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Mag. Christian Pollhammer

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Introduction

The **summer of 2019** in Austria was the second warmest since records began with a deviation of + 2.7 °C above the average (relative to the period 1961-1990)[1] - the **year 2022** with a temperature deviation of + 2.3 °C was the second warmest since measurements began[2] .

Heat waves naturally occur at regular intervals in our latitudes, but their frequency and intensity are increasing with climate change. A high risk potential arises when persistent daytime and nighttime temperatures are reached, which pose a massive burden on the health of vulnerable people and risk groups. The definition of heat stress and the classification of threshold values for

Load classes vary from country to country, depending on the climatic
Basic requirements and evolutionary adaptations of the local people are given.

The heat waves in Europe in recent years (2003 is an example) have clearly shown the effects that strong or extreme heat stress can have on parts of the population, such as children, the sick and the elderly. The combination of factors such as an ageing society, increasing urbanization and the general state of health of the population will in future increase the risk potential of heat waves as a multifactorial burden. Worldwide, up to 95% of deaths from natural disasters can be attributed to heat waves.

The WHO[3] recommends the development of strategies, plans and packages of measures for the optimal adaptation of the population and public health services to climate change. With this in mind, the **Styrian Heat Protection Plan** (HSPL) was presented in 2011 and at the same time a heat warning system was installed in cooperation with GeoSphere Austria.[4]

[1] Geosphere Austria, Klima News vom 27.08.2019, https://www.zamg.ac.at/

[2] Geosphere Austria, Klima News vom 27.08.2019, https://www.zamg.ac.at/

[3] WHO, Heat-Health-Action Plans, www.euro.who.int

[4] Department 8 - State of Styria, Styrian Heat Protection Plan, www.verwaltung.steiermark.at

General part & framework conditions

The general part covers key topics on the current state of science regarding the development of climate change and its consequences for health.

1. Climate change scenarios

The fifth assessment report5 of the Intergovernmental Panel on Climate Change (IPCC) 2014 assumes a further increase in average temperatures depending on the concentration pathway (RCP – Representative Concentration Pathways). These four concentration pathways RCP 8.5, RCP 6.0, RCP 4.5 and RCP 2.6 describe the possible future state of the climate up to the year 2100. The most important influencing factors such as greenhouse gas emissions (CO_2 emissions), radiative forcing and other Factors such as population growth, energy consumption, etc. are caused by humans.

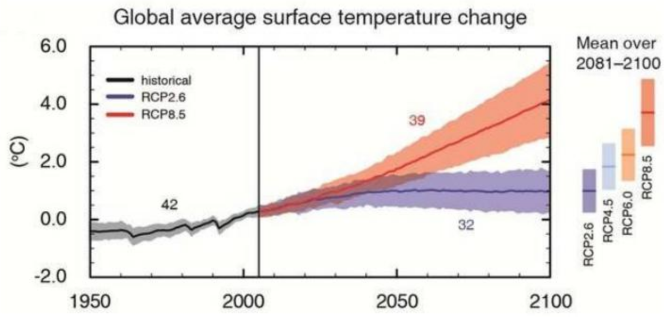


Fig. 1: RCP scenarios and Temperature changes, IPCC 2013

The RCP 8.5 scenario, for example, assumes an increase in the world population to 12 billion people and a corresponding increase in the consumption of fossil fuels and CO_2 emissions. In this worst-case scenario, hardly any environmental protection measures are implemented and economic growth is based on fossil fuels as before. The optimistic RCP 2.6 scenario is based on the assumption that the world population will be limited to 9 billion people and that an environmentally friendly energy mix will be implemented. This emissions path would require a reduction in greenhouse gas (GHG) emissions to almost zero.

The increase in the global average temperature by 2100 will be in the range of 1 to 2°C for the moderate RCP 2.6 scenario, or up to 6°C for the RCP 8.5 scenario. However, these global averages say relatively little about regional temperature values. For example, the temperature over the oceans will hardly rise relative to the continents - but over individual land masses in different regions it will rise all the more.

5 IPCC, Climate Change 2014 – Fifth Assessment Report, www.ipcc.ch

1.1 Development in Austria

The year 2018 was the warmest year on record6 with little rainfall.
In addition to the health impacts on people at risk, there were also significant consequential damages to agriculture and forestry.

Temperaturverlauf im Jahr 2018

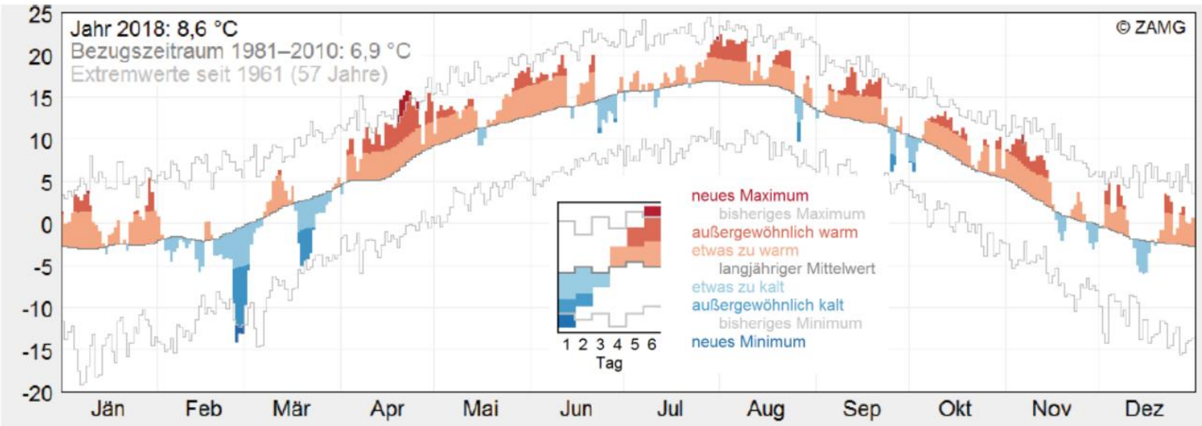


Fig. 2: Daily mean air temperature for Austria 2018 (reference: period 1981 – 2019)7

As can be seen in the figure, there were an exceptionally high number of warm days with new maximum temperatures and particularly long periods of high pressure in 2018. The summer of 2019 was also exceptionally hot and, as mentioned at the beginning, the second warmest since records began.

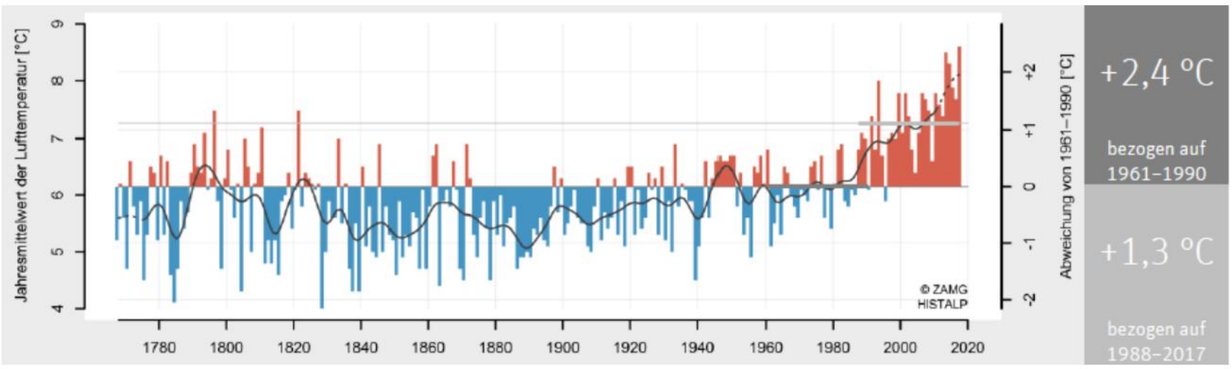


Fig. 3: Development of average temperatures in Austria8 , GeoSphere Austria

[6] Climate and Energy Fund Austria, Climate Status Report Austria 2018, www.klimafonds.gv.at

[7] ibid p. 4

8 Austrian Climate Bulletin 2018, www.zamg.ac.at

If we look at the Southeastern Austria region in isolation, the average temperature in June, July and August even increases to + 3.9 °C above the average for the 2019 summer season – This is the highest average value ever recorded9 .

1.2 Climate change in Styria

A study by the Wegener Center for Climate and Global Change, commissioned by the state Steiermark10 comes to the conclusion that a further increase in temperature is very likely to occur in Styria. **Tropical days** are those with a maximum temperature of at least 30°C.

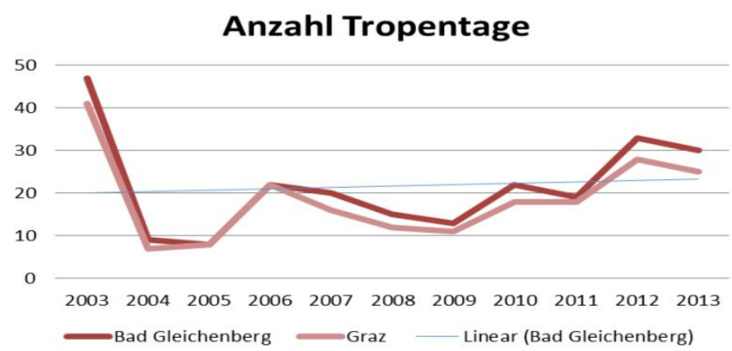
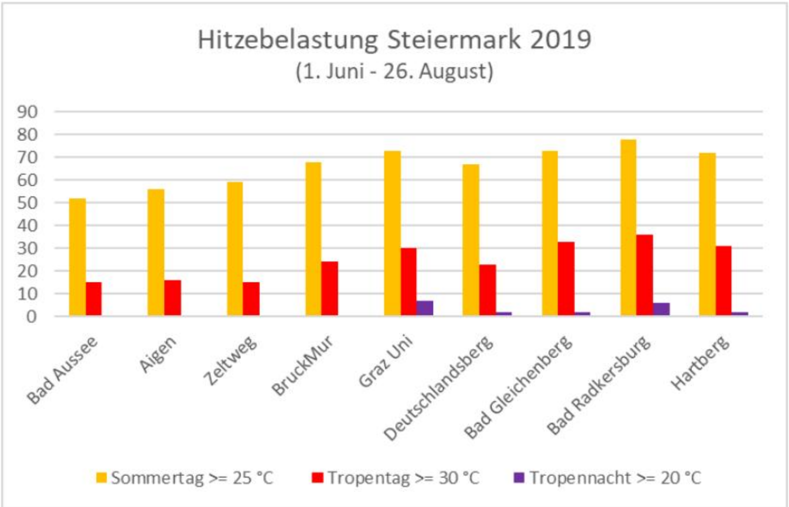


Fig. 4: Number of tropical days in Graz and Bad Gleichenberg11

Over the last ten years, the Number of days with tropical temperatures also increased. This trend continued in 2019 continued.

Abb. 5: Heat stress in the Styria - Season 2019, selected Stations, GeoSphere Austria12



[9] ZAMG Austria, HISTALP Summer Report 2019, https://www.zamg.ac.at/cms/de/dokumente/klima/dok_news/dok_histalp/sommerbericht-2019/sommerbericht

[10] A15 State of Styria, Climate scenarios for Styria until 2050, www.umwelt.steiermark.at

[11] A7 State statistics, climate data, www.statistik.steiermark.at

[12] ZAMG Styria, Heat stress in Styria – selected stations, unpublished data

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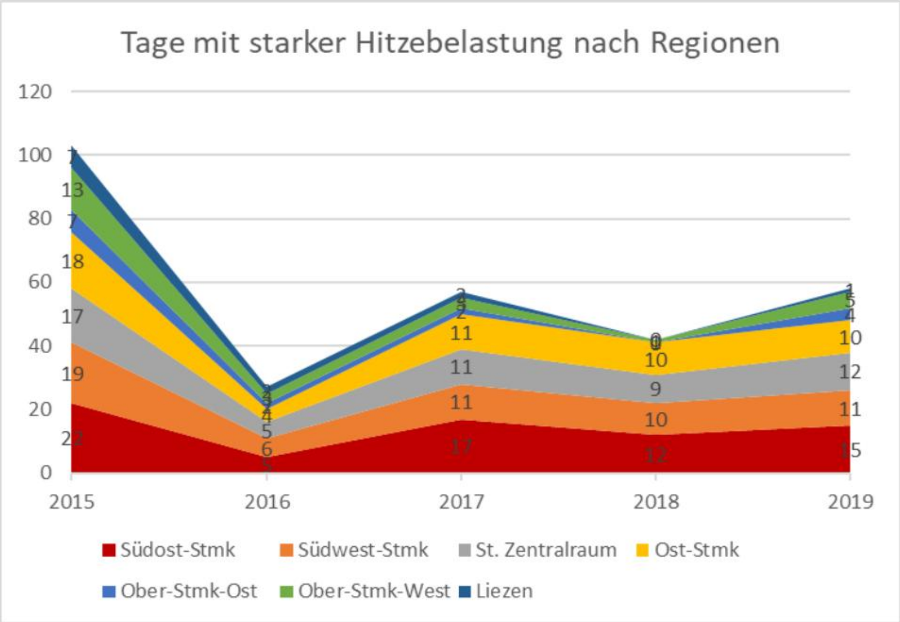
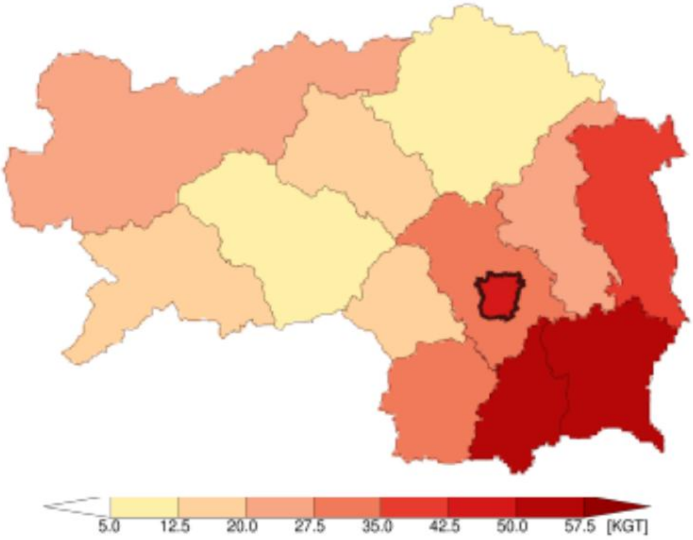


Another measure of the increase in temperatures is the number of **cooling degree days** (CDs) with cooling requirements for days with an average temperature higher than 18.3°C. The model used to create the graph is based on the greenhouse gas emissions scenario A1B (moderate increase in GHG emissions by 60% compared to the year 2000) - which was used before the introduction of the RCP scenarios and corresponds roughly to today's RCP613. The potential for change up to the year 2050 is related to the comparison period 1971 - 2000.

Fig. 5: Cooling degree days in Styria
Annual average of expected
Climate change in the individual
Districts(Unit: KGT/year)



As can be seen, the city of Graz and the southeastern districts of Leibnitz, Südoststeiermark and Hartberg-Fürstenfeld are particularly affected. The following scenarios14 are likely:

- Increase in cooling degree days in **Graz** by 98.4 per year (fluctuation range over the entire Year: 30.8 to 157.5 KGT)
- In the district **of Leibnitz,** an increase of 106.8 KGT is likely (fluctuation range over the whole year: 34.9 to 170.5 KGT)
- For the district **of Southeast Styria ,** an increase of 107.4 KGT (fluctuation range over the whole year: 34.9 to 171.1 KGT)
- The increase in Graz and these districts is thus far above the National average of 58.4

In general, it is clear that temperatures and thus the need for cooling in the city of Graz and southeast Styria will increase significantly more than in the rest of Styria. This creates a particular need for action for the city of Graz, with its topographically unfavourable basin location and increasing population.

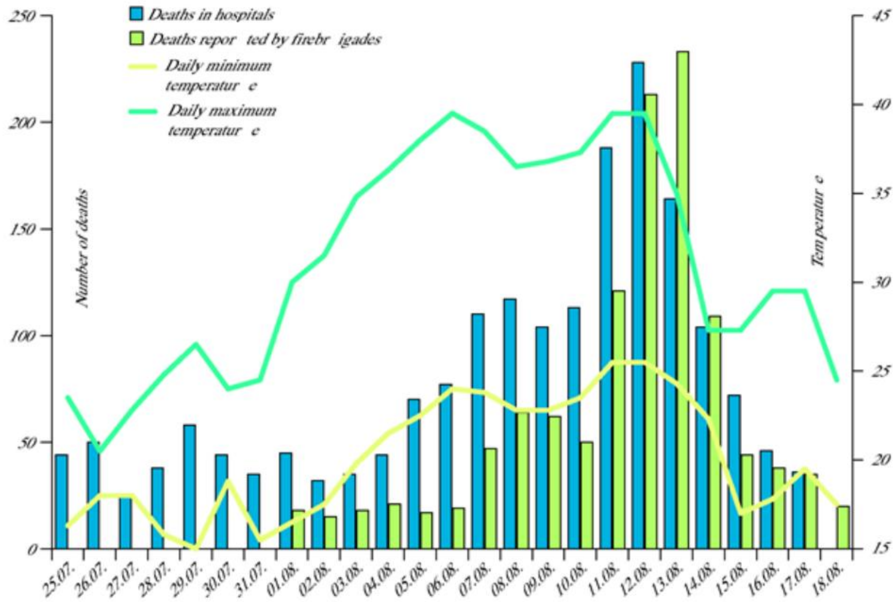
[13] German Weather Service, RCP scenarios, www.dwd.de

[14] A15 State of Styria, Climate scenarios for Styria until 2050, www.umwelt.steiermark.at

2. Thermal stress & mortality

According to the results of the EU Canicule project 2007, the number of heat-related deaths in Europe in the summer of 2003 was around 70,000[15]. In Frankfurt, for example, the daily death rate rose from 14 people per day in June/July to 27.6 people per day in the first half of August. The highest number of deaths was reached on August 13, 2003, with 51 deaths - ten days after the start of the heat wave with average daily temperatures of 30°C.

Fig. 6: Correlation between high Temperatures and Deaths[16]



As can be seen in the figure, there is a clear relationship between mortality and Temperature.

The increase in mortality is particularly dependent on age. The mortality rate increases more sharply among those over 60. Compared with mortality in June/July 2003, mortality in the first half of August increased by 66% among 60-70 year olds, by 100% among 70-80 year olds, and by as much as 146 % among those over 90[17] .

In addition to the measured temperature, influencing factors such as wind velocity, vapor pressure, etc. when calculating the physiological equivalent temperature **(PET)** for a Average person taken into account.

Tab. 1: Allocation of PET areas[18]

PET	Empfinden	Thermophysiologische Belastungsstufe
18°C	behaglich	keine thermische Belastung
23°C	leicht warm	schwache Wärmebelastung
29°C	warm	mäßige Wärmebelastung
35°C	heiß	starke Wärmebelastung
41°C	sehr heiß	extreme Wärmebelastung

[15] Robine JM. et al., Report on excess mortality in Europe during summer 2003, ec.europa.eu

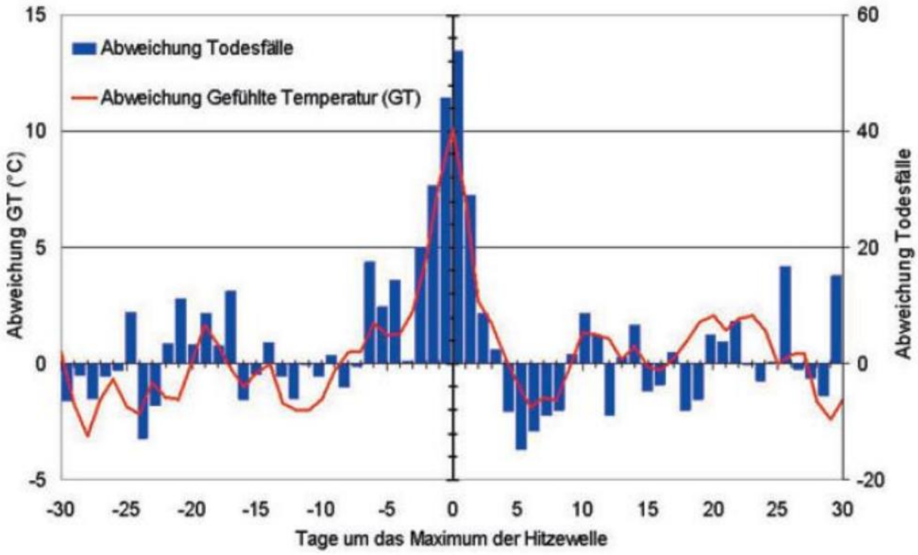
[16] EEA-Report, Impacts of Europe´s changing climate, S. 73, www.eea.europa.eu

[17] Heudorf U. et. al., Health effects of extreme heat in Germany, www.thieme-connect.com

18 Austrian Medical Journal, Climate influences mortality, ÖAZ 10, www.aerztezeitung.at

The perceived temperature **(PET)** is the basis for the classification of the thermophysiological stress levels, which can reflect the actual stress on the human organism, as clearly shown in the following graphic.

Fig. 7: Relationship between perceived temperature and deaths19



Among other factors, the increase in mortality rates during heat waves is due in particular to **night temperatures** outside the comfort range20 during

responsible for so-called **tropical nights .**

The **temperature comfort zone** (temperature zone with the lowest mortality rate) varies regionally. For example, in Oslo it is around 10°C, in Athens it is 23 – 26°C and in Austria it is around 20°C PET21

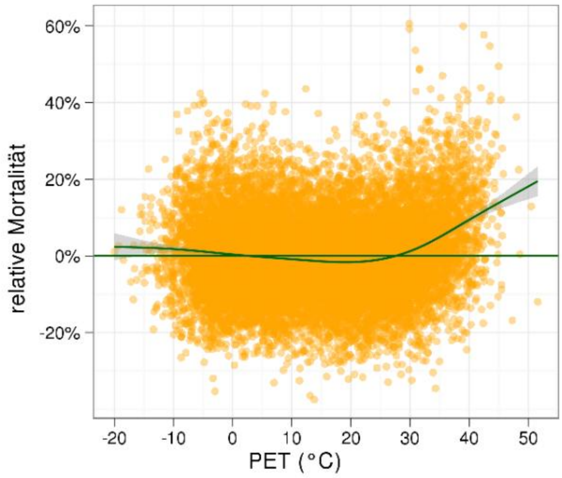


Fig. 8: Comfort temperature range **Styria22**

The comfort temperature range is also an indicator of the regionally varying ability of the population to adapt to heat stress. Extreme heatwave events in northern latitudes can therefore pose a much greater risk to the population.

[19] Koppe Ch. et al., Impact of the 2003 heat wave on health, DWD Climate Status Report 2003, p. 160

[20] Start-Clim 2005, Climate Change and Health, www.austroclim.at

[21] Robert Koch Institute, Status Report on Climate Change and Health, Berlin 2010, Chapter 4, p. 110 ff

[22] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 137

2.1 Timeline

The effects of thermal stress on the health of vulnerable individuals and groups become apparent with a certain time delay. This time delay is quite long in the case of cold stress, but **very short** in the case of **heat stress .** In general, the strongest associations between high temperatures and overall mortality were observed within the first few days23 .

As part of an interdisciplinary study24 for Austria (study period 1970 – 2007), bioclimatic data were related to mortality rates. The individual federal states were examined separately, with the focus on Vienna. The results generally show an immediate increase in the relative mortality rate from the first day. In general, the peak of the mortality rate in “normal” heatwaves occurs within the first few days and tends to return to normal mortality levels after about one week to ten days – of course depending on the intensity, duration and characteristics of the heatwave and

other environmental factors.

Individual hot days have less impact than continuous periods of heat. The course of the relative mortality rate as the heat wave progresses depends fundamentally on the **PET stress class** (severe heat stress, extreme heat stress...).

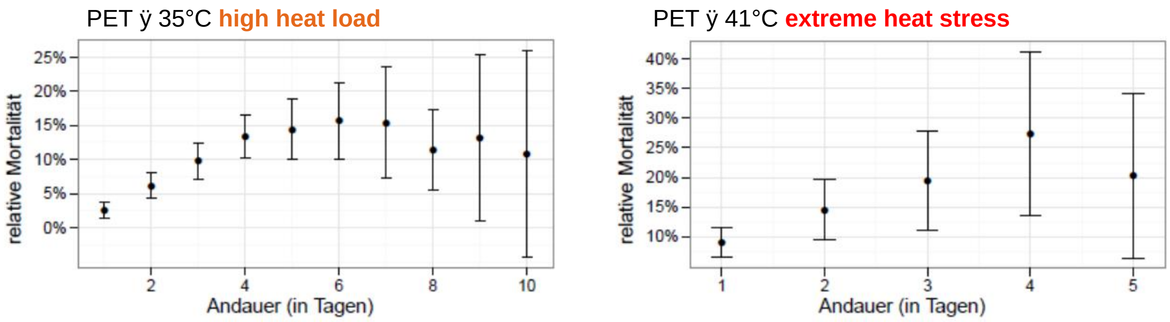


Fig. 9: Mortality rate trend for heat waves according to **PET classes**

(several days of consecutive intense heat episodes in Vienna)

Mortality in Vienna increased by 2.6% right from the start during intense heat waves with consecutive days of high heat stress (PET of over 35°C) and reached its peak of around 15.6% in the following days. In heat waves with extreme heat stress (PET >41°C), the mortality rate increases with increasing duration from 8.9% to up to 27.4 percent around the fourth day.

[23] Robert Koch Institute, Status Report on Climate Change and Health, Berlin 2010, Chapter 4, p. 114ff

[24] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 67

The burden on the population will vary depending on local factors and topographical conditions, but the course of the mortality rate curves is typically characterized by a sharp increase at the beginning of the heat wave. In Styria, too, the mortality rate shows a similar picture based on the study period (1970 - 2007).

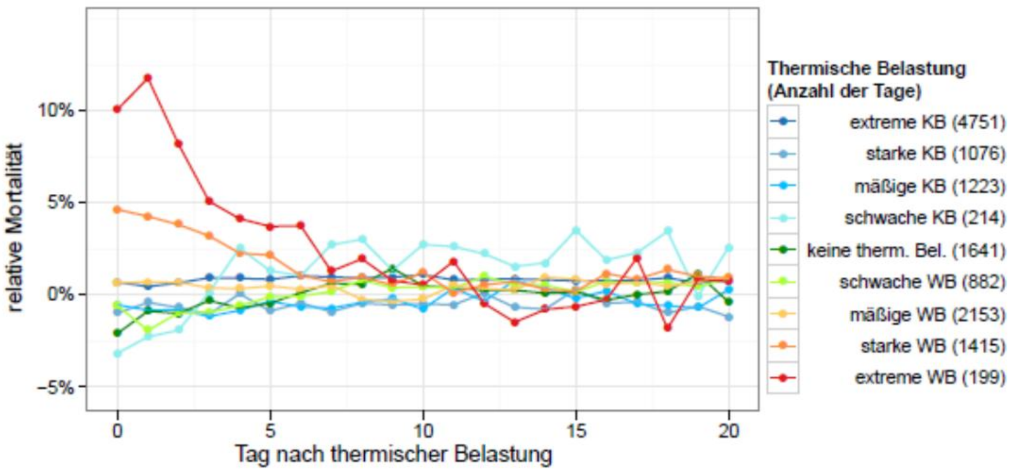


Fig. 10: General temporal course of the relative morality rates for Styria (number of days per stress class between 1970 and 2007 in brackets)25 .

After an immediate increase in mortality, the mortality rate decreases as the heat wave continues due to adaptive responses. This short-term acclimatization develops within a few days but is completely reversed after about a month.

With regard to the timing of the heat wave's occurrence during the year, there is evidence that the previous meteorological situation influences the organism's ability to acclimatize - whereby heat waves occurring early in the year can result in relatively higher mortality rates. On the one hand, the challenge of adaptation is greater, and on the other hand, fewer people die in later heat waves than in the first early heat waves, since some of the people susceptible to heat stress have already died during the earlier heat wave26 .

The so-called **harvesting effect** – the drop in the mortality rate below the expected average value (under-mortality) – describes the advancement of the time of death in vulnerable risk individuals27. This effect can be seen in the above graph for Styria, where the relative mortality from the 10th day onwards is partly in the negative range.

[25] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 139

[26] Koppe Ch., Health-relevant assessment of thermal stress, University of Freiburg 2005, p. 56ff

[27] ibid p. 119

Overall, a general adaptation reaction of the population has already taken place in recent years. The reaction of the average mortality rates to heat stress has tended to decrease in the various stress classes or has remained relatively constant in the case of extreme heat stress.

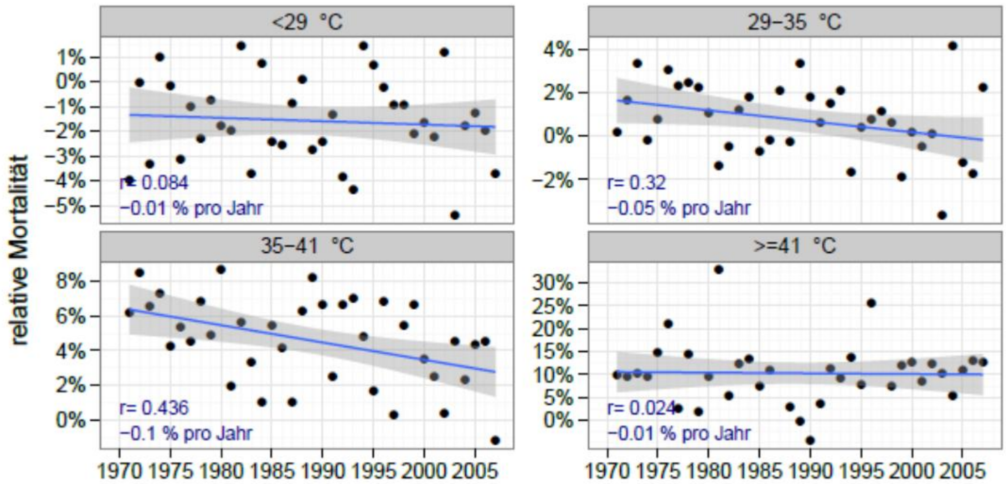


Fig. 11: Sensitivity trends in PET exposure classes – Styria[28]

Accompanying circumstances are essential for the stress scenario during a heat wave - here in particular the air quality and the level of air pollutants such as NO_2, SO_2, PM10, PM2.5 and ozone. Environmental factors such as topography, fresh air supply, demographics, urban densification, etc. can further increase the reactions of people who are already exposed to heat stress.

In heavily polluted air, people with cardiovascular diseases **(HD)** respond quite quickly to heat stress within the first three days, whereas people with Respiratory diseases (without HD problems) show a prolonged reaction time (3 – 12 days)[29] .

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[28] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 139

[29] Grass D. et al., Effects of weather and air pollution on cardiovascular and respiratory mortality, Int. Journal of Climatology S. 1120, onlinelibrary.wiley.com

2.2 Age and gender specific risk

The ageing of society will pose a correspondingly great challenge for society in all areas of private and public life. Regarding the sensitivity of the over 75 age group, the results of a study for Baden-Württemberg show a

clear picture.

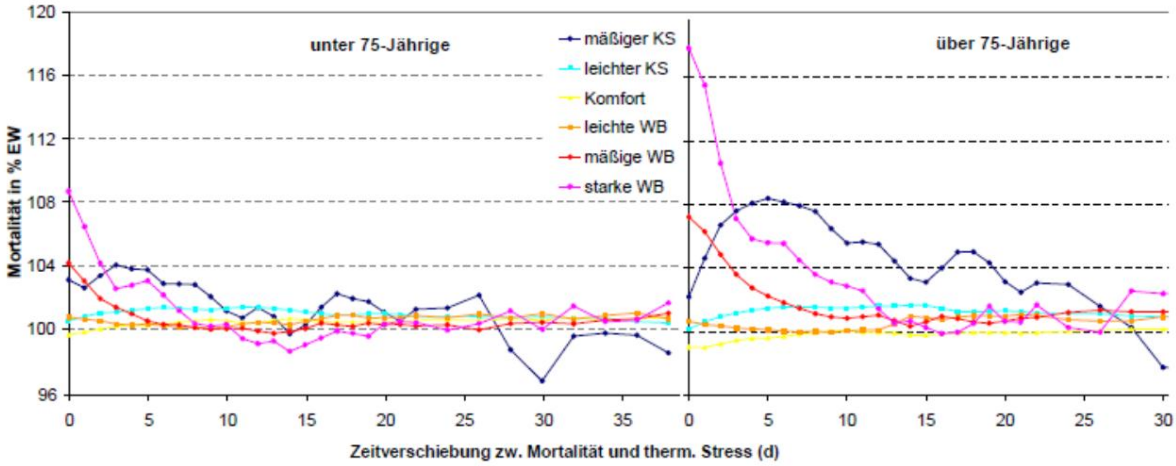


Fig. 12: Relative mortality by age group30

People in the over 75s group react to thermal stress in all stress classes significantly more sensitively than people of younger age - especially during longer periods of heat. In the case of extreme heat stress (WB), the mortality rate initially increases more sharply in people over 75 than in younger people.

In addition to the generally poorer health of older people, an additional reason for the higher mortality rate may be their immobility. During prolonged periods of heat, immobile people are exposed to severe, persistent indoor overheating, particularly on tropical nights, which increases the risk potential.

Problematic housing conditions, inadequate building fabric, lack of cooling facilities and local
Factors such as urban heat islands and air quality are exacerbating the overall situation.

Older people over 75 years of age are particularly sensitive to ozone and PM10 pollution. Mortality during heatwave days with high ozone pollution is 54% higher in this age group than on days with normal or low ozone pollution – the situation is similar for high PM10 pollution, with an increase of 36 to 106 %31 .

[30] Koppe Ch., Health-relevant assessment of thermal stress, University of Freiburg 2005, p. 113ff

[31] Ippoliti D. et al., Effects of heatwaves on mortality, PubMed 2014, ncbi.nlm.nih.gov

In general, women are more sensitive to heat stress than men. The reaction to the continuation of heat waves is also somewhat more pronounced in women32 .

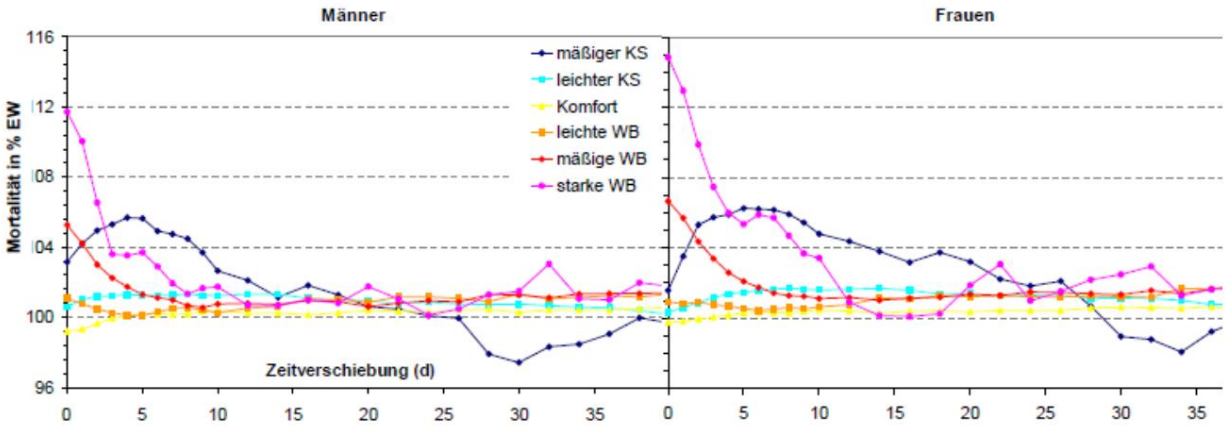


Fig. 13: Relative mortality of men and women during thermal stress

The increased vulnerability of women to heat stress was also confirmed in a time series study for

Austria and Vienna respectively.

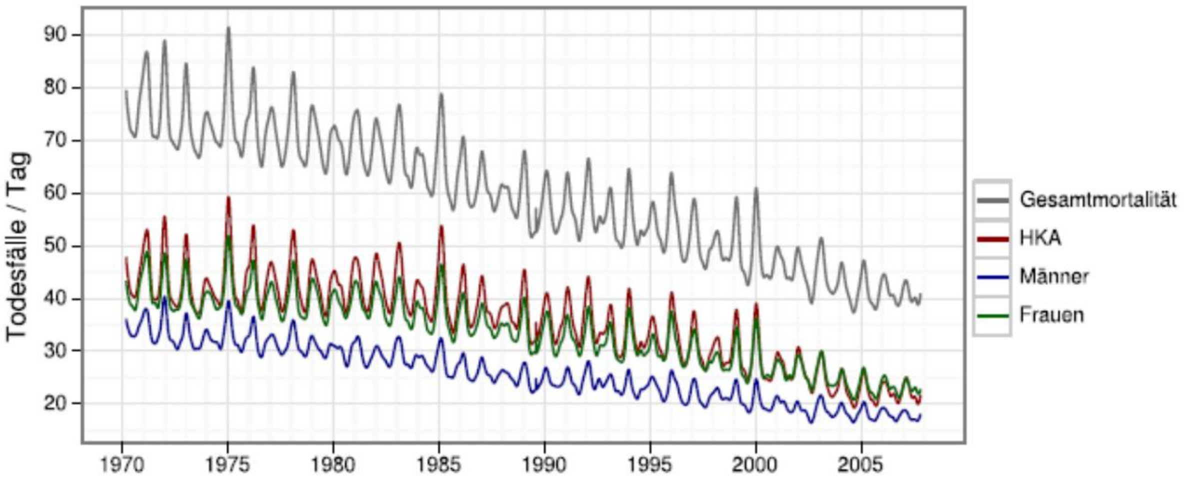


Fig. 14: Smoothed trend of overall mortality in Vienna33
(Cardiovascular and respiratory diseases (CVD), in men and women)

The extent to which medical-biological reasons or cultural, sociological and other factors cause women to be more sensitive has not yet been sufficiently clarified.

32 Koppe Ch., Health-relevant assessment of thermal stress, University of Freiburg 2005, p. 118

33 Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 65

2.3 Geographical differences

People in different climate zones are better or worse adapted to heat stress. Studies of heat waves as part of the EuroHEAT project34 in nine European cities have shown different results, but a connection between the increase in mortality rates and the increase in temperatures is present everywhere.

Mediterranean cities have

overall, mortality rates tend to be higher over time

ity rates, as heat stress is generally

more frequent and intense there.

The results show that the duration of heat waves

and whose intensity (very high

temperatures…) increases mortality.

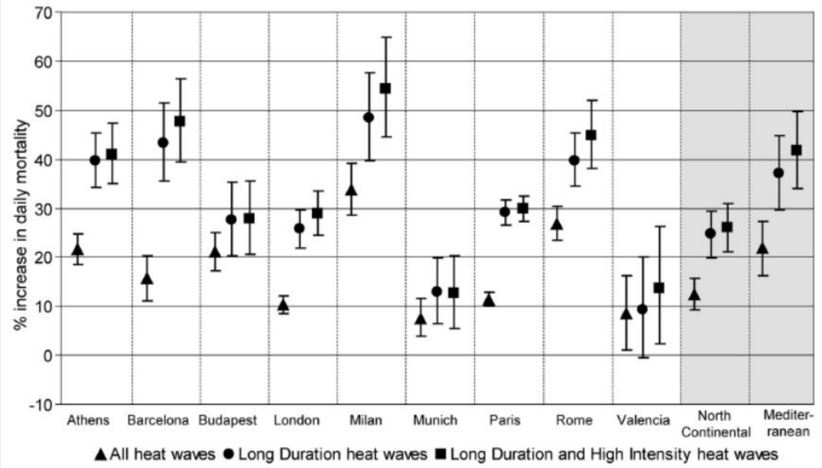


Figure 1 City-specific and pooled estimates of the effect of heat-waves on daily mortality (% increase and 90% CI) by duration and intensity.

Fig. 15: Mortality rates of individual cities from 1990 – 2004 (excluding 2003)

During intense heat waves

As in 2003, however,

People in northern cities – where

heat waves are less common –

due to the lower

adaptability tends to be disadvantaged, which is reflected in a stronger increase in

Mortality in northern

Cities like London or

Paris.

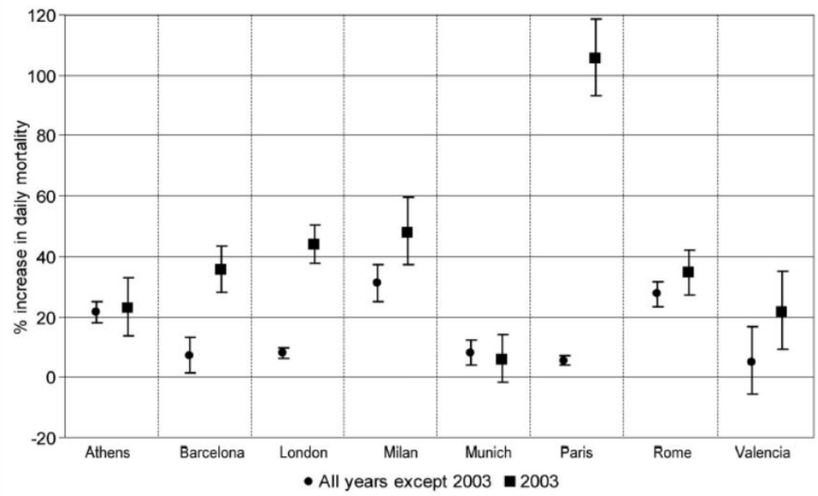


Figure 2 City-specific estimates of the effect of heat-waves on daily mortality (% increase and 90% CI) during summer 2003 and in other years.

Fig. 16: Mortality rates of individual cities including 2003

[34] D´Ippoliti D. et al., The Impact of heatwaves on mortality in 9 European cities, Environmental Health 2010, www.ehjournal.net

In most of the cities studied, heat stress had a greater impact on the number of respiratory-related deaths than on cardiovascular-related deaths35. The different sensitivity of the population to thermal stress is reflected in the trend in mortality rates.

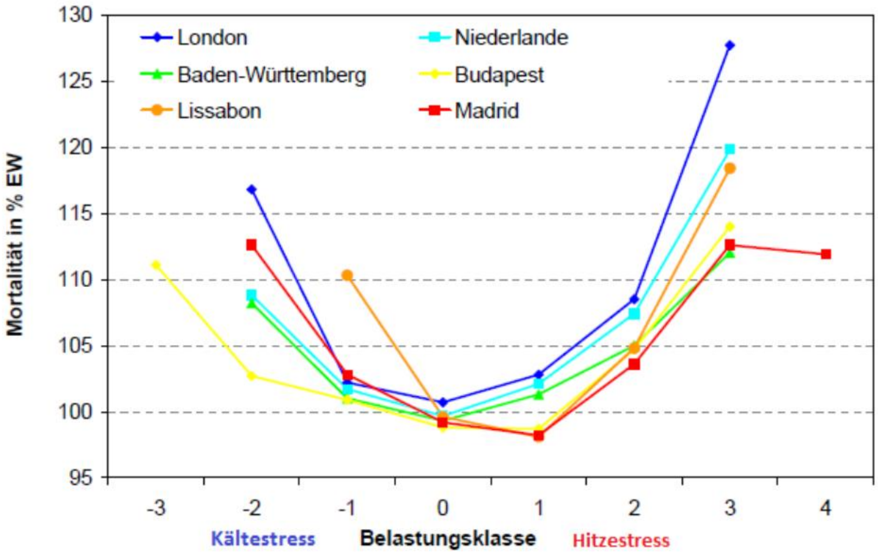


Fig. 17: Mean relative mortality for different stress classes36

The figure above shows the course of the relative mortality rates in the individual cities. The stress classes are shown on the horizontal axis. Class **"0"** represents the comfort zone with the lowest average additional mortality rates. To the left of this are the stress classes for cold stress **(KS)** and to the right of this for heat stress **(HS) .**

-3: severe cold stress

-2: moderate cold stress **-1:** mild cold stress

0: Comfort zone

4: extreme heat stress

3: strong heat stress

2: moderate heat stress

1: slight heat stress

In Austria, the mortality rates of the individual federal states vary due to the influence of the alpine topography and population density. There is a slight east-west gradient in terms of heat stress, but this can mainly be attributed to demographic age structures or the concentration of the age density of those over 65 in the large cities37 .

[35] D´Ippoliti D. et al., The Impact of Heatwaves on Mortality in 9 European Cities, Results from the EuroHeat Project, Environmental Health 2010, www.ehjournal.net

[36] Koppe Ch., Health-relevant assessment of thermal stress, University of Freiburg 2005, p. 121

[37] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 75

In addition to the demographic criteria and other influencing factors mentioned above, the frequency of occurrence of the individual stress classes is decisive for mortality in the population due to thermal stress.

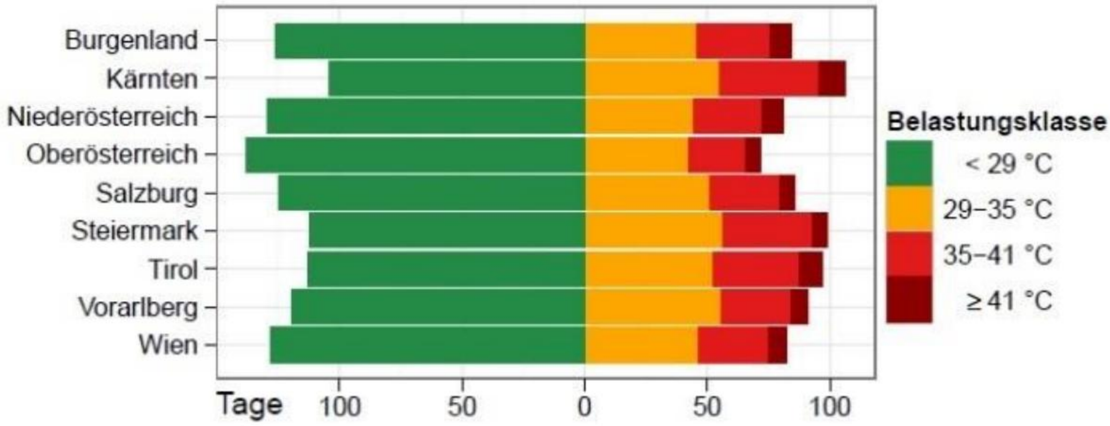


Fig. 18: Average number of days per stress class38

In Styria, the proportion of heat stress classes is currently quite high. This will probably increase accordingly due to climate change.

[38] Muthers S., Bioclimate and Mortality in Austria, University of Freiburg 2010, p. 75

3. Environmental conditions

The human body's heat balance reacts to important environmental parameters such as wind speed, solar radiation, humidity, air quality... Environmental factors are therefore extremely important for people's living conditions during heat waves.

3.1 Urban Agglomeration & Urban Heat

Cities and urban regions are particularly affected by climate change. These are generally characterized by high population density, high surface sealing and air pollution. Urban centers are subject to additional warming during heat waves –

the so-called urban heat island effect.

The formation of heat islands can be attributed to several factors such as climatically unfavourable locations (cauldrons and valleys), urban planning, building density, population density, surface sealing, displacement of evaporatively active areas (parks, green spaces...), additional radiant heat from industry, households and traffic. During heat periods with very strong thermal stress, the degree of **sealing** has a major influence on the mortality risk in older people (over 65 years of age)39, as the higher temperature storage capacity at night means that more heat is radiated and the night temperature is increased.

During these so-called **tropical nights** (temperatures outside the comfort range

area), the body's ability to regenerate is impaired, which has a particularly strong impact on the health

condition.

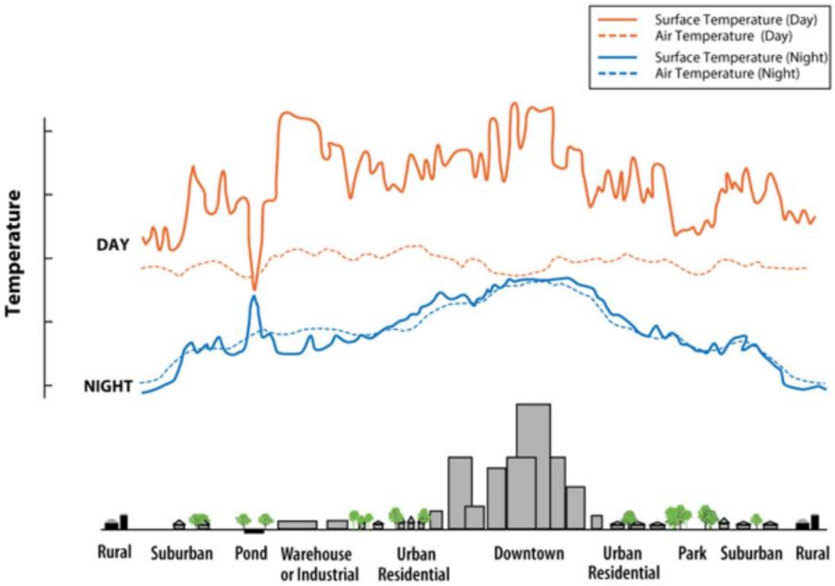


Fig. 19: Day and night temperatures in urban and rural areas40
or with varying degrees
sealed surfaces

[39] Gabriel K., Health risks due to heat stress in urban areas, dissertation, edoc.hu-berlin.de

[40] US Environmental Protection Agency, Urban Heat Island, www.epa.gov

When comparing measuring stations in the city of Vienna and outside it can be seen in the following Graphic clearly shows the city effect.

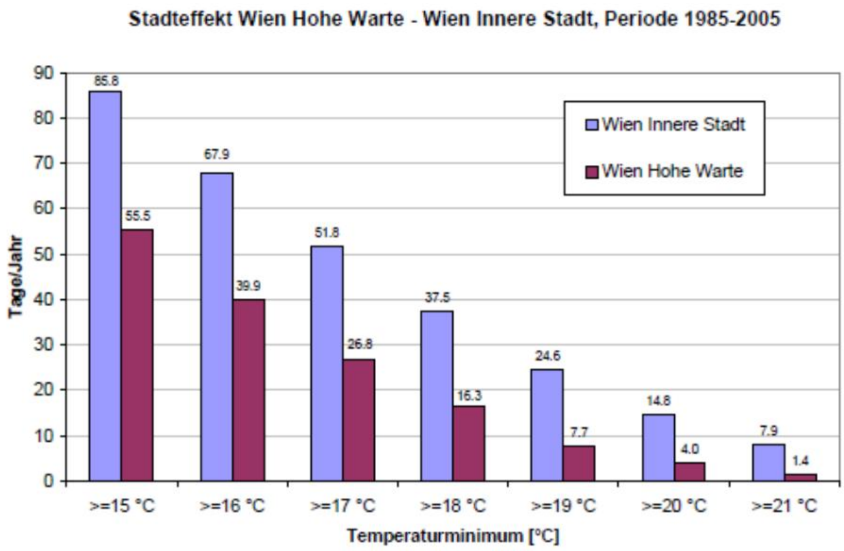
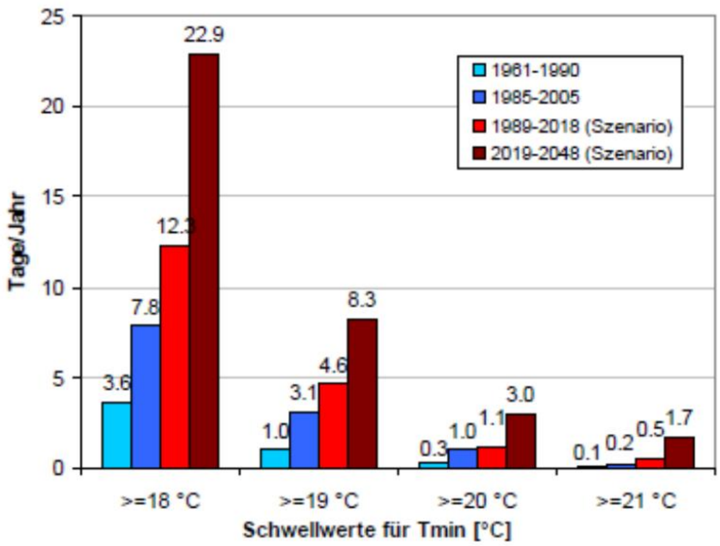


Fig. 20: Frequency (days/year) of **nighttime** minimum temperatures41

Within the city, significantly more nights are measured with temperatures above the respective threshold values. In the nighttime temperature classes above 20°C (ratio of city to country 3.7:1) or above 21°C (5.64:1), which are stressful for the organism, it can be seen that the relative difference between city (urban heat) and country also increases with increasing temperatures.

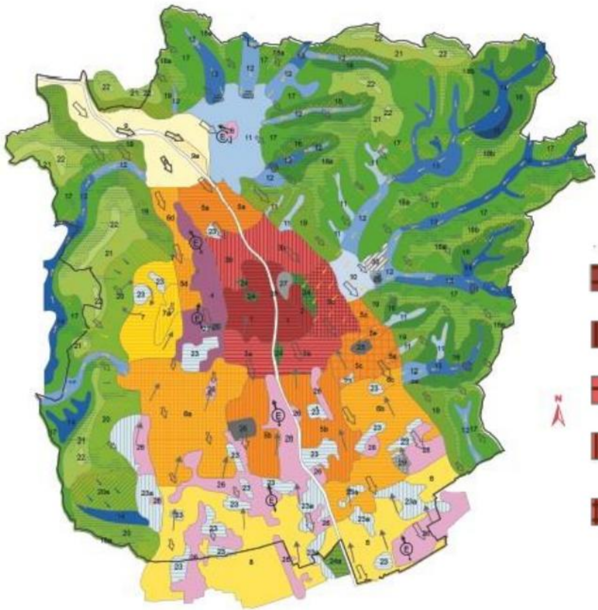
The situation is similar in Graz with the two measuring stations at the university and the airport. A further increase in the frequency of warm nights is forecast for the future.

Fig. 21: Historical development of nighttime minimum temperatures above the respective thresholds the Graz-University station for the Periods 1961-1990 and 1985-2005, as well as the expected development for the periods 1989-2018 and 2019-204842 . Here again, a larger forecast increase is shown in relative frequencies in the high stress classes (ÿ 20°C: 2.7 times as many days and ÿ 21°C: 3.4 times as many).



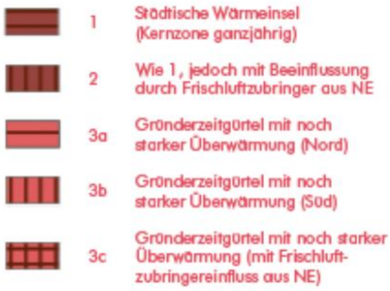
41 Startclim2005, Climate Change and Health, www.austroclim.at

42 ibid p. 28



The graphic shows individual temperature zones and air currents for the city of Graz. The heat island in the center of the city is clearly visible. The surrounding

The surrounding areas in the east and west are partly benefiting from better supplies of fresh air.



The northern and southern founders However, time belts are also prone to severe overheating.

Fig. 22: Climate map Graz43

The interaction of several factors during heat waves can increase the risk potential for those affected and risk groups. For example, elderly people living alone within the heat island, who have no technical cooling options and are also immobile, would be particularly affected. In addition, for people in the lower income brackets, other socioeconomic factors such as poorer general health, housing situation (quality of the building structure), etc. must be taken into account. An analysis of the situation in Vienna has shown that the mortality rate is higher in the inner, densely built-up districts (reduced ventilation) and in the "poorer" districts (building structure) than elsewhere in the city44 .

Although indoor spaces can be effectively cooled with air conditioning systems, this is associated with a significant increase in electricity consumption and increased CO2 emissions. The commissioning of

Air conditioning systems cause **additional warm air to** be released into the already **heated urban atmosphere.** This additional radiation of heat increases the heat island effect.

In terms of climate protection and adaptation to climate change, measures and adaptation processes of a sustainable nature should be preferred - e.g. shading concepts for public and private facilities (schools, kindergartens, office buildings, etc.). In particular, hospitals and care facilities would need to be adapted, as they care for particularly vulnerable people. Climate-relevant aspects should be given greater consideration in urban planning and in the design of urban development measures. Above all, the preservation and/or

Expansion of inner-city green spaces but also the development and implementation of newer concepts such as greening of buildings.

[43] Geoportal City of Graz, Digital Climate Map Graz, www.geoportal.graz.at

[44] StartClim 2008, Adaptation to climate change in Austria, www.austroclim.at

3.2 Air pollutants – summer smog

As stated in the Austrian Assessment Report, there is now sufficient scientific evidence on the adverse health effects of air pollutants such as

Particulate matter, ozone, etc.45 The sensitivity of the population to air pollution is higher in the cold seasons than in the summer due to the obviousness and media coverage. For risk groups, however, polluted air during heat waves is an additional health risk factor. Polluted air is referred to as summer **smog .**

referred to when air near the ground has, among other things, high ozone concentrations due to strong solar radiation.

A study on the 2003 heat wave in the Netherlands concludes that additional

1000 to 1400 deaths, 400 to 600 cases (>30%) are due to increased ozone and particulate matter pollution (summer smog)46 . In France, too, studies of nine cities found an increase in the mortality rate of 0.3 to 1 percent for every 10 ÿg/m³ increase in ozone levels47 . Analyses of the 2010 heat wave in Moscow show a significant connection between air pollutants and temperature.

The mortality rate increased by **0.43%** (per 10 ÿg/m³ PM10 - Increase in particulate matter pollution) at **below 18°C** and by up to **1.44%** when Temperatures of **30°C** can be achieved. [48]

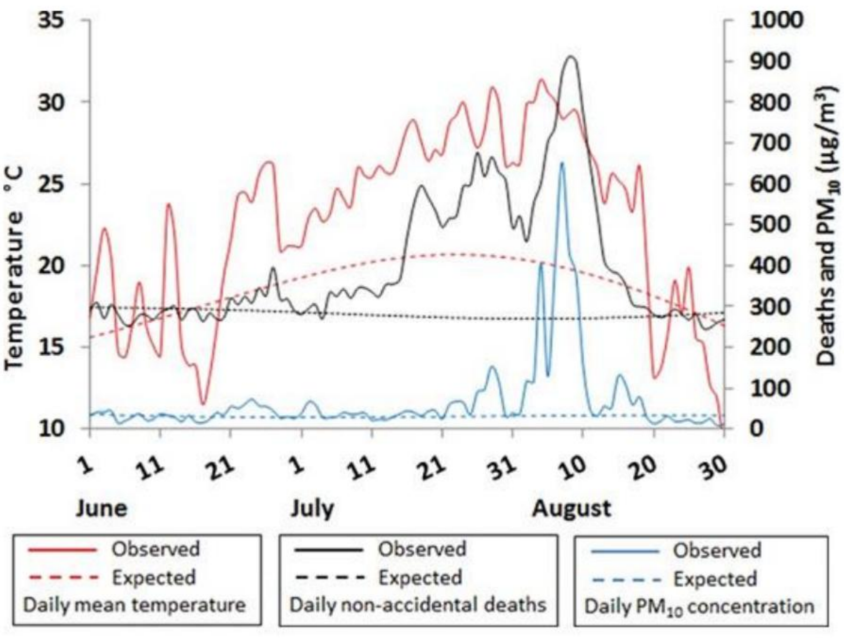


Abb. 23:
mortality rate,
Temperature and PM10 - Level, heatwave Moscow 201049

[45] Austrian Panel on Climate Change, Austrian Assessment Report on Climate Change, www.apcc.ac.at

[46] Fischer P. et al., Air pollution related deaths during the Heatwave 2003 - Netherlands, www.sciencedirect.com

[47] Filleul L. et al., The relation between temperature, ozone, and mortality in nine french cities during the heat wave of 2003, Environ Health Perspectives, www.ncbi.nlm.nih.gov

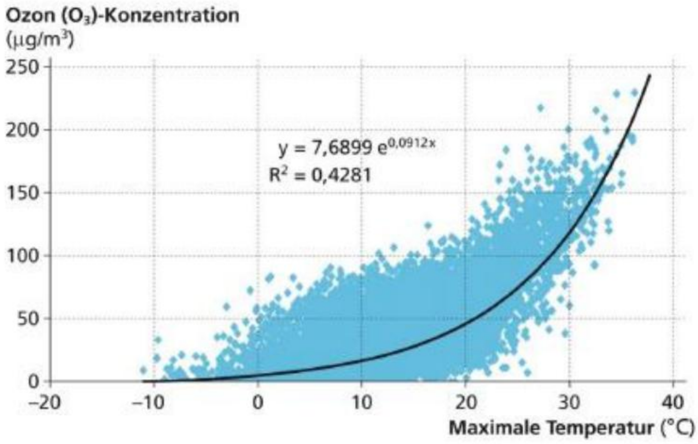
[48] Shaposhnikov D. et al., Mortality related to air pollution – Moscow Heat Wave 2010, www.ncbi.nlm.nih.gov

[49] ibid

3.2.1 Ozone

During hot days, high **levels of ozone pollution** can build up, especially when there is no wind.
In very hot weather, high ozone levels and air pollutants place an additional burden on the organism. Heat and ozone formation often occur together because air pollutants from car and industrial exhaust fumes are converted into ozone under the influence of solar radiation. The increase in ground-level ozone pollution can be significant due to high temperatures and strong solar radiation[50] .

Fig. 24: Relationship between ozone concentration and air temperature[51]



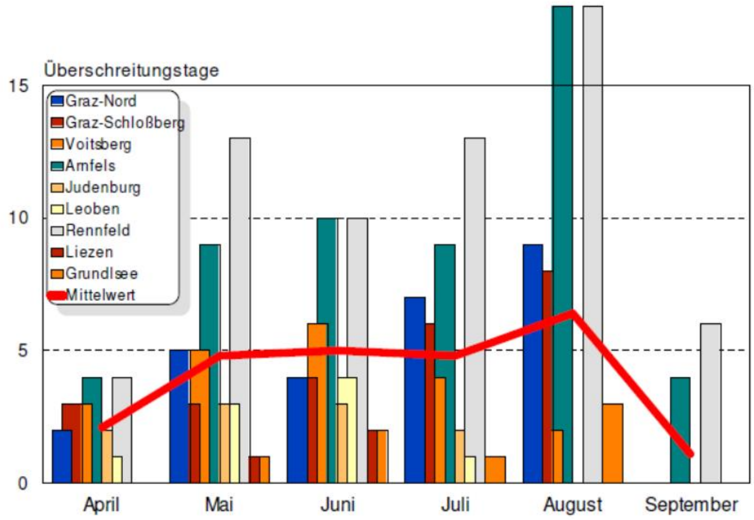
High, continuous ozone levels can cause irritation of the mucous membranes, burning eyes, a scratchy throat, pressure on the chest and pain when breathing, inflammation of the respiratory tract and lungs, temporary restriction of lung function, etc.
In addition, the reaction to other air pollutants and allergy triggers such as pollen and mites
A link between ozone pollution and heart attacks has also been demonstrated.[52]

The **WHO** estimates that **21,000 premature deaths** in Europe are due to long-term ozone exposure above 70 ÿg/m³[53]. In terms of mortality, ozone causes an increase of 0.3% for every 10 ÿg/m³ increase in ozone in the air we breathe[54] . Another study comes up with similar figures (26,000 to 28,000 deaths) for Europe, with the focus here being on southern European countries.[55]

[50] Kuttler W., Climate Change in Urban Areas, Environmental Sciences Europe, www.enveurope.com
[51] ibid p. 9
[52] Ruidavets J. et al., Coronary Heart Disease, American Heart Association, circ.ahajournals.org
[53] WHO, Healtrisks of Ozone from long-range transboundary air pollution, www.euro.who.int
[54] WHO, Ambient Air Quality and Health, www.who.int
[55] Orru H. et al., Impact of climate change on ozone-related mortality in Europe, ERS, erj.ersjournals.com

Fig. 25: Days with exceedance of the ozone target value in 201256

8-hour average of 120 ÿg/m³



The **information threshold** (informing the population about ozone pollution) is set at 180 ÿg/m³ and the **alarm threshold** is set at 240 ÿg/m³ in accordance with the Ozone Act. The long-term **target value** of 120 ÿg/m³ may not be exceeded on more than 25 days per year (averaged over three years)57 . The WHO recommendations for this target value are 100 ÿg/m³.

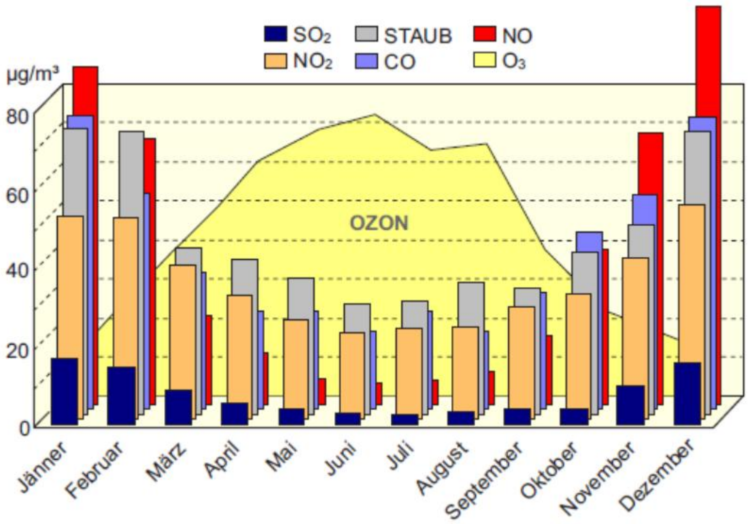


Fig. 26: Annual course of ozone concentration in Graz from 1998 to 200158

Ozone pollution is highest in the afternoon hours.
During the night, the
Values decrease again. If
lasting summer beauty
During periods of bad weather the values tend to be higher59 .

At very high values (1-hour maximums of over 240 ÿg/m³) above the alarm threshold, lung function in the average population is reduced by 15% during strenuous physical activity outdoors. In people with existing respiratory problems, this can be reduced by 30% or more60 .

[56] A15 State of Styria, LUIS Annual Report 2012, www.umwelt.steiermark.at

[57] A15 State of Styria, Ozone Information, www.umwelt.steiermark.at

[58] Environmental Education Center Styria, Our Food Air, www.ubz-stmk.at

[59] Swiss Accident Insurance Fund, summer smog and ozone, www.suva.ch

[60] Federal Commission for Air Hygiene, Summer smog in Switzerland, www.ekl.admin.ch

Air masses containing ozone precursor substances from the industrial areas of the Po Valley in Italy are also problematic for Graz and the Alpine foothills in the event of unfavourable wind directions.

Heatwave analyses also show that older people over 75 years of age are particularly sensitive to ozone pollution. Mortality during heatwave days with **high ozone pollution** is **54% higher** in this age group than on days with normal or low ozone pollution. The situation is similar for high PM10 pollution, with an increase in the mortality rate in individual cities of 36 to 106 %61 .

Especially older people and those with cardiovascular diseases and respiratory

Restrictions should be placed on physical exertion outdoors in the afternoon hours avoid.

www.umweltbundesamt.at

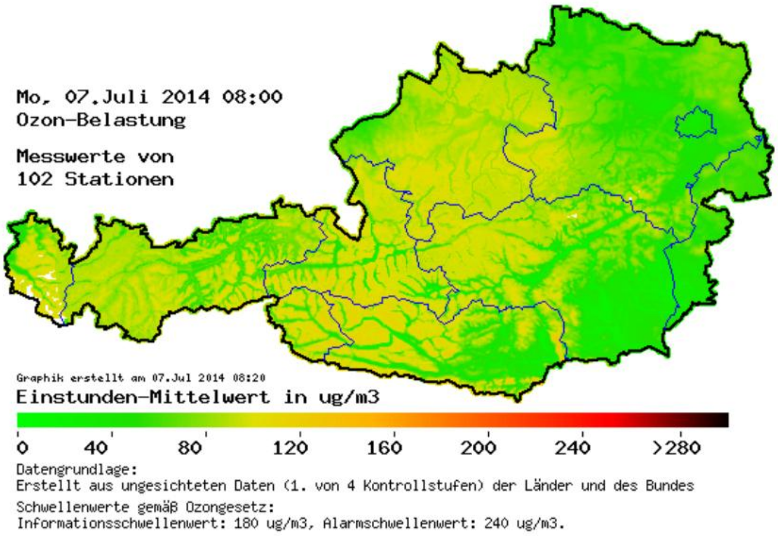


Fig. 27: Ozone pollution in Austria

Exact daily ozone values for Styria can be found at umwelt.steiermark.at.

Children up to the **age of five** should also be exposed to elevated ozone levels and poor air quality as little as possible, as their lungs are not yet fully developed and their airways are therefore less resilient62 .

Since ozone is an unstable chemical compound, it decomposes relatively quickly into normal oxygen. The concentration indoors drops to 10% of the

Initial value63 .

When ventilating common rooms, attention must be paid to the ozone concentration – for this purpose, the early morning hours are best suited.

[61] D'Ippoliti D. et. Al, Effects of heatwaves on mortality, PubMed 2014, ncbi.nlm.nih.gov

[62] Ozone Info Switzerland, www.ozon-info.ch

[63] General Accident Insurance Institute – AUVA, work outdoors, www.aushang.at

3.2.2 Nitrogen oxides NOx

Nitrogen oxides are considered to be particularly harmful to the respiratory system. In long-term high concentrations, this group of pollutants is sometimes considered to be one of the causes of susceptibility to heart attacks.
Epidemiological analyses of data from Graz, Linz and Vienna demonstrate acute effects on mortality from 30 ÿg/m³. For example, in Vienna, with an average additional exposure of 10 ÿg/m³ over two weeks, there were 4.6% more deaths from cardiovascular diseases; the mortality rate from respiratory diseases increased by 6.7 %64 .

Children and older people, or people whose respiratory tracts are sensitive or already affected, are particularly affected. Nitrogen dioxide pollution in Austria exceeds the limit in many places.

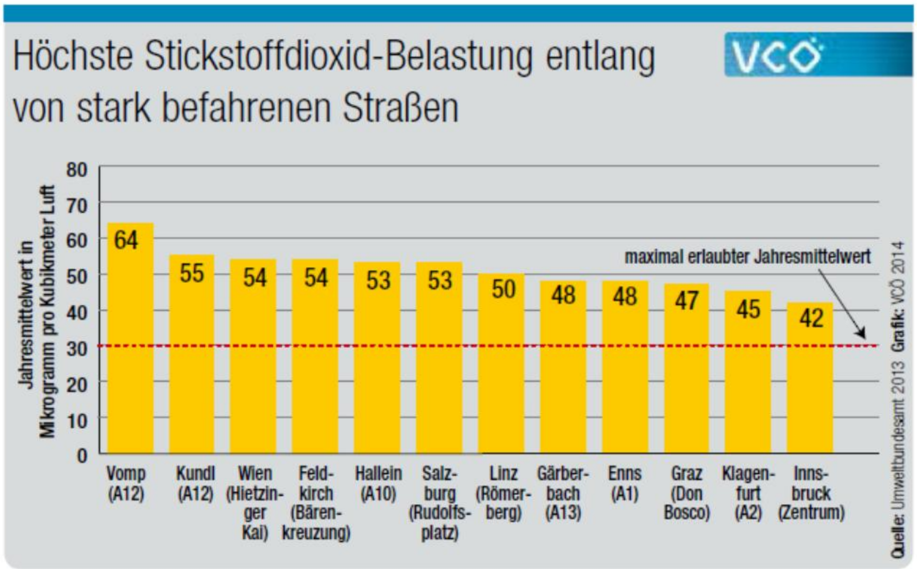


Fig. 28: NO2 pollution at different Measuring stations

Nitrogen oxides are a contributing factor to fine dust and are considered **precursor substances** that are converted into ground-level ozone when exposed to strong sunlight. Industry and traffic are considered to be the main causes of nitrogen oxides. A long-term approach to reducing nitrogen emissions across the board will therefore also lead to a reduction in ground-level ozone.

Nitrogen oxides and ozone interact with each other, so depending on the presence of the pollutants ground-level ozone is converted back into nitrogen dioxide by nitrogen monoxide and Oxygen is broken down, which is why ozone pollution in the city (more NO due to increased traffic in the evening) can be lower than in rural areas65 .

64 VCÖ, fact sheet on nitrogen oxides, www.vcoe.at

65 ibid

3.2.3 Fine dust PM10

Fine **dust PM10** is a group of dusts in the air, of which about 50% of the Particles have a diameter of 10 µm or the rest is distributed among even smaller and, to a lesser extent, larger particles66 . Particles under 10 µm in size can penetrate deep into the lungs, are therefore particularly harmful to health and cannot be seen with the naked eye. Clearly visible dust from construction sites etc. is referred to as coarse dust and can be filtered out by the body via nose hairs and mucous membranes. The WHO estimates that 3.7 million people die prematurely worldwide due to fine dust.

The main causes of fine dust Traffic, domestic heating and industry are seen, with traffic having a high share, especially due to turbulence (diffuse traffic +

secondary) of already existing fine dust. The extent of the turbulence also depends on the speed67 .

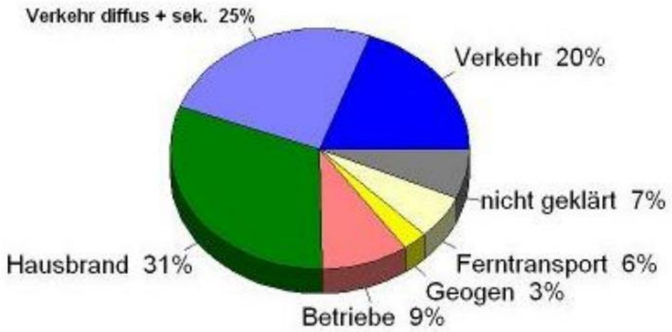
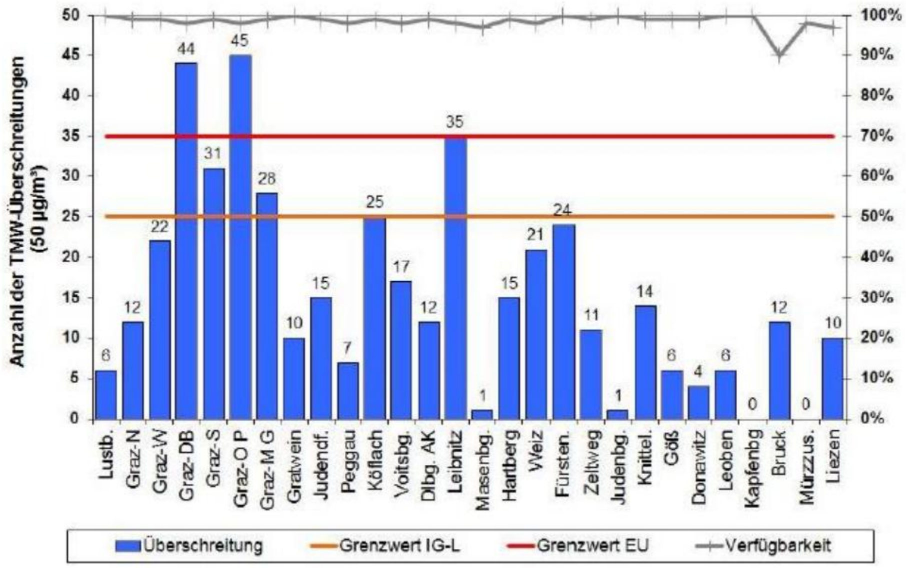


Fig. 29: Causes of fine dust pollution in Graz South68

In Styria, more than half of the municipalities are located in fine dust remediation areas. This particularly affects the greater Graz area, almost all municipalities south of the main Alpine ridge, the Mur-Mürz-Furche and the central Murtal69 . The following graph shows the number of days with exceedances of the limit value (daily mean value – TMW) for PM10.

Fig. 30: Number of days with PM10 limit value exceeded in 2013



At TMW: 50 µg/m³ - permissible according to IG-L are 25 days of excess per Year70

[66] UBA, Feinstaubinformation PM10, www.umweltbundesamt.at

[67] UBZ, Our Food Air, www.ubz-stmk.at

[68] A15, LUIS - That Steiermark, