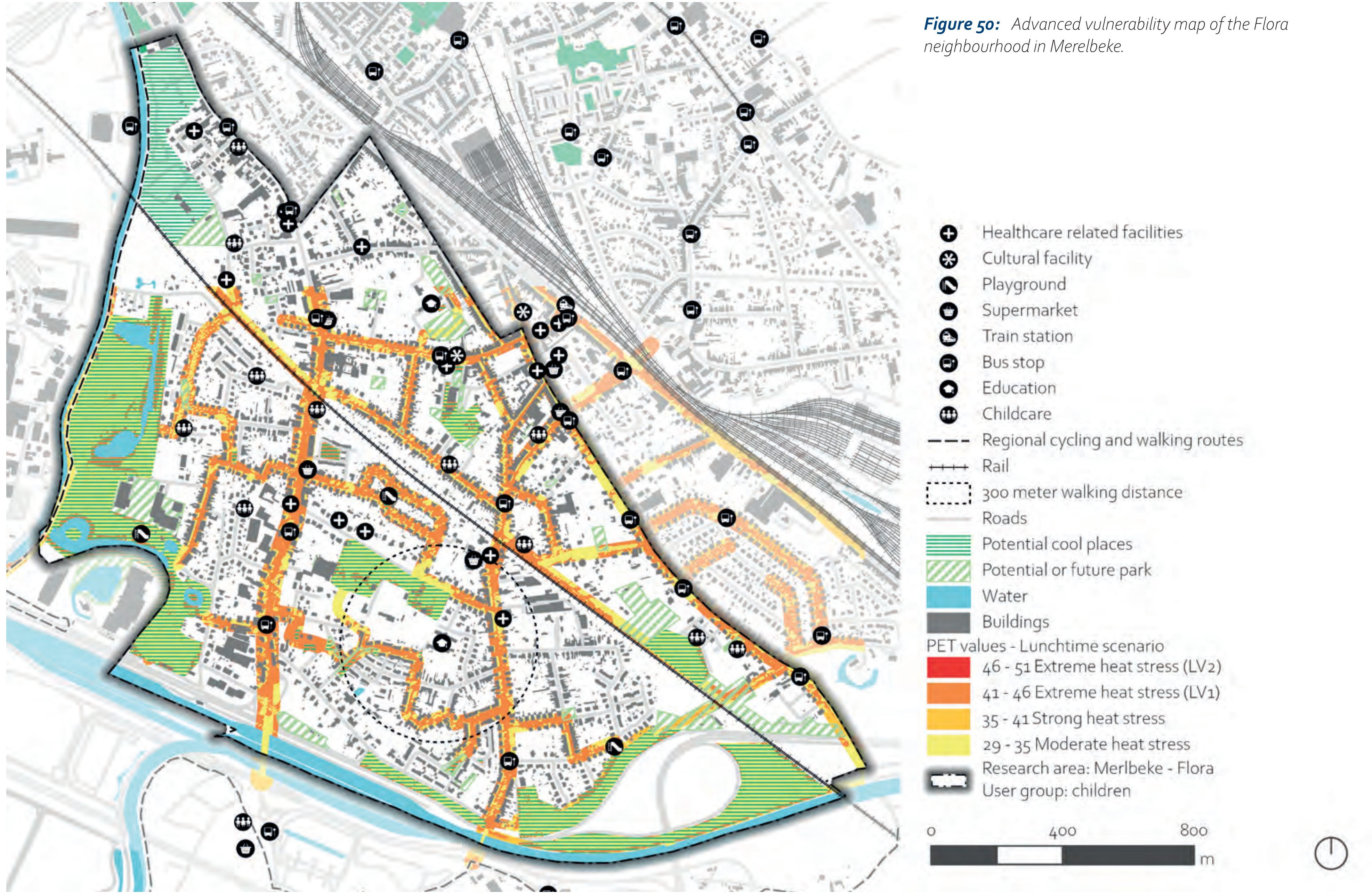


Figure 50: Advanced vulnerability map of the Flora neighbourhood in Merelbeke.

Merelbeke vulnerability maps

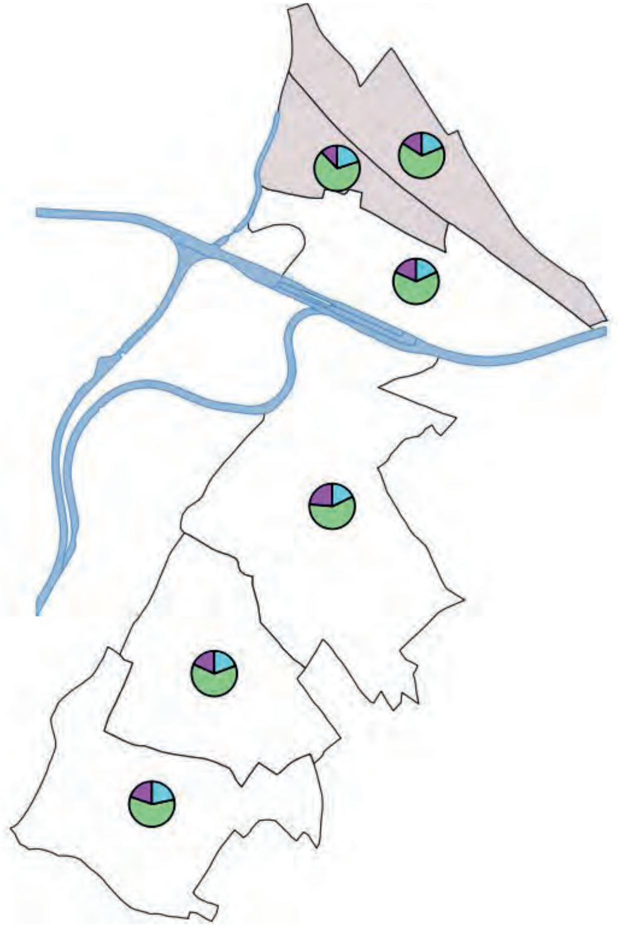


Figure 51: Left: vegetated percentage

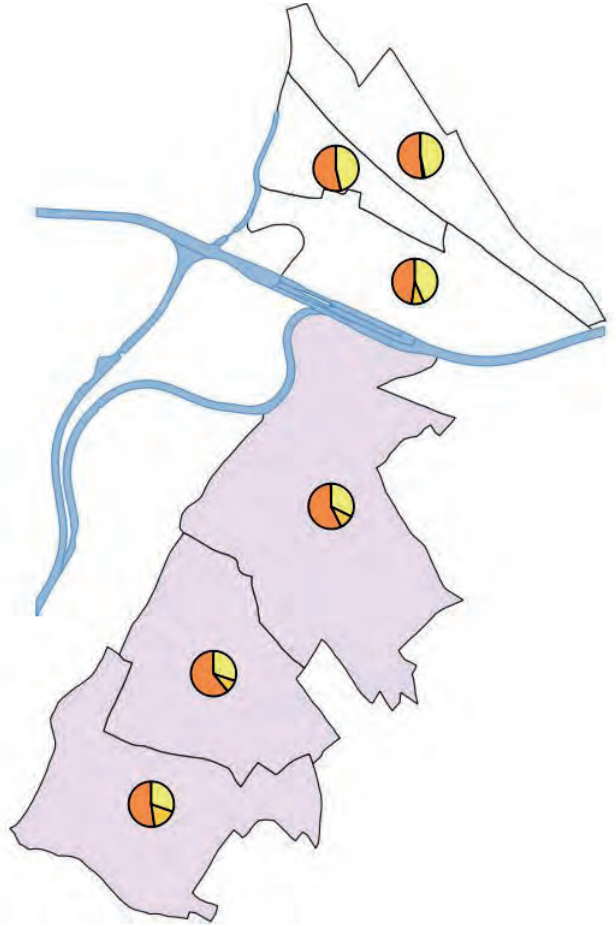
0-10%	0-10%
0-20%	0-20%
20-30%	20-30%
30-40%	30-40%
40-50%	40-50%
	Water
	Train track

Figure 52: Right: population density and age distribution

Population density
- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution
- > 65
- 18 - 64
- 0 - 17

- Water
- Train track



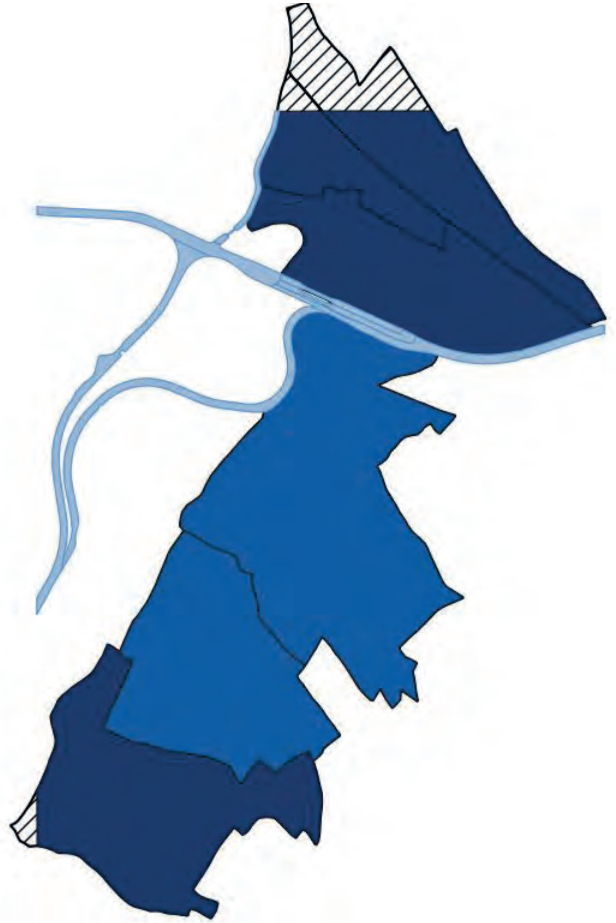


Figure 53: Left: socioeconomic status (SES) and heat stress levels (PET)

Socioeconomic status
- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

- Water
- Train track

Heat stress levels
- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress

Figure 54: Right: cool outdoor ground level area per inhabitant

- 0-10 m^2 [PET < 35 °C] / inhabitant
- 10-20 m^2 [PET < 35 °C] / inhabitant
- 20-30 m^2 [PET < 35 °C] / inhabitant
- 30-40 m^2 [PET < 35 °C] / inhabitant
- 40-50 m^2 [PET < 35 °C] / inhabitant
- 50-75 m^2 [PET < 35 °C] / inhabitant
- 75-100 m^2 [PET < 35 °C] / inhabitant
- 100-125 m^2 [PET < 35 °C] / inhabitant
- 125-150 m^2 [PET < 35 °C] / inhabitant
- >500 m^2 [PET < 35 °C] / inhabitant

- Water
- Train track
- No data

5.7 Saint-Omer

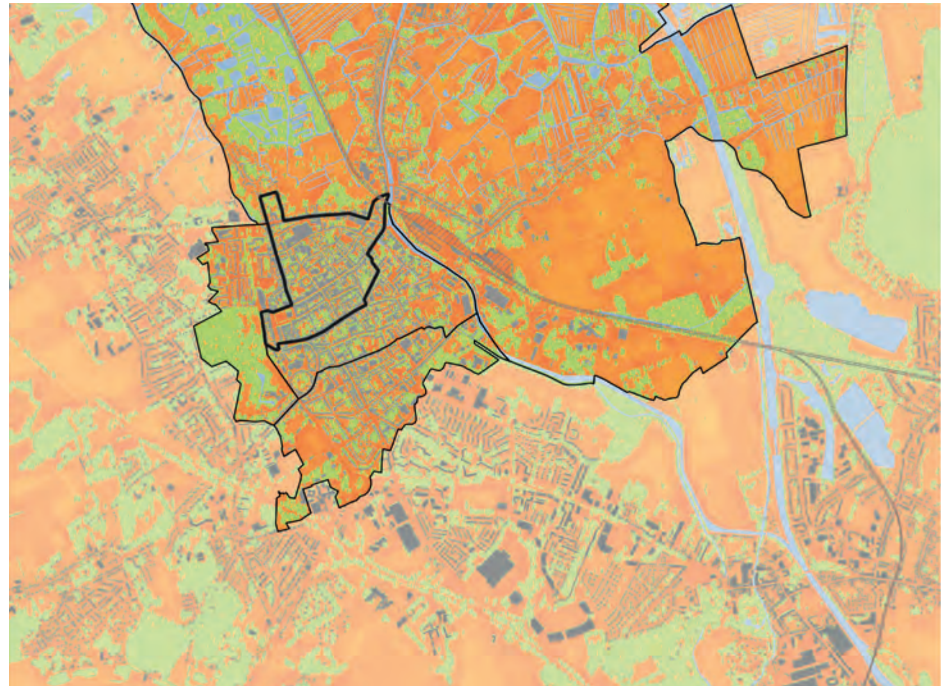


Figure 55: Saint-Omer lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C

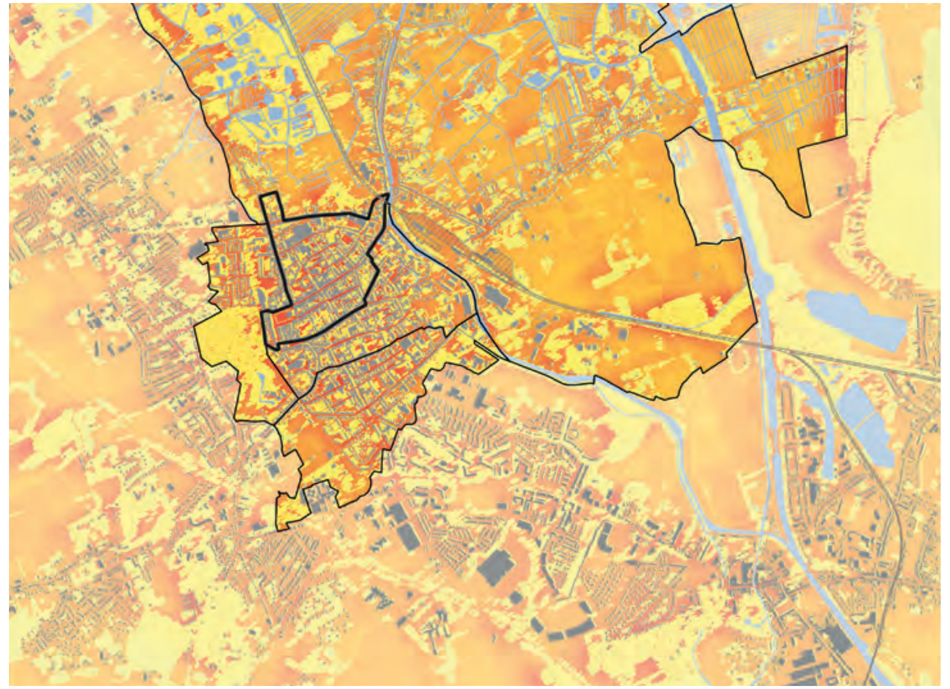


Figure 56: Saint-Omer rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C

Heat stress level (PET)

46-51 Extreme Heat Stress (LV2)
41-46 Extreme Heat Stress (LV1)
35-41 Strong Heat Stress
29-35 Moderate Heat Stress
23-29 Slight Heat Stress

Building
Water
Train track
City centre
Neighbourhood

N

Figure 57: Advanced vulnerability map of the Centre-Ville neighbourhood in Saint-Omer.

Cultural facility
Supermarket
Bus stop
Hotel
Train station
Education
Childcare
Playground
Rail
Road
300 meter walking distance
Future park
Potential cool place
Park or recreation area
Water
Building
PET values - Rush hour scenario
46 - 51 Extreme heat stress (LV2)
41 - 46 Extreme heat stress (LV1)
35 - 41 Strong heat stress
29 - 35 Moderate heat stress
Research Area: Sint Omer - Centre-ville
User group: visitors

0 250 500 m

Saint-Omer vulnerability maps I

Figure 58: *Vegetated percentage*

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%
- Water
- Train track

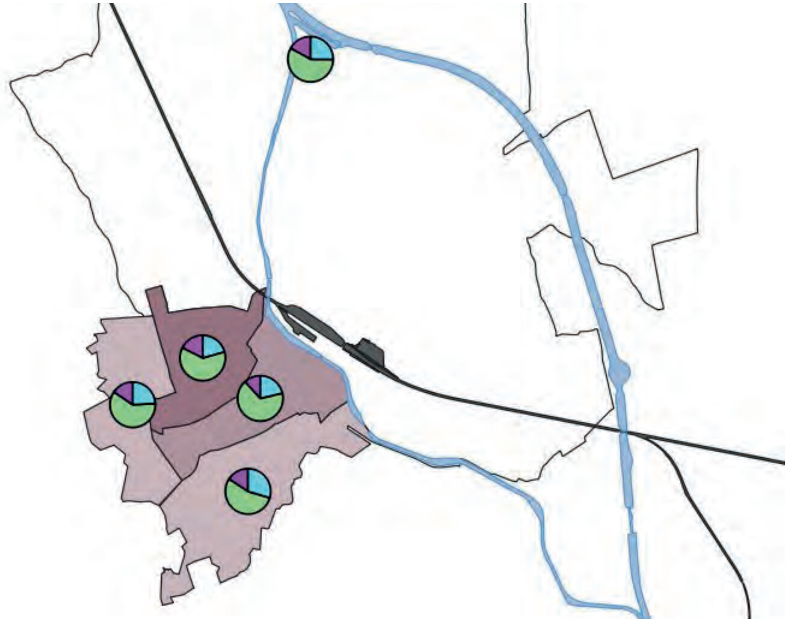


Figure 59: *Population density and age distribution*

Population density

- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17
- Water
- Train track

Figure 60: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Water
- Train track

Figure 61: *Cool outdoor ground level area per inhabitant*

- 0-10 m^2 [PET < 35 ° C] / inhabitant
- 10-20 m^2 [PET < 35 ° C] / inhabitant
- 20-30 m^2 [PET < 35 ° C] / inhabitant
- 30-40 m^2 [PET < 35 ° C] / inhabitant
- 40-50 m^2 [PET < 35 ° C] / inhabitant
- 50-75 m^2 [PET < 35 ° C] / inhabitant
- 75-100 m^2 [PET < 35 ° C] / inhabitant
- 100-125 m^2 [PET < 35 ° C] / inhabitant
- 125-150 m^2 [PET < 35 ° C] / inhabitant
- >500 m^2 [PET < 35 ° C] / inhabitant

- Water
- Train track
- No data

Saint-Omer vulnerability maps II

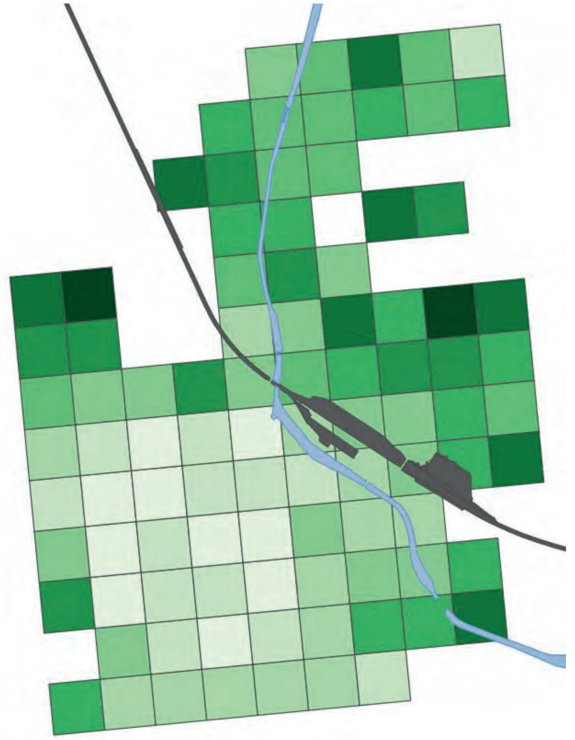


Figure 62: *Vegetated percentage*

0-10%
0-20%
20-30%
30-40%
40-50%

0-10%
0-20%
20-30%
30-40%
40-50%
Water
Train track

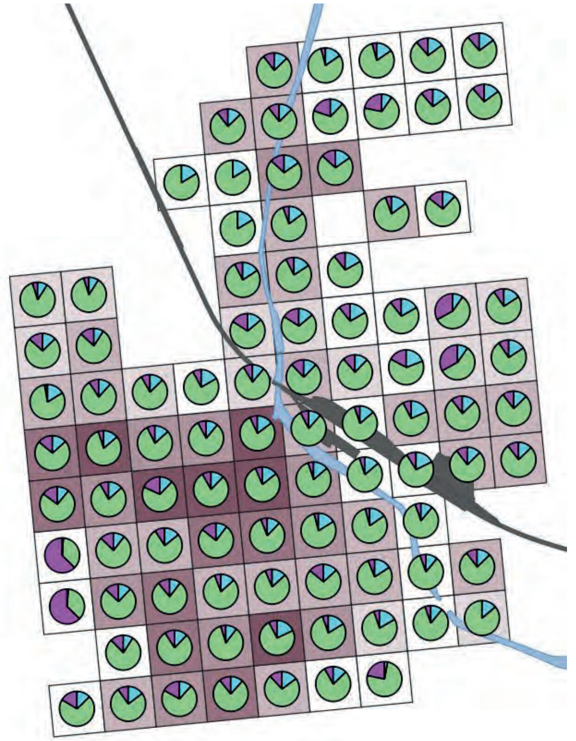


Figure 63: *Population density and age distribution*

Population density
0-50 m^2 per inhabitant
50-100 m^2 per inhabitant
100-150 m^2 per inhabitant
150-200 m^2 per inhabitant
200-350 m^2 per inhabitant
350-500 m^2 per inhabitant
>500 m^2 per inhabitant

Age distribution
> 65
18 - 64
0 - 17
Water
Train track

Figure 64: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status
Extremely below city average
Strongly below city average
Moderately below city average
Slightly below city average
Slightly above city average
Moderately above city average
Strongly above city average

Heat stress levels
46-51 Extreme Heat Stress (LV2)
41-46 Extreme Heat Stress (LV1)
35-41 Strong Heat Stress
29-35 Moderate Heat Stress
23-29 Slight Heat Stress
Water
Train track
No data

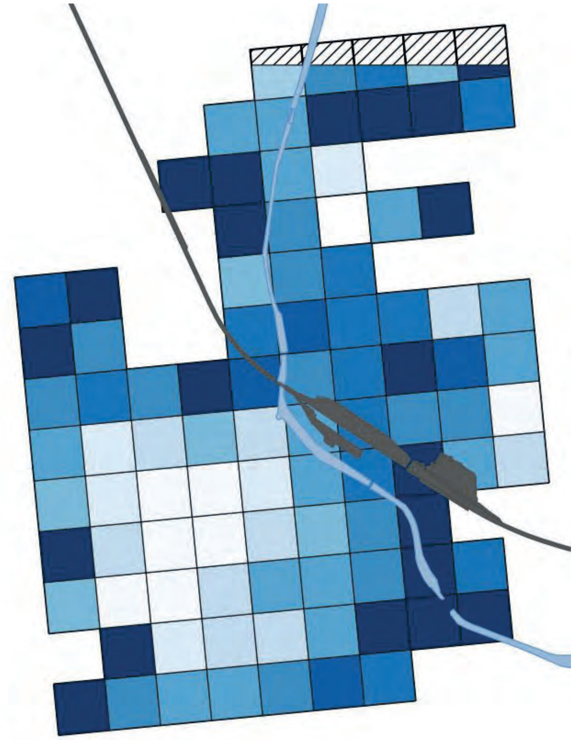


Figure 65: *Cool outdoor ground level area per inhabitant*

0-10 m^2 [PET < 35 °C] / inhabitant
10-20 m^2 [PET < 35 °C] / inhabitant
20-30 m^2 [PET < 35 °C] / inhabitant
30-40 m^2 [PET < 35 °C] / inhabitant
40-50 m^2 [PET < 35 °C] / inhabitant
50-75 m^2 [PET < 35 °C] / inhabitant
75-100 m^2 [PET < 35 °C] / inhabitant
100-125 m^2 [PET < 35 °C] / inhabitant
125-150 m^2 [PET < 35 °C] / inhabitant
>500 m^2 [PET < 35 °C] / inhabitant

Water
Train track

5.8 Southend

Figure 66: *Southend lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C*

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress

- Building
- Water
- Train track
- City centre
- Neighbourhood

N

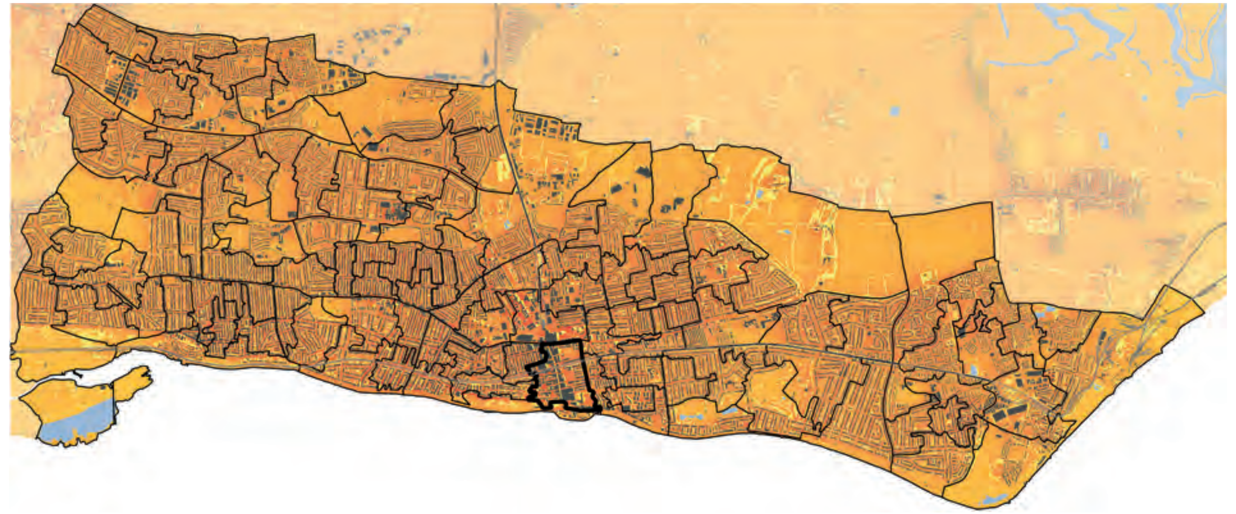


Figure 67: *Southend rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C*

Figure 68: *Advanced vulnerability map of Westcliff neighbourhood in Southend.*

- Childcare
- Shopping centre or mall
- Supermarket
- Bus stop
- Education
- Playground
- Rail
- Road
- 300 meter walking distance
- Building
- Potential cool place
- Park or recreation area
- Water

PET values - Lunchtime scenario

- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress
- 23 - 29 Slight heat stress
- Research area: Southend - Westcliff User group: children

0 400 800 m

Southend vulnerability maps

Figure 69: Vegetated percentage

0-10%	0-10%
0-20%	0-20%
20-30%	20-30%
30-40%	30-40%
40-50%	40-50%
	Water
	Train track

Figure 70: Population density and age distribution

Population density

- 0-50 m² per inhabitant
- 50-100 m² per inhabitant
- 100-150 m² per inhabitant
- 150-200 m² per inhabitant
- 200-350 m² per inhabitant
- 350-500 m² per inhabitant
- >500 m² per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17

- Water
- Train track

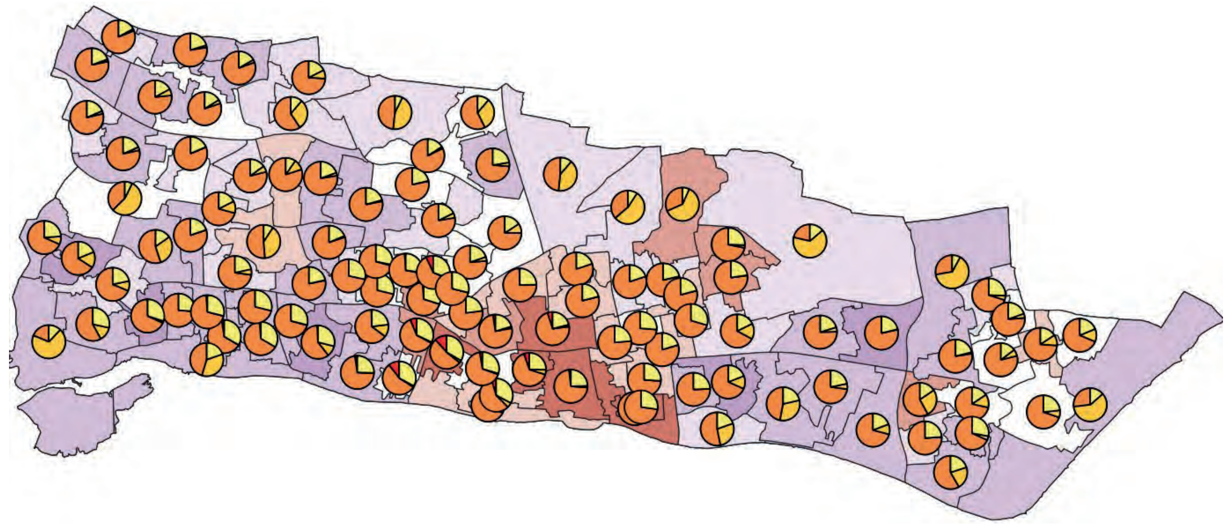


Figure 71: Socioeconomic status (SES) and heat stress levels (PET)

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

- Water
- Train track
- No data

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress

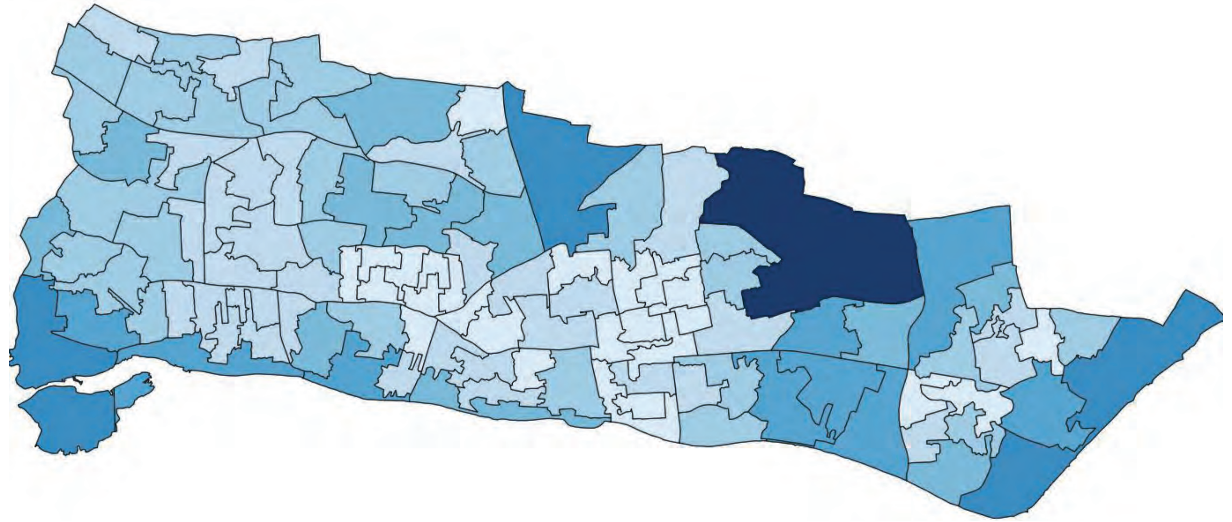


Figure 72: Right: cool outdoor ground level area per inhabitant

- 0-10 m² [PET < 35 °C] / inhabitant
- 10-20 m² [PET < 35 °C] / inhabitant
- 20-30 m² [PET < 35 °C] / inhabitant
- 30-40 m² [PET < 35 °C] / inhabitant
- 40-50 m² [PET < 35 °C] / inhabitant
- 50-75 m² [PET < 35 °C] / inhabitant
- 75-100 m² [PET < 35 °C] / inhabitant
- 100-125 m² [PET < 35 °C] / inhabitant
- 125-150 m² [PET < 35 °C] / inhabitant
- >500 m² [PET < 35 °C] / inhabitant

- Water
- Train track

5.9 Kent

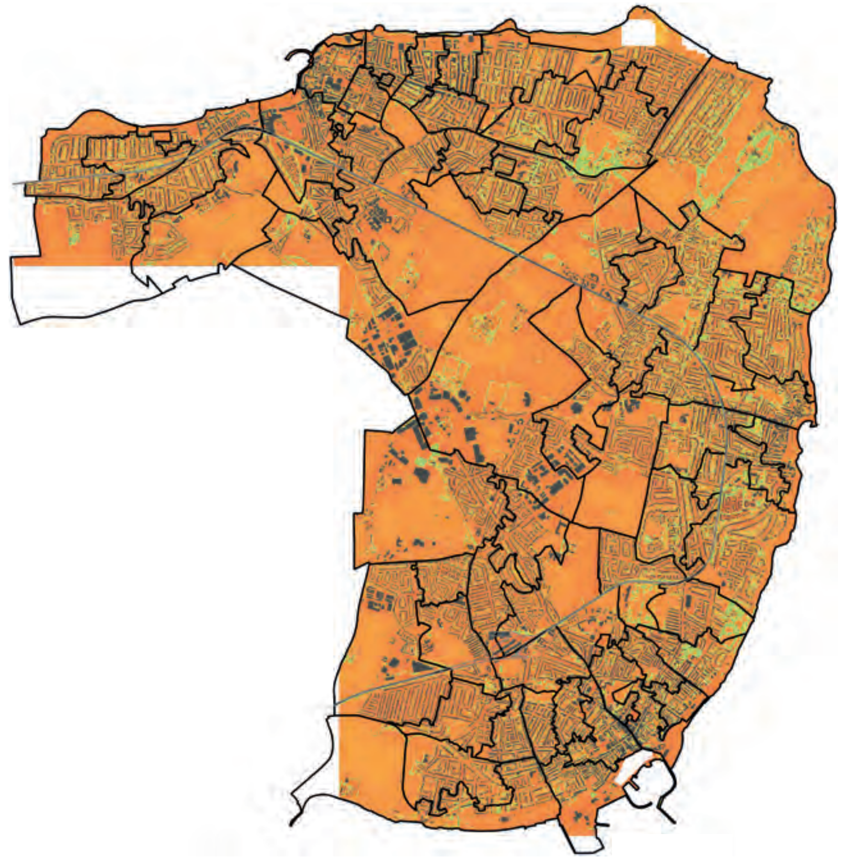


Figure 73: *Kent lunchtime scenario, Time: 12 UTC (14 CEST), Tair: 28 °C*

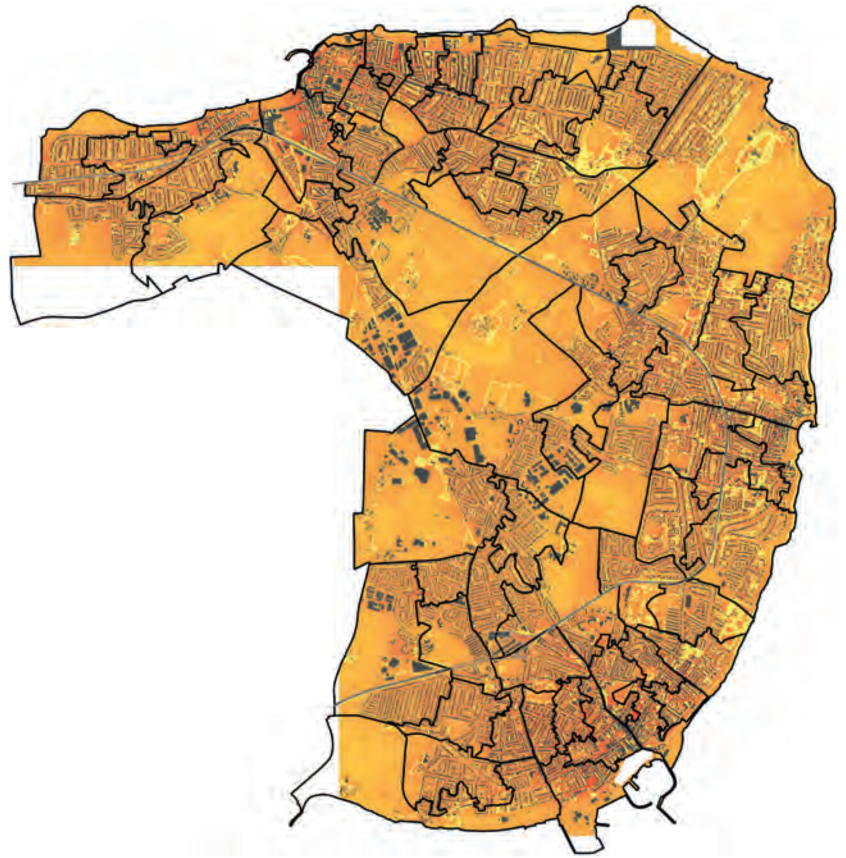


Figure 74: *Kent rush hour scenario Time: 15 UTC (17 CEST), Tair: 33 °C*

Heat stress level (PET)

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Building
- Water
- Train track
- City centre
- Neighbourhood

N

Figure 75: *Advanced vulnerability map of Margate central in Kent.*

- Train station
- Attraction
- Swimming
- Cultural Facility
- Shopping centre or mall
- Supermarket
- Bus stop
- Hotel
- Rail
- Road
- 300 meter walking distance
- Building
- Water
- Park or recreation area
- Potential cool place

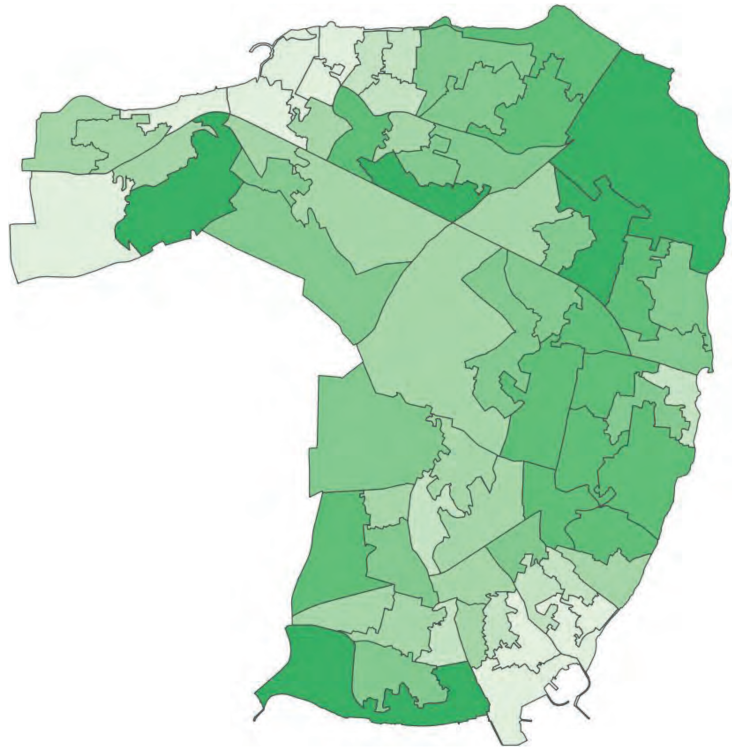
PET values - Rush hour scenario

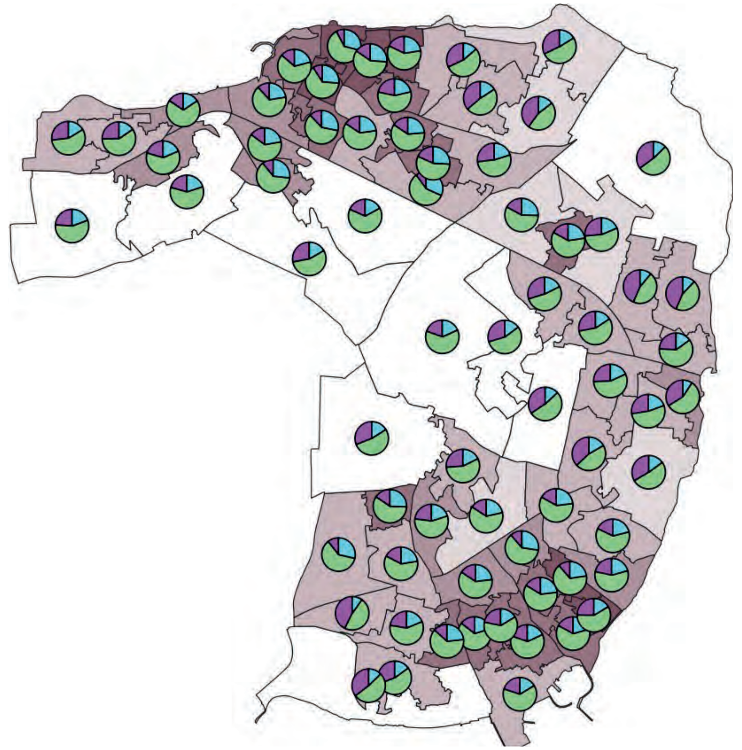
- 46 - 51 Extreme heat stress (LV2)
- 41 - 46 Extreme heat stress (LV1)
- 35 - 41 Strong heat stress
- 29 - 35 Moderate heat stress
- Research area: Kent - Margate central

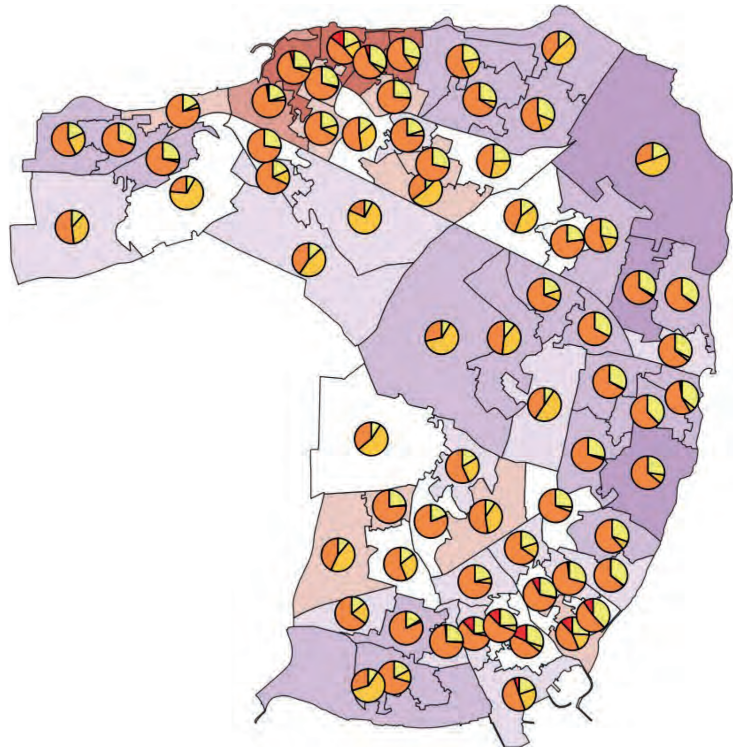
User group: visitors

0 250 500 m

Kent vulnerability maps







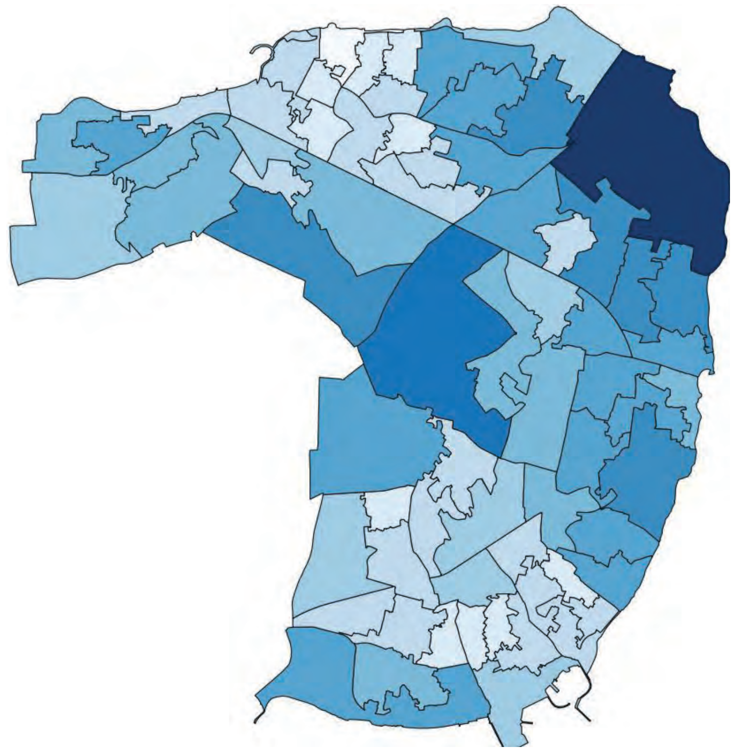


Figure 76: *Vegetated percentage*

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%

- 0-10%
- 0-20%
- 20-30%
- 30-40%
- 40-50%
- Water
- Train track

Figure 77: *Population density and age distribution*

Population density

- 0-50 m^2 per inhabitant
- 50-100 m^2 per inhabitant
- 100-150 m^2 per inhabitant
- 150-200 m^2 per inhabitant
- 200-350 m^2 per inhabitant
- 350-500 m^2 per inhabitant
- >500 m^2 per inhabitant

Age distribution

- > 65
- 18 - 64
- 0 - 17
- Water
- Train track

Figure 78: *Socioeconomic status (SES) and heat stress levels (PET)*

Socioeconomic status

- Extremely below city average
- Strongly below city average
- Moderately below city average
- Slightly below city average
- Slightly above city average
- Moderately above city average
- Strongly above city average

Heat stress levels

- 46-51 Extreme Heat Stress (LV2)
- 41-46 Extreme Heat Stress (LV1)
- 35-41 Strong Heat Stress
- 29-35 Moderate Heat Stress
- 23-29 Slight Heat Stress
- Water
- Train track
- No data

Figure 79: *Cool outdoor ground level area per inhabitant*

- 0-10 m^2 [PET < 35 ° C] / inhabitant
- 10-20 m^2 [PET < 35 ° C] / inhabitant
- 20-30 m^2 [PET < 35 ° C] / inhabitant
- 30-40 m^2 [PET < 35 ° C] / inhabitant
- 40-50 m^2 [PET < 35 ° C] / inhabitant
- 50-75 m^2 [PET < 35 ° C] / inhabitant
- 75-100 m^2 [PET < 35 ° C] / inhabitant
- 100-125 m^2 [PET < 35 ° C] / inhabitant
- 125-150 m^2 [PET < 35 ° C] / inhabitant
- >500 m^2 [PET < 35 ° C] / inhabitant

- Water
- Train track

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