Interreg CENTRAL EUROPE

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Ready4Heat

D.1.2.1: Analysis of the Areas

Version 2

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Ready4Heat

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For more information visit: https://www.interreg-central.eu/projects/ready4heat/

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1. Introduction

This deliverable aims to give the cities Maribor, Hajdúböszörmény and Weiz a clear idea of the heat hot spots and future climate development in their communities. Based on this knowledge they can build and adjust their heat adaptation strategy to the data. The satellite analysis of Landsat 8/9 data will give them the option to concentrate their efforts on regions of their municipality, which are especially affected by the heat and therefore make their investments as efficient as possible. The climate analysis will, by the analysis of three periods, today 1991 – 2020, near future 2031 – 2060 and far future 2071 – 2100, show municipalities how important heat indicators like heat days will evolve in the future. It will present the data of the future periods in comparison to the situation of today, therefore directly giving an idea how the situation will progress and why heat adaption will be a necessity.

2. Methodology

2.1.1. Satellite Analysis

Landsat 8 and 9 are Earth-observing satellites operated by NASA and the U.S. Geological Survey (USGS). They are instrumental in monitoring various aspects of the Earth's surface and can detect multiple wavelengths of the electromagnetic spectrum. Landsat 8 and 9 are equipped with the Thermal Infrared Sensor (TIRS). These satellites capture multispectral imagery, across the electromagnetic spectrum, and by combining them with different other bands in the near infrared spectrum, allowing for the monitoring of the land surface temperature (LST).

Monitoring LST is essential for understanding environmental conditions, climate patterns, and land-use changes. It provides valuable insights into temperature variations across landscapes. Even though it has its limitations, it can clearly show the relative heat differences in a city and give municipalities knowledge about the heat hot spots in the city.

2.1.2. Choosing the right images to analyse

To identify the right days to choose the satellite imagery from, an analysis via Copernicus was conducted. Copernicus is the European data centre for a great amount of environmental and climate data with open access and no cost attached. One product is the "ERA5 Reanalysis2, which was used here.

Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. This principle, called data assimilation, is based on the method used by numerical weather prediction centres, where every so many hours a previous forecast is combined with newly available observations in an optimal way to produce a new best estimate of the state of the atmosphere, called analysis, from which an updated, improved forecast is issued. Reanalysis works in the same way, but at reduced resolution to allow for the provision of a dataset spanning back several decades. Reanalysis does not have the constraint of issuing timely forecasts, so there is more time to collect observations, and when going further back in time, to allow for the ingestion of improved versions of the original observations, which all benefit the quality of the reanalysis product.

Through this reanalysis data, heat days of the past decade (2013-2022) where identified and for those days corresponding satellite imagery was chosen for the heat analysis of the cities. These hot days were picked to show the situation on the city in those extreme weather events and to highlight the differences of land surface temperatures.

2.1.3. Calculating land surface temperature

For the calculation of the LST (= Land Surface Temperature) the Landsat-8/9 bands 4 (0.64-0.67 µm), 5 (0.85-0.88 µm) and 10 (10.6-11.19 µm) were used. For this purpose, with the help of the software ArcMap and the included calculation tools, the infrared data (band 10) was converted into the surface temperature and then displayed in colour.

2.1.4. Classifying heat vulnerability

After calculating the LST, the classification process could start. Aim of this process is to group areas in the maps, which share the same characteristics, in this case have similar LST values to clearly identify areas that are especially affected by heat in relative to the rest of the city. The classification results can be seen in the legend of every map.

For Weiz: analysing the heat vulnerability to the elderly people

Weiz had the fortunate case that the town is in possession of age structure data of its inhabitants. This made it possible to calculate areas of high density of its elderly citizens and overlay this with the classified heat stress map. Two age groups were chosen, 65 to 85 year old and above 85-year-old citizens.

This shows in which parts of the city the elderly are especially affected by heat and where measures to target them should take place.

Disclaimer: The original full resolution maps are provided to the municipalities. They cannot be imported properly in to a word document without reducing their size. The municipalities can use these maps in any future capacity they want and zoom in to building level.

2.2. Climate Analysis

To create the climate analysis an ensemble of scenarios was prepared to give a range of different climate developments. Using only one or two scenarios are prone to mistakes or inaccuracies and cannot portray the possible developments of climate change.

What are these climate models? The Representative Concentration Pathways (RCPs) are a set of greenhouse gas concentration trajectories used in climate modelling to explore different potential future climate scenarios. These scenarios are characterized by the levels of radiative forcing, which is a measure of the imbalance between incoming and outgoing energy in the Earth's atmosphere due to greenhouse gases. The RCPs were developed to provide a structured framework for assessing future climate changes and their impacts.

<u>To give a deeper explanation here is a short summary of the three different RCPs used</u>

RCP 2.6: This scenario represents a future where stringent mitigation measures are in place to limit greenhouse gas emissions. It corresponds to a radiative forcing level of 2.6 watts per square meter by the end of the 21st century. The aim of RCP 2.6 is to achieve the international target of limiting global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit it to 1.5 degrees Celsius. Achieving this scenario requires substantial reductions in emissions and widespread adoption of clean energy technologies.

RCP 4.5 represents a scenario where moderate emissions reduction efforts are made. It corresponds to a radiative forcing level of 4.5 watts per square meter by the end of the century. In this scenario, emissions are reduced compared to business-as-usual, but they still lead to a significant increase in global temperatures. It represents a pathway that is less ambitious than RCP 2.6 but more optimistic than RCP 8.5.

RCP 8.5 is a scenario that assumes no climate mitigation policies are implemented, resulting in high greenhouse gas emissions throughout the century. It corresponds to a radiative forcing level of 8.5 watts per square meter by the end of the 21st century. This scenario represents a future with the most severe consequences of climate change, including substantial global temperature increases, more frequent and severe extreme weather events, and significant impacts on ecosystems and societies.

In summary, RCP scenarios are used to explore a range of potential futures based on different levels of greenhouse gas emissions. Lower RCP numbers indicate scenarios with more aggressive emissions reductions and less severe climate change impacts, while higher numbers represent scenarios with minimal emissions reductions and more pronounced climate change consequences. These scenarios serve as valuable tools for assessing the risks and impacts associated with different climate pathways.

<u>On important note that needs to be mentioned:</u>

The climate models used cannot calculate the heat island effects of cities and include them in the data. The analysed ensemble comes from the region of the respective pilot city and not from a city centre where we find the heat hotspots. This means that the model data underestimate the temperatures and therefore the heat indicators in the city are even higher than the models show us.

The following scenarios were used:

Global Climate Model	Regional Climate Model	Name of Scenario			Project
MPI-M-MPI-ESM-LR (r1)	SMHI-RCA4	RCP2.6	RCP4.5	RCP8.5	CORDEX EUR11
MPI-M-MPI-ESM-LR (r2)	MPI-CSC-REMO2009	RCP2.6	RCP4.5	RCP8.5	CORDEX EUR11

Table 1: Properties of the used climate scenarios

Heat leads to serious health issues for a great variety of target groups. To characterize future heat development specific heat indicators were chosen to be analysed. Those are often events especially exacerbate the heat stress. Those indicators are:

Name	Meaning (all events are per year)	Importance
Heat Days	Days with maximum temperature of above 30°C	Days with temperatures above 30°C are especially burdensome for the human health and can bring serious health implications to vulnerable groups, like the elderly, children, pregnant persons or outside workers.
Summer Days	Days with a maximum temperature of above 25°C	Summer days are not as burdensome as heat days but they still contribute to the urban heat island effect and increase the temperature difference between city and surroundings. Long periods of summer days can also impact the human health and put stress on them. They also give an reference of the general climate in a location and how it changes, the more summer days there are, the smaller the transition periods between winter and summer is.
Tropical Nights	Days were the temperature never goes below 20°C	These events pose serious issues for the human health. By not falling under 20°C the body cannot cool down properly at night, reduce the heat stress levels, and rejuvenate.

Consecutive Heat Days	Average number of heat days directly back-to-back	This number is a good indicator for how heat wave lengths will develop in the future. The more heat days will happen after each other the longer heat waves will become. Moreover, the human body cannot recover if there are heat days after heat days. Therefore a higher number of average heat days after each other will increase heat stress.
Consecutive Summer Days	Average number of summer days directly back-to-back	This is an indicator for the “consistency” of summer. Without some cool days here and there the heat build-up in cities can commence quicker and therefore can lead to a higher impact of the urban heat island effect.
Consecutive Tropical Nights	Average number of tropical nights directly back-to-back	Tropical nights themselves are a very stressful event for the human body especially for vulnerable groups. This event back-to-back over multiple times means a prolonged time without any relieve for the body and chance for recover. Therefore, this indicator is critical to asses heat stress in a city.

Table 2: Heat indicators, which are analyzed with the climate scenarios

These indicators were analysed for three 30 years periods. Those lengthy periods are standard practice for meteorological surveys and established in the scientific community. The three periods are **today** 1991 – 2020, **near future** 2031 – 2060 and **far future** 2071 – 2100. The same indicator is shown for each 30-year period and a comparison between them is easily made.

3. Maribor

3.1. 1. Satellite Results

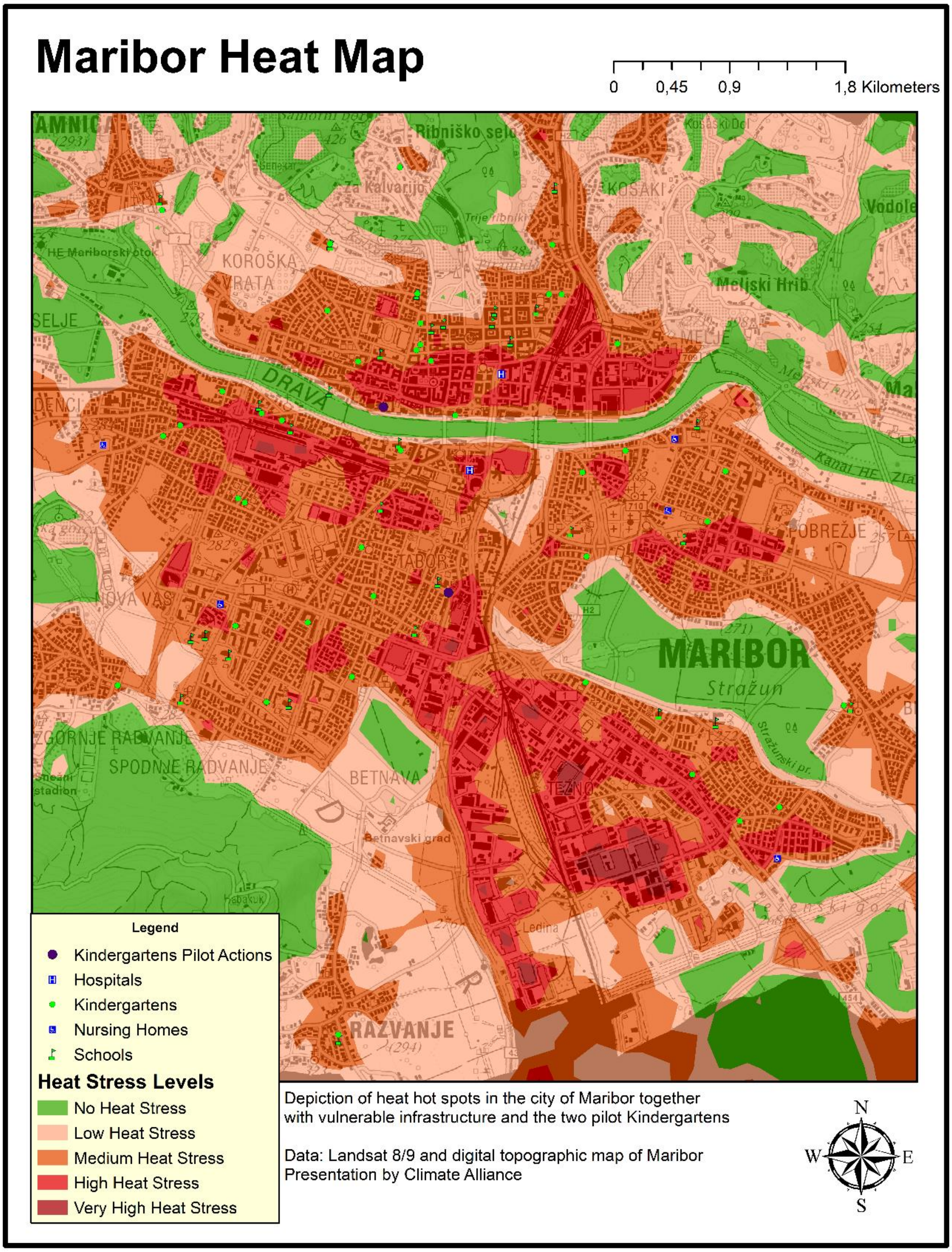

Figure 1: Heat stress levels in the city of Maribor together with vulnerable infrastructure

Description of the Map:

The map, which you can see on the page before, is the general heat stress map for the city of Maribor. We can clearly see the effects of urban heat build-up, with little to no heat stress on the outer parts of the city and the biggest heat stress in the centre areas of the city or in areas with high degree of surface sealing.

The heat stress level is divided into 5 classes and colour coded, so that the darker the red becomes on the map the bigger the heat stress. You can also find vulnerable infrastructure marked in the map. Those are hospitals, kindergartens, nursing homes and schools.

The next map will show the heat hot spots in the city and where they overlap with vulnerable infrastructure.

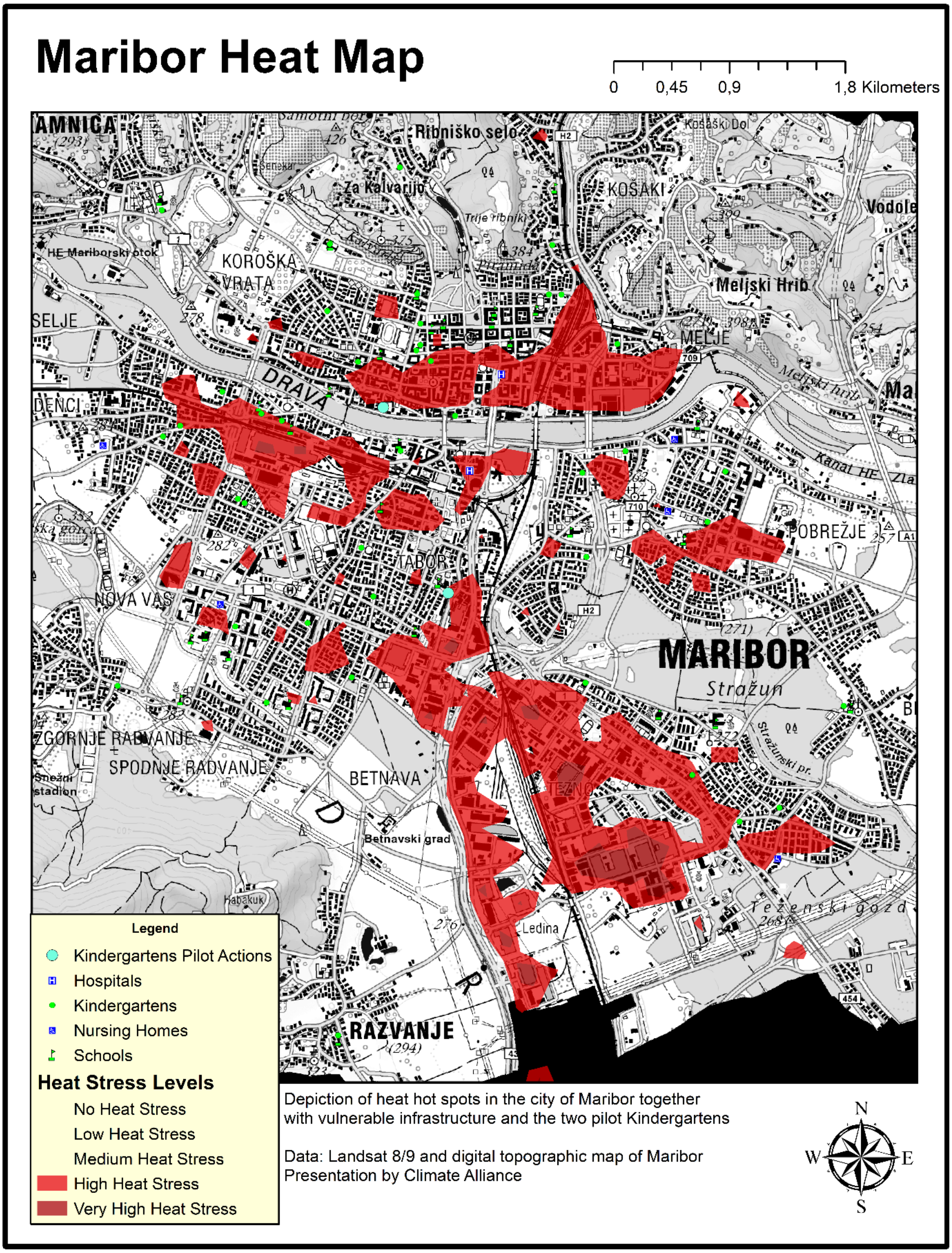

Figure 2: Hot spots of Maribor together with vulnerable infrastructure

Description of the map:

This map exclusively shows the high and very high heat stress areas in the city. We can make out a couple of heat centres. Namely to the east and west of the hospital north of the river. It does not start too close to the river, which highlights the cooling properties of the river in these heat days. Another one is to the west of the first one, on the south side of the river. A third small one lays to the east of the heat hot spot described before, south of the river, to the east of the graveyard. The largest connected heat hot spot lays to the south of the city where we can find a lot of industry and business. There, a lot of the ground was sealed for parking lots, warehouses or stores. Those areas create a very heated environment, which is also transferred to the neighbouring settlements.

4. Climate Analysis Maribor

4.1.1. Heat Days

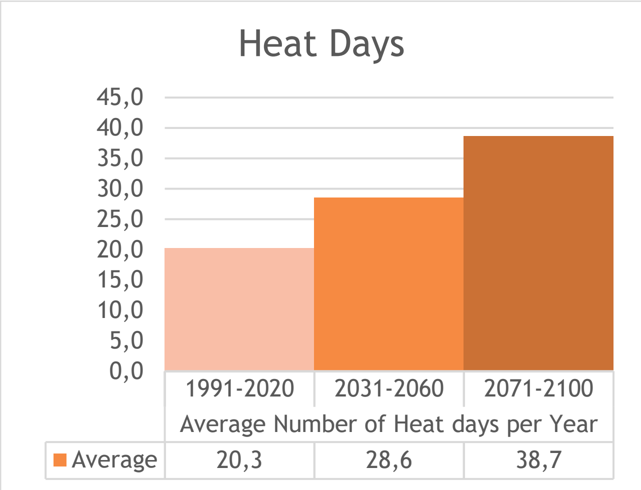

Figure 3: Heat days in Maribor

The development of Heat days speak a clear language, the number of heat days will increase from the first to the second period by 8,3 average heat days per year. This represents a 41% increase. For the second period there is an increase of 10,1 days in comparison to the second period, which represents another 35,5 % increase. Comparing the first and last period we can almost see a doubling of average heat days per year.

4.1.2. Consecutive Heat Days

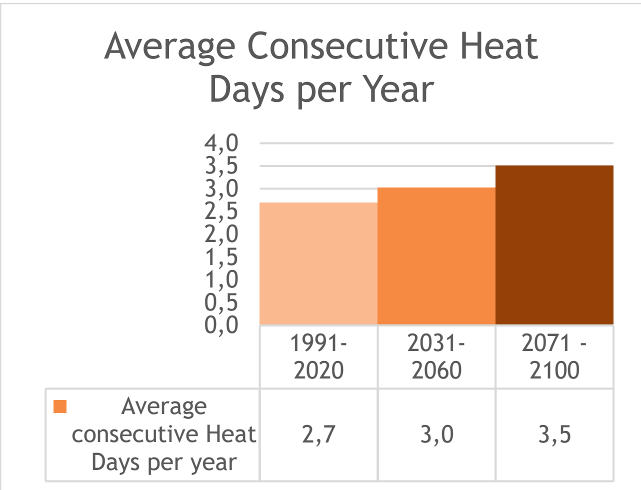

Figure 4: Average consecutive heat days per year

The number of consecutive heat days is a good indicator for the development of heat waves. The average number of consecutive heat days per year will increase only slightly by 0.3 days in the first period comparison. This is not quite a small absolute increase, but it is a respectable 11% relative increase. From the second to the third period, we calculated an increase of 0.5 days, which represents a 14% increase.

4.1.3. Summer Days

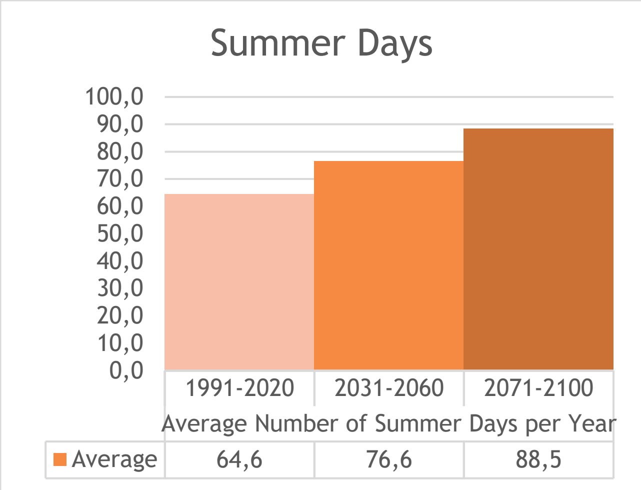

Figure 5: Summer days on average per year

Summer days represent days with temperatures of above 25°C. From the first to second period there is an increase of 12 days, which represents an increase of 18,6 %. From the second to third period we see almost the same absolute increase in days with 11,8 more summer days per year, which represents an increase of 15,5 %.

4.1.4. Consecutive Summer Days

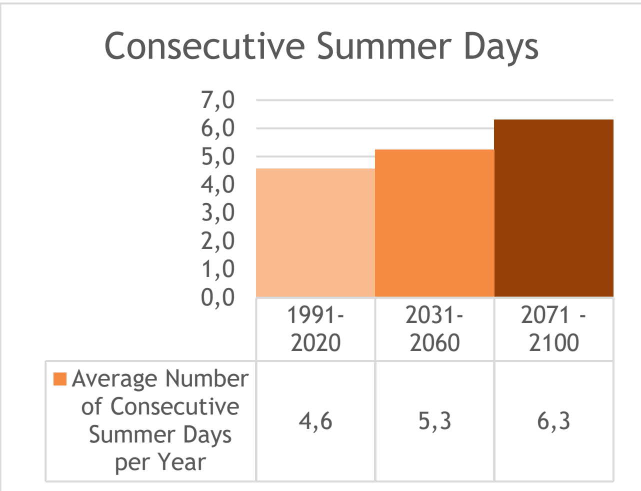

Figure 6: Consecutive summer days per year on average

The average number of back-to-back summer days shows an accelerating increase. From the first to the second period, we see a slower 0,7 days increase from 4,6 to 5,3 average consecutive days per year. From the second to third period, we can see a full day increase per year ending at 6,3 consecutive summer days per year on average.

4.1.5. Tropical Nights

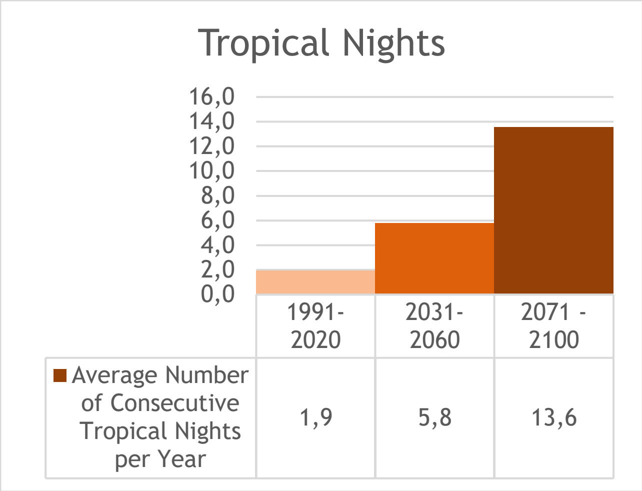

Figure 7: Tropical nights per year on average

Tropical nights are characterized by a minimum temperature that never falls below 20°C. This means a warm night without real cooling of the region. In the present period, 1991-2020, we see that there are only around two tropical nights on average per year. In the near future, we already see a steep increase of tropical nights by +3,8 to 5,8. This represents a 196% relative increase. However, the steepest increase is projected for the far future, from 2071 to 2100. There we see a plus of 7,8 tropical nights per year, to an average of 13,6 tropical nights per year. This is an enormous absolute increase and represents a challenge for the city in future.

4.1.6. Consecutive Tropical Nights

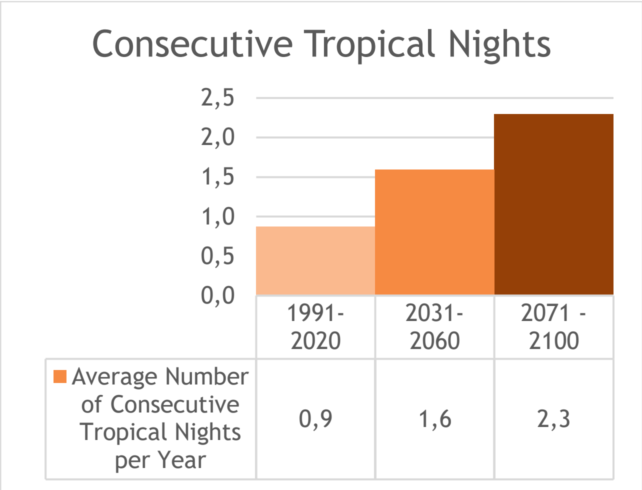

Figure 8: Consecutive tropical nights on average per year

For consecutive tropical nights, we can notice that for the first period there is almost one consecutive tropical night on average per year. In the graph about Tropical nights, we can see that there are only ~2 on average per year. This means that more often than not, if there is one tropical night it is followed by another one. This trend is not as strong in the two future periods, where there is a significant increase in tropical nights. Nevertheless, we can see a relative high and linear increase in consecutive tropical nights. An increase of 0,7 days per period to a maximum of 2,3 average consecutive tropical nights per year.

4.1.7. Summary for Maribor

The data is clear for Maribor, the heat stress for the city and its inhabitants will steadily grow in the future. We will see a strong climate change signal in the middle of the century already. Heat days will almost double in the course of the 21st century and tropical nights, being a seldom event now, will become a regular occurrence in the future. The growing numbers of consecutive heat days are a sign of prolonged heat waves, which will become longer and therefore, as seen, create the right conditions for more tropical nights to occur. Leading to more burdensome heat stress especially to vulnerable groups. More summer days are a sign for shorter seasons and more abrupt changes from winter to summer, which can bring their own kind of problems to the biosphere and Maribor's inhabitants

5. Hajdúböszörmény

5.1. Satellite Analysis

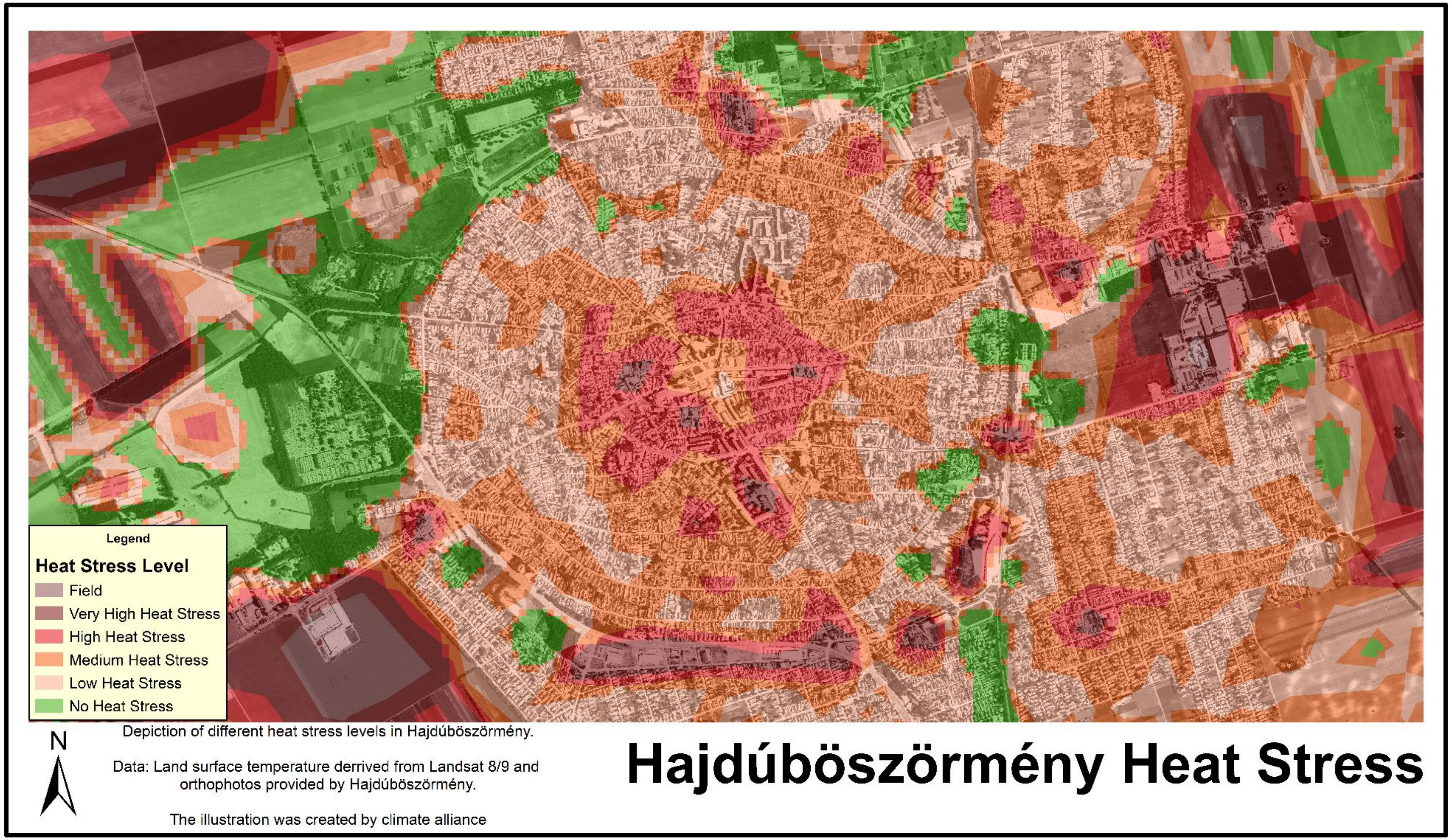

Figure 9: Heat stress map of Hajdúböszörmény

Description of the map:

The map on the previous page shows the full extent of heat stress in the city of Hajdúböszörmény. We can see that the very circular shape of the city is fully covered by at least a low heat stress level, which still means land surface temperature of over 37 °C in this case. Around the city, we can notice one important anomaly needs to be pointed out. We can see that some areas are classified as “Field” and show a high level of heat stress. This is attributed to the rich dark soil we can find in the area around Hajdúböszörmény. This dark soil will heat up even more and reach very high surface temperatures because of its dark colour. Most of the satellite images were take towards the middle or end of the year, where at some field the crops are already harvested and the ground was ploughed and dark soil laid bare.

Other areas around the city are showing the usual aspect of being a lot cooler then the city itself. We see some patches of green areas in the city itself, too. These are situated along parks or green areas.

Around half the city is affected by heat stress levels of “Medium” and upwards. Hajdúböszörmény had by far the highest land surface temperatures from all analysed cities, these measurements being a relative comparison of the city area, in absolute numbers a medium heat stress level in Hajdúböszörmény can mean a high heat stress level in Maribor or Weiz.

The individual heat hot spot areas will be analysed in the next map.

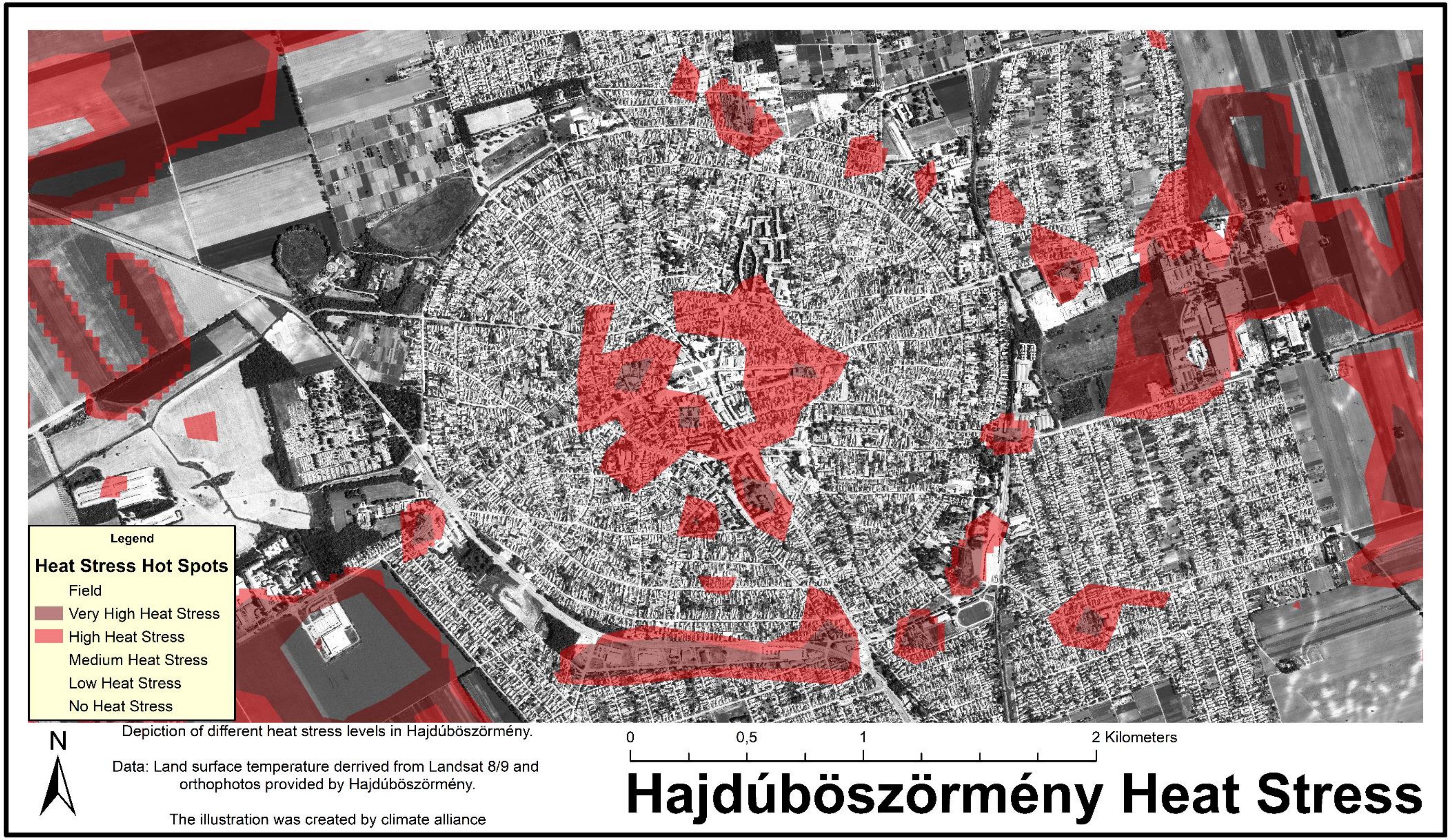

Figure 10: Hot spots of Hajdúböszörmény, focus on the city centre

Description of the map:

This map highlights only the areas in the cities affected by the most severe heat stress. The fields covered in high heat stress levels are explained in the map description before, but it can be attributed to very dark soil, which lays bare and can heat up a lot.

In the city, we have a few distinct areas of high heat stress. Foremost there is a big hot spot right around the central square of the city. The square itself has some greenery, because of that it is not affected by the highest amount possible, but still falls in the (still relative high) category of medium heat stress. This can be attributed to the sealed parts of the square.

This heat hot spot follows the main roads, which are going off from the centre and the areas right behind them to the south, east and west.

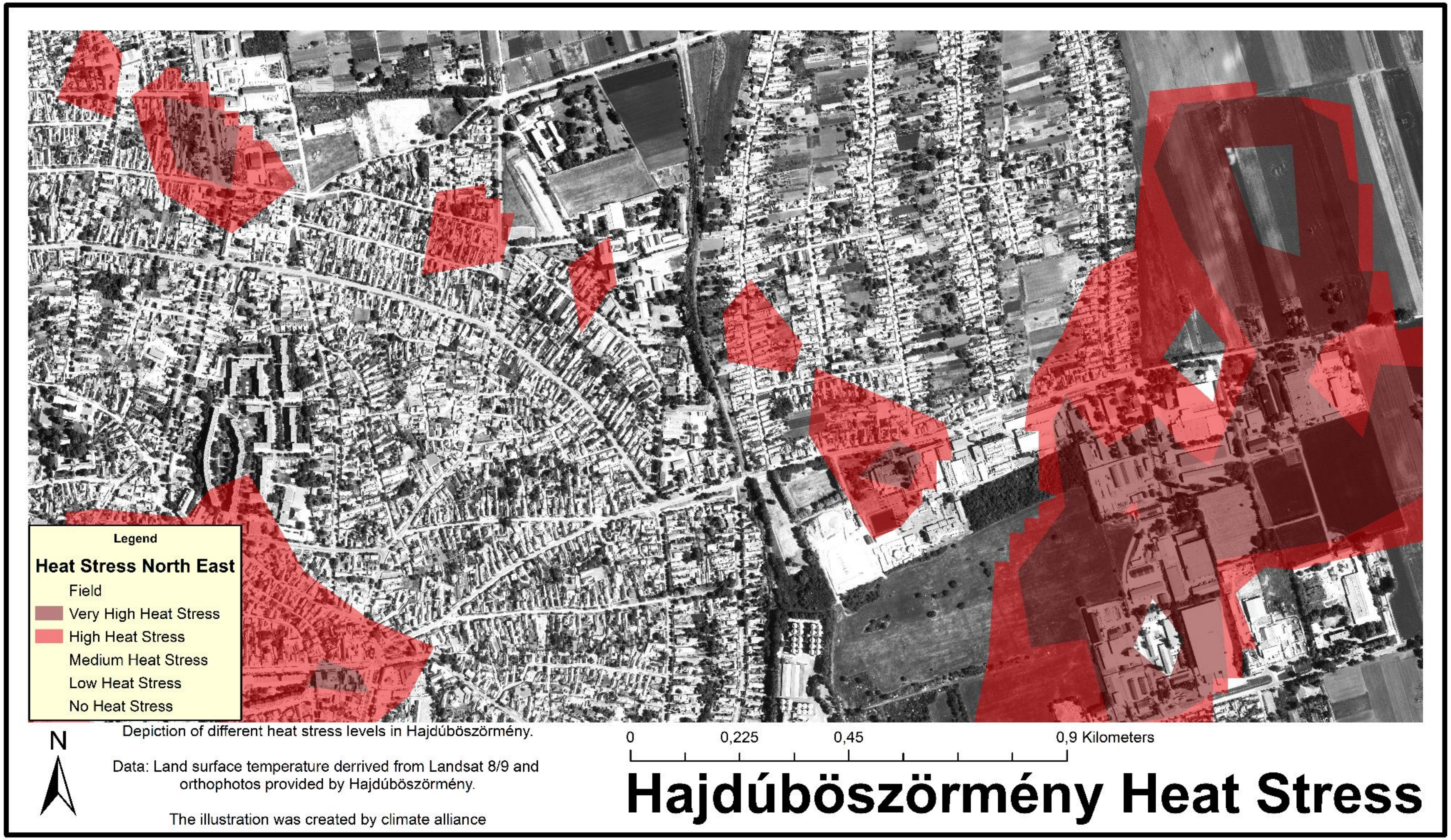

Figure 11: Hot spots of Hajdúböszörmény, focus on the north east of the city

Description of the map:

This map highlights the heat hot spots in the north east of the city. To the north, we can find a couple of individual hot spots building a chain from the severest hot spot in the north west of the map to the industry and business area in the east. There we can see the typical example of highly sealed areas with lots of warehouses and asphalt heating up and creating high heat stress areas.

To the east, we can once again see the fields, which are heating up a lot because of their dark coloured soil. In this area, the business park and the barren dark soil could lead to an additional heating effect of each other.

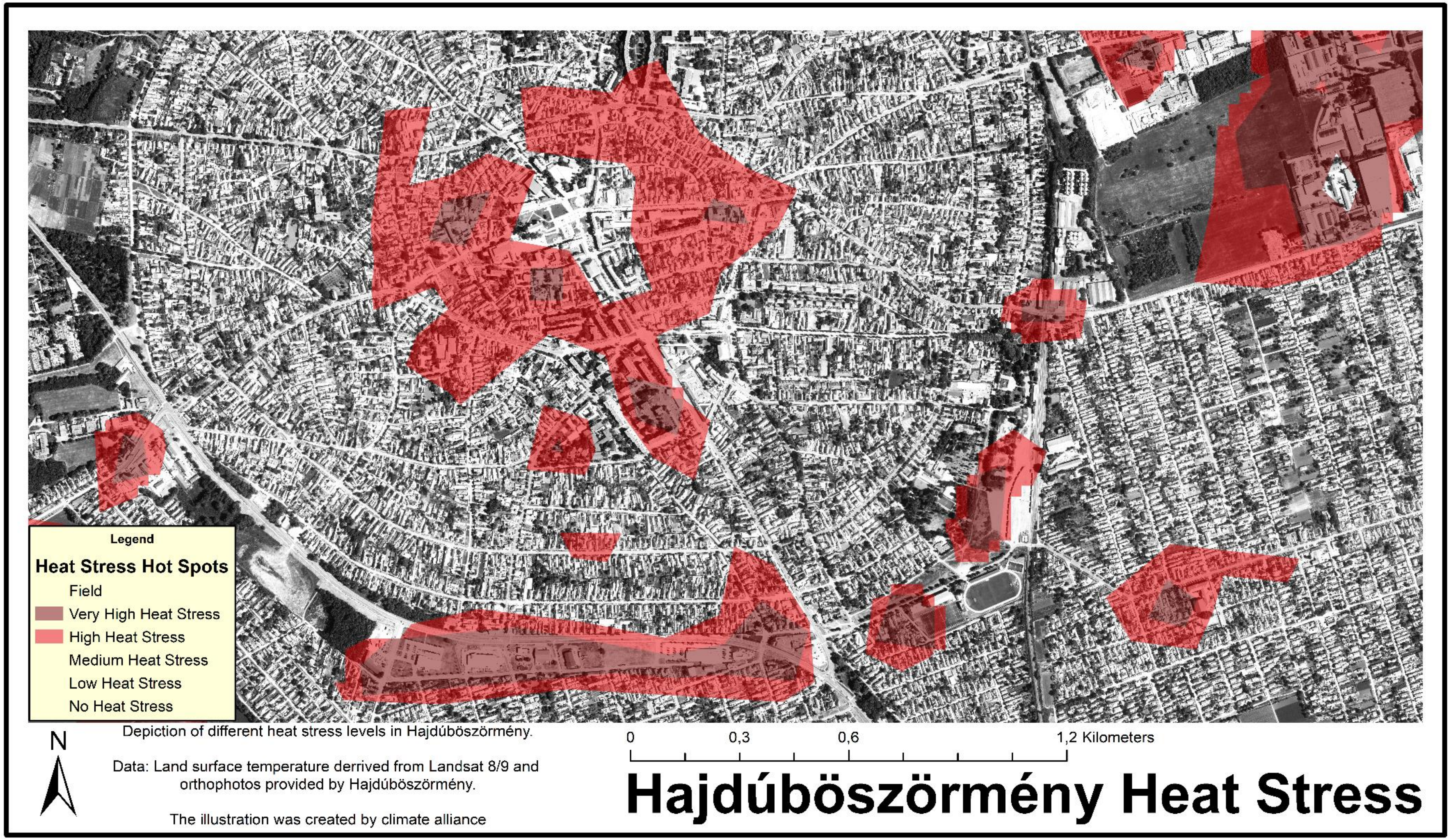

Figure 12: Heat hot spots of Hajdúböszörmény, focus on the south of the city centre

Description of the map:

This map depicts the heat hot spots to the south of the city centre. The most severe one sits along the street 35 where we can find big grocery stores with many parking spaces, starting to west of ALDI and ending in the east at the SPAR and leading a bit towards the centre. To the east of this hot spot, we can find four other hot spots, which reach into the settlement areas.

5.2. Climate Analysis Hajdúböszörmény

5.2.1. Heat Days

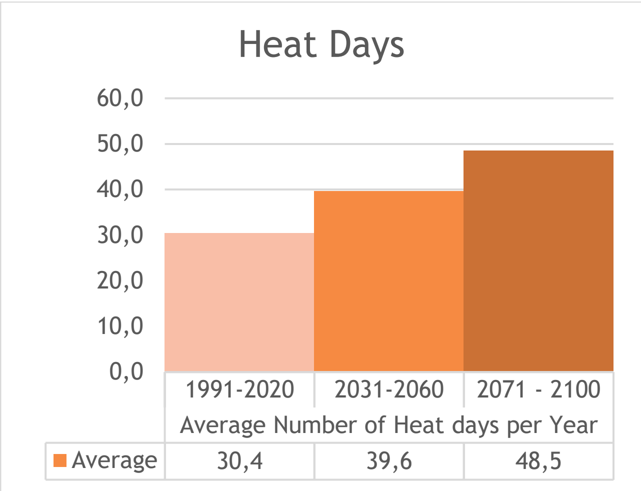

Figure 13: Average heat days per year

Because of its more southern continental location and low elevation, out of the three analysed pilot cities, Hajdúböszörmény is affected most by heat. With already 30,4 heat days in the present period it starts with almost 10 more days then Maribor. The increase from the first to the second period is 9,2 more heat days, which represents a relative increase of around 30%. Form the second to third period we see another big increase of 8,8 more heat days per year. This is an increase of another 22%.

5.2.2. Consecutive Heat Days

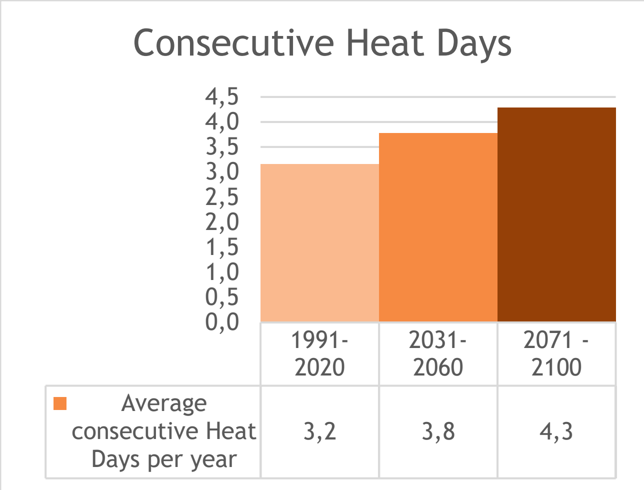

Figure 14: Consecutive heat days on average per year

For consecutive heat days, we see a steady increase. Starting of high with 3,2 average consecutive heat days per year the first increase is to 3,8 at the second period and to 4,3 at the third period. This means that heat waves will have longer durations.

5.2.3. Summer Days

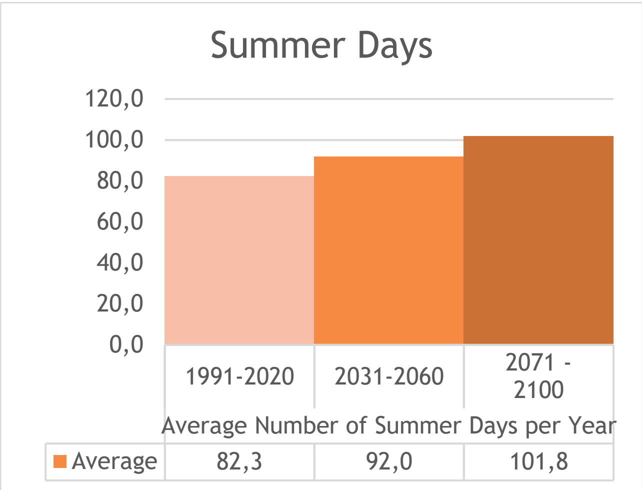

Figure 15: Average number of summer days on average per year

Summer days for Hajdúböszörmény are starting at 82,3 days, with over 25°C, on average per year and increase to 92 days in the second period. An 11 % increase. To the third period, we see another 9,8 days rise in summer days to 101,8 on average per year, another 10% increase. Having 101 summer days per year would mean that seasons will be short and the transition periods between summer and winter will be reduced even more.

5.2.4. Consecutive Summer Days

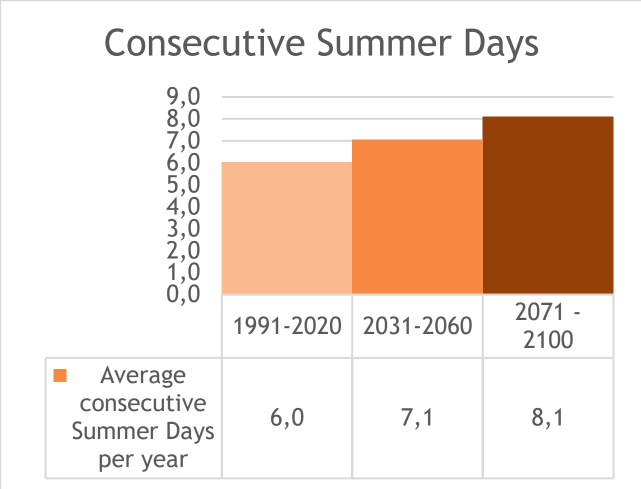

Figure 16: Average number of consecutive summer days per year

The number of consecutive summer days shows a relative steady increase in consecutive summer days with a first increase from the first to the second period of +1,1 days and from the second to third with a 1 day increase.

5.2.5. Tropical Nights

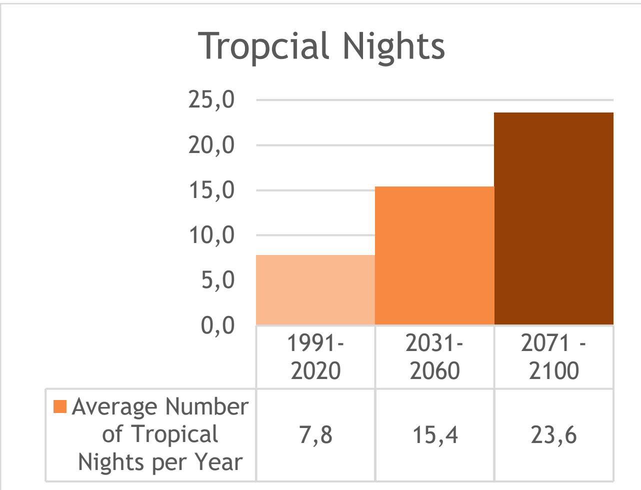

Figure 17: Average number of tropical nights per year

Tropical nights are already a problem in the city, if we look at the 7,8 average tropical nights per year on the first period. Nevertheless, this number will steeply increase and almost double to 15,4 day's mid-century, an increase of 98 %. This poses a serious issue in the immediate future. Until the end of the century the number of tropical nights will again increase significantly by 8,1 to an average of 23,6 tropical nights per year. We have to keep in mind that these nights pose a serious health risk for vulnerable groups and should not forget, that average numbers can mean lower numbers per year but also significantly higher numbers per year.

5.2.6. Consecutive Tropical Nights

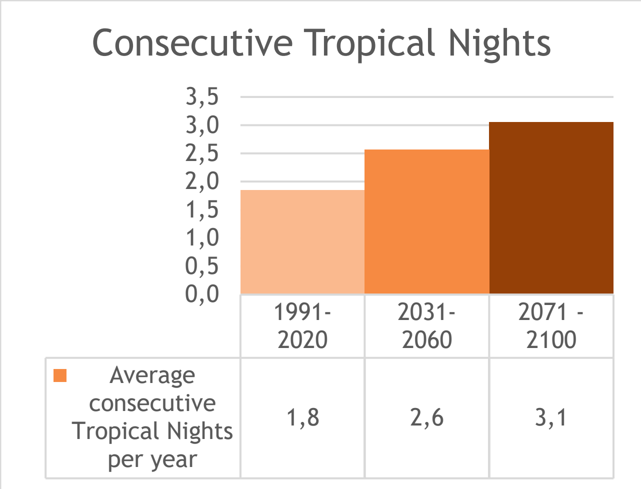

Figure 18: Average number of consecutive tropical nights per year

The number of consecutive tropical nights are increase steadily with a high relative increase from 1,8 to 2,6 average consecutive tropical nights per year. From the second to the third period the momentum is decrease a small amount to increase by half a day's more on average to 3,1 consecutive tropical nights per year. This increase means that there will be longer periods of back-to-back tropical nights, when the body and city cannot cool down and reduce heat stress.

5.2.7. Summary for Hajdúböszörmény

Because of the low elevation and the continental climate, Hajdúböszörmény suffers a lot more from heat stress than any other city analysed. Already having around 30 heat days per year in the current period with those increasing by a significant amount until the end of the 21st century. Together with a rising number of consecutive heat days this will mean that heat waves of up to 4-5 days becomes the normality multiple times each year towards the end of the century. This development in turn facilitates the growing number of tropical nights. A heat wave most of the times comes with tropical nights, because cities can warm up over days and because of urban buildings cooling is normally not sufficient to reduce the temperatures at night to fall below 20 °C. For its inhabitants the strong increase in both heat days and tropical nights pose a serious threat their health, especially to the vulnerable groups.

6. Weiz

6.1. Satellite Results

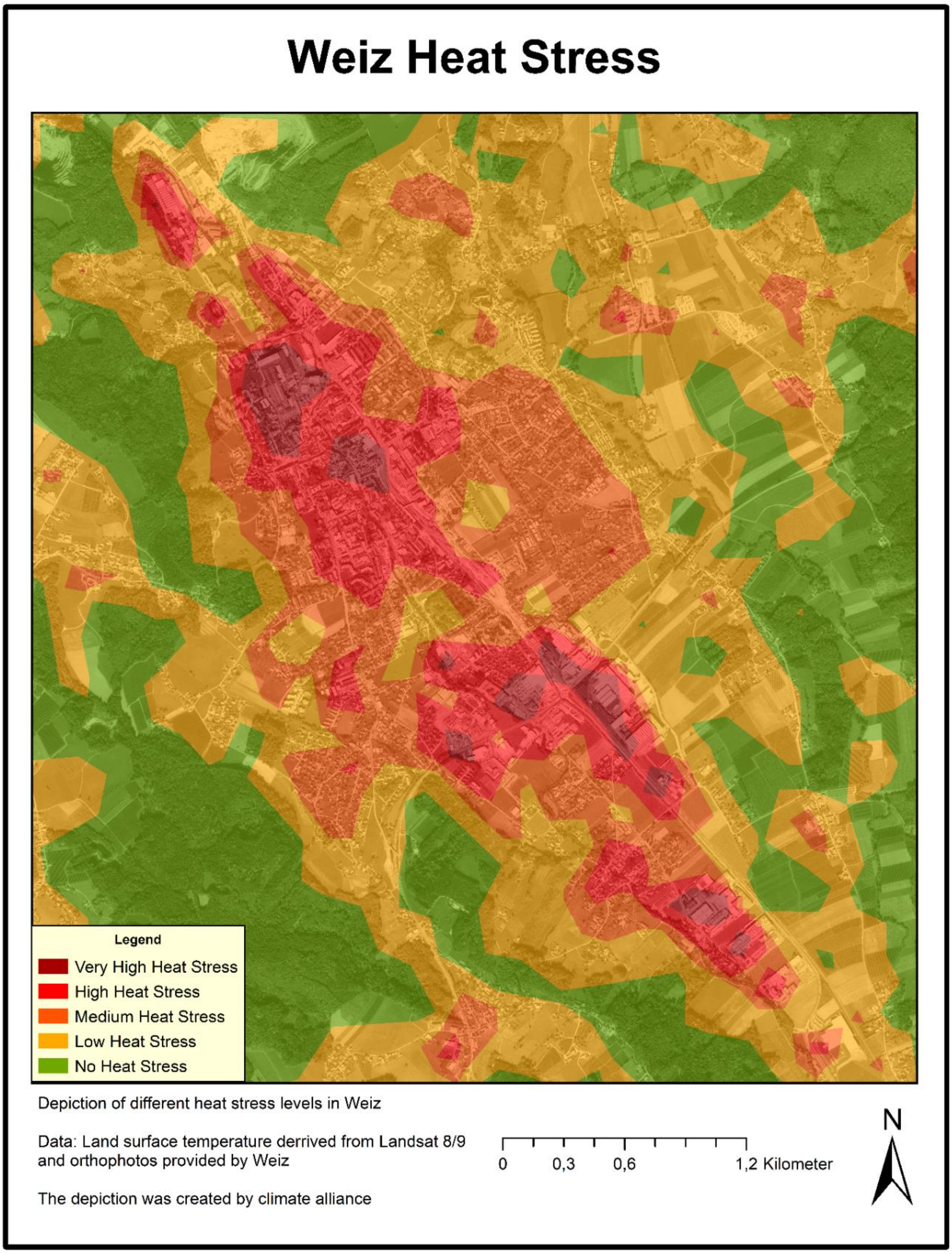

Figure 19: Heat Stress levels of Weiz

Description of the map:

This map depicts all heat stress levels in the town of Weiz. We can see the forest areas in the west and in the very east of the city being a cool spots with no heat stress. The closer we come from these areas toward the street 64 the more the heat stress intensifies. There the area gets more and more dense and there is more sealed spaces, buildings, parking spaces and warehouses. The biggest heat hotspots are close to these warehouses and business areas, where there is little to no unsealed area.

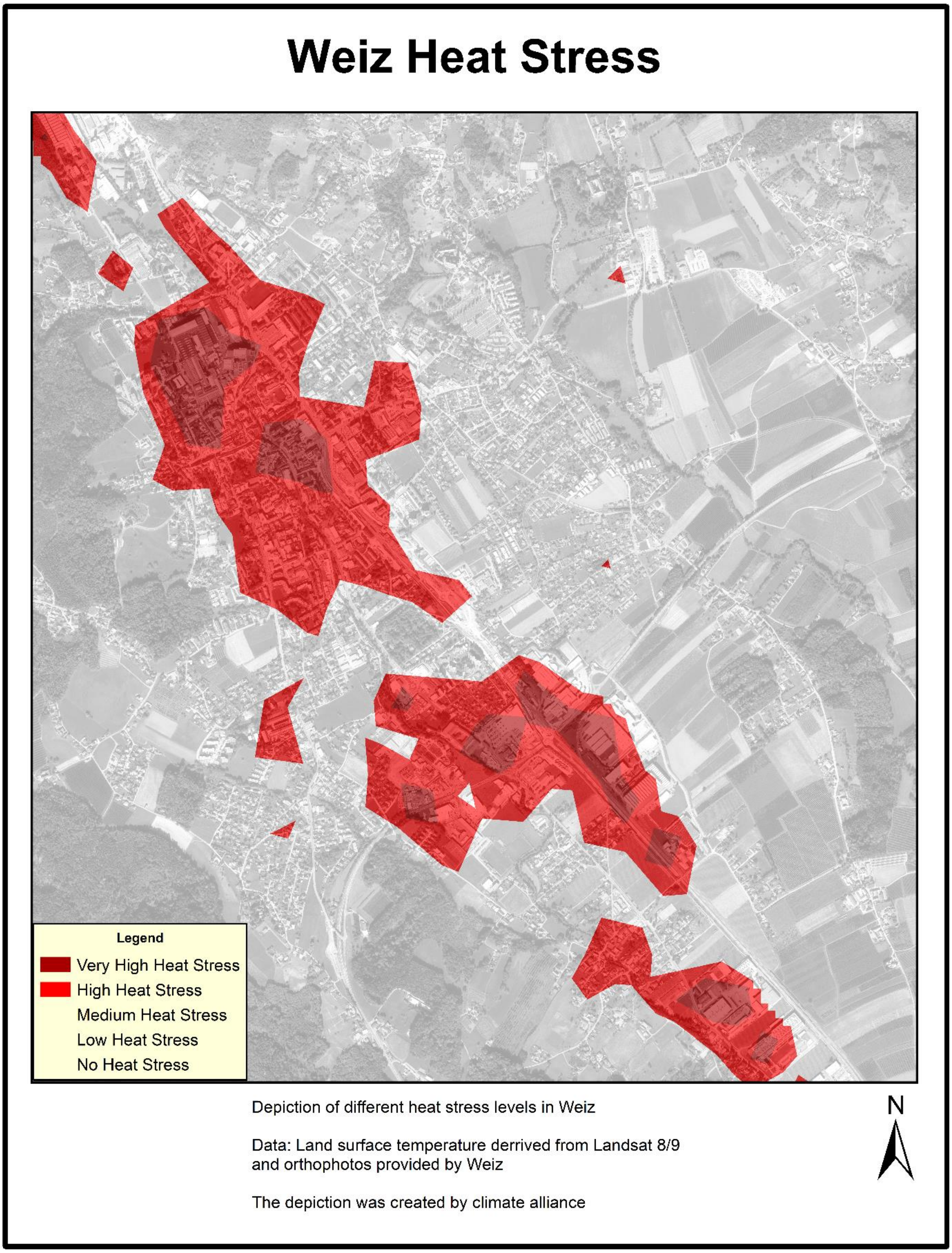

Figure 20: Heat hot spots of Weiz

Description of the map:

The map on the previous page highlights the heat hot spots, the highest two heat stress levels, in the town of Weiz. The areas go from the north west to the south east of the city alongside the street 64. They intensify at areas with a high ground sealing rate and where warehouses and businesses are found. From there they spread out to the surrounding settlements. We can define the three most severe heat hot spots. The biggest one is to the north east of the city with its centre at the Siemens business park with another hot spot centre around the “Intersport”. Around that is quite a large area, which is affected by high heat stress.

The second hot spot is not as big but more intense with its heat cores cantered around the crossing of the streets 64 and 72. There we can find a lot of parking spaces, warehouses and businesses. The heat stress is also present at the nearby settlements.

The last one is at the very south of the city where a settlement and the business park is affected by high heat stress levels.

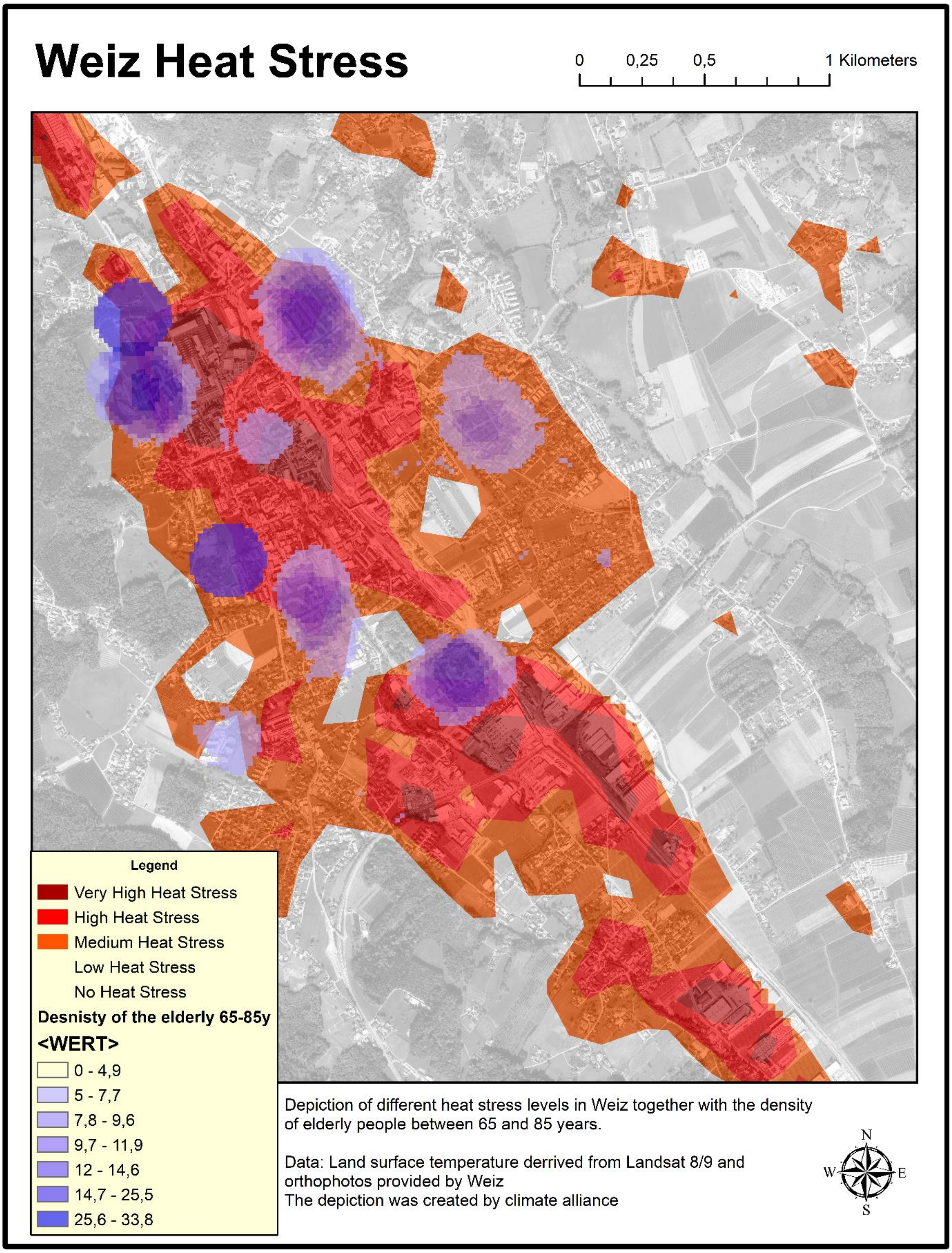

Figure 21: Heat hot spots together with the density of the elderly, aged between 65 and 85 years in Weiz

Description of the map:

This map presents a combination of heat stress levels and the relative densities of the elderly aged between 65 and 85 of years. It gives us information where in the city the elderly, which are a vulnerable group, are especially affected by heat. The deeper the blue colour gets, the higher the density of the elderly.

Some especially dark blue spots, in the north west and centre west of the town, are clearly visible, those are two nursing homes. The one in the north west is situated directly next to the Siemens business park in a very high heat stress area. The other one centre west is directly on the edge of a high heat stress area.

Another high-density area lays in the centre very close to the very high heat stress area in the centre south.

All other high-density areas of the elderly are affected by at least medium heat stress levels.

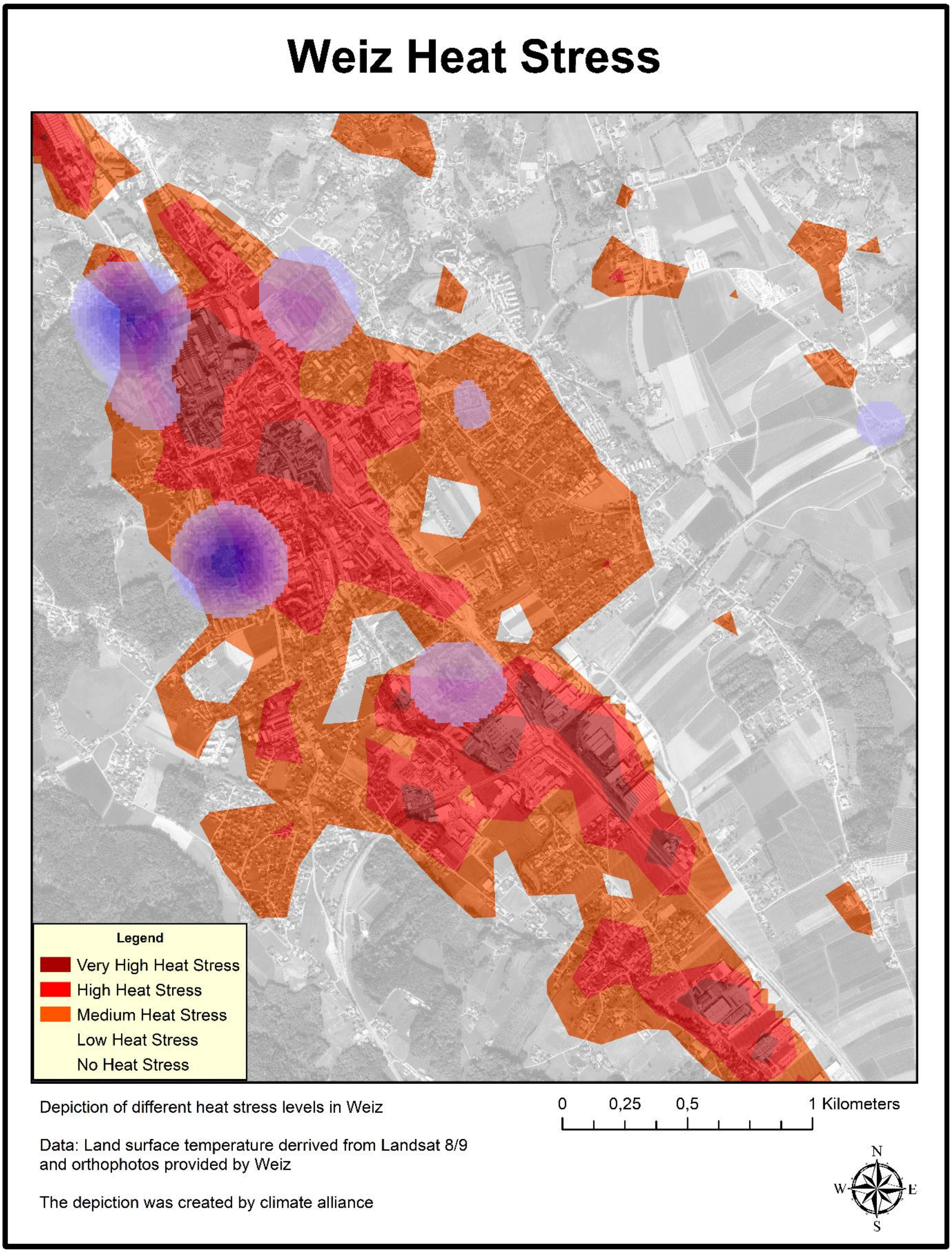

Figure 22: Heat hot spots together with the density of the elderly, aged above 85 years in Weiz

Description of the map:

This map presents a combination of heat stress levels and the relative densities of the very elderly aged above 85 years. It gives us information where in the city the very elderly, which are a vulnerable group, are especially affected by heat. The deeper the blue colour gets, the higher the density of the very elderly.

We see the same two high-density areas in the centre west and north west, where we can find the nursing homes. Those are still areas with high heat stress, bordering very high heat stress zones.

Two other areas, which were already known from the map of the elderly between 65 and 85, in the centre and to the east of the nursing home in the north are also areas with a higher density of the very elderly. Both of them are in high heat stress regions, almost bordering very high heat stress zones.

A smaller but notable denser area lays to the east of the city in a medium heat stress zone.

6.2. Climate Analysis Weiz

6.2.1. Heat Days

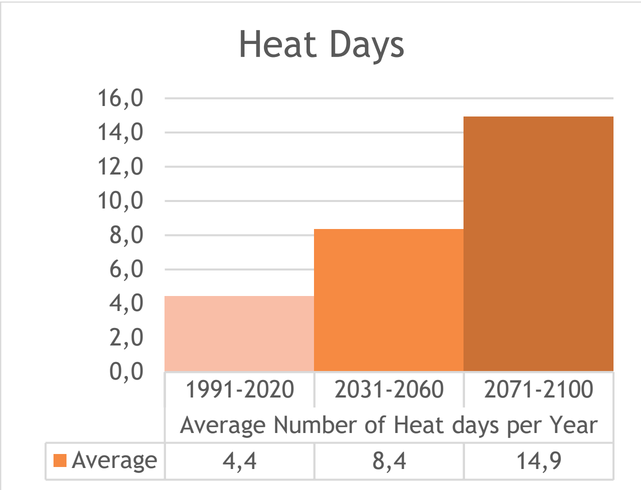

Figure 23: Number of Heat Days on average per year

In the present period of 1991-2020 Weiz has the lowest number of heat days of all pilot cities analysed. However, data shows a steep and accelerating increase of heat days through the century. This is a new problem created by climate change for the town to which infrastructure and health services must be adapted. From the first to the second period, models are projecting almost a doubling of heat days, an increase of 4 days to an average of 8,4 heat days per year. This represents almost a 90 % increase. From mid to the end of century, the number of heat days will increase by another 6,5 days, to almost 15 heat days on average per year, another 77 % rise.

6.2.2. Consecutive Heat Days

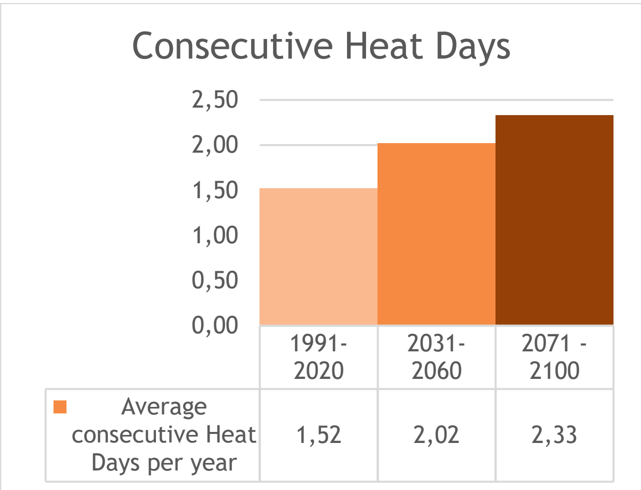

Figure 24: Consecutive number of heat days per year

The number of consecutive heat days is a good indicator for heat wave development. Here we can see a high relative increase from the first to the second period by a 33 % to 2,02 consecutive heat days on average per year. From the middle of the century until the end, the increase slows down to a 15 % increase to 2,33 consecutive heat days on average per year. The steep increase in heat days and more consecutive heat days will make heat waves more frequent and longer already by mid-century.

6.2.3. Summer Days

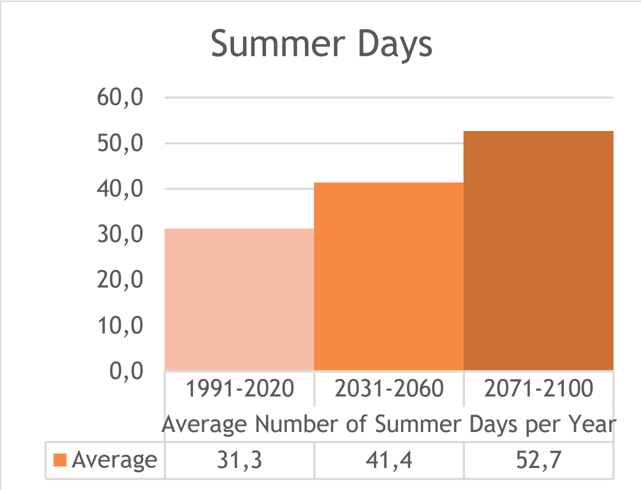

Figure 25: Average number of summer days per year

Models have shown a steady increase of around ~10 summer days per period, with a slight acceleration towards the end of the century. This speaks for consistently warmer summers and a reduced length of spring and autumn.

6.2.4. Consecutive Summer Days

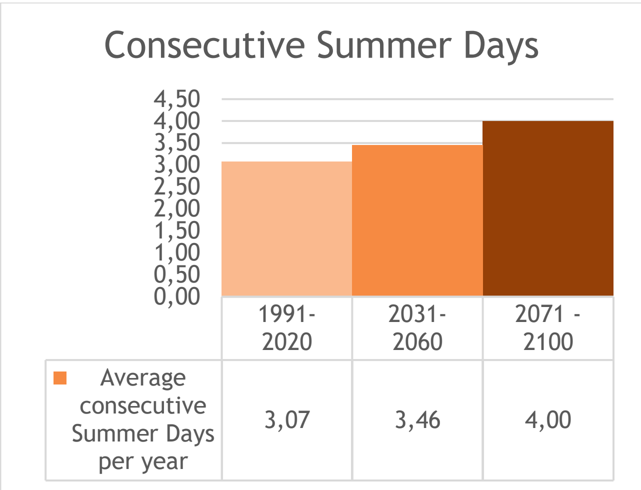

Figure 26: Average number of consecutive summer days per year

The number of consecutive summer days show a relative increase in the first half on the century by 0,39 days to almost three and a half summer days back-to-back on average. From the second to the third period we can detect a slight acceleration to around 0,54 more consecutive summer days per year on average.

6.2.5. Tropical Nights

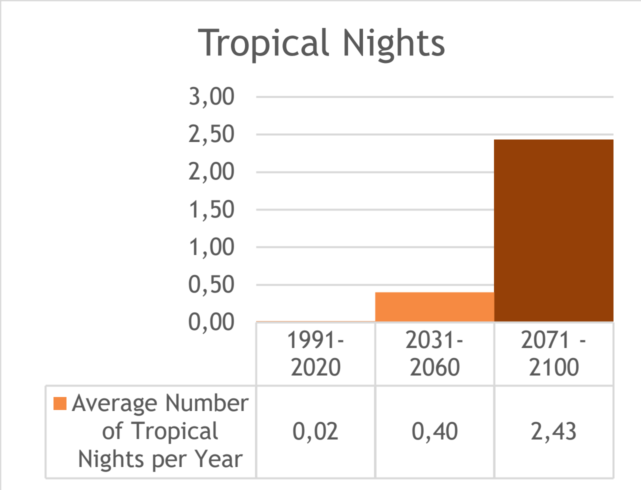

Figure 27: Number of tropical nights per year on average

Weiz seems to have a very fortunate position when it comes to tropical nights. There were not almost any in the present decade of 1991-2020. In the second period in the middle of the century, these number increase by a lot in the relative sense, but still only one every 2-3 years. With speaks for the changing climate but is comparably low. Towards the end of the century, this all changes quite drastically with a sharp increase to 2,4 tropical nights each year on average.

6.2.6. Consecutive Tropical Nights

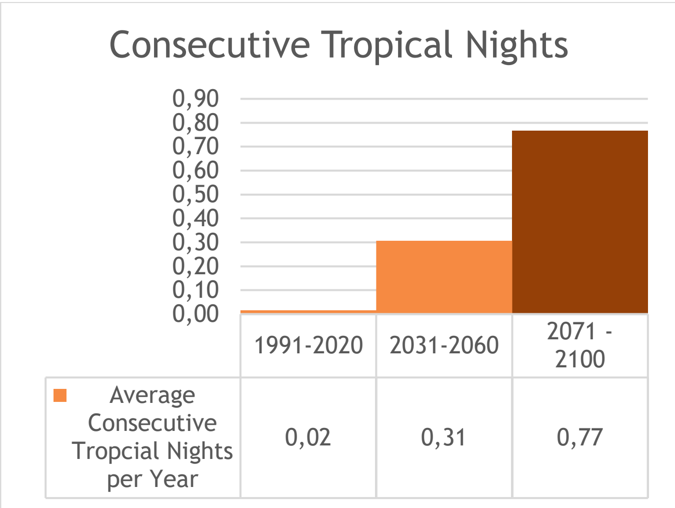

Figure 28: Number of consecutive tropical nights per year on average

With a low amount of absolute tropical nights, there comes a low number of consecutive tropical nights. However, once we reach the middle of the century we can see that we have a relative high number of consecutive tropical nights compared to the absolute number of them. This can mean that when there is heat in the city, in heat waves events for example, that the cooling capacity comes to its limits and even at night the temperature never goes below 20 °C for a longer period. Similar to the sharp increase of absolute tropical nights, we can see a sharp rise until the end of the century in the third period.

6.2.7. Summary for Weiz

In comparison to the other cities, Weiz has the lowest heat stress. However, the developments, especially the steep increases in heat days during the middle of the century will bring heat exposure to a town, which is not used to it right in that, amount right now. This can pose challenges of its own, to sensitize official institutions and health services, to adapt to the coming changes. The relative high number of consecutive heat days leads to the assumption, that if there is heat in Weiz, it will be in the form of multiple heat days back-to-back. This can be a situation especially straining for the health of the towns inhabitants. For tropical nights, the situation is quite peculiar, for the longest time they will be a rather rare event. Winds coming down the mountains could relieve the town in certain way that they will not develop as much as in Maribor. Towards the end of the century climate change has progressed far enough, that there will be a significant increase in tropical nights, which will then happen simultaneously with the ever more heat days.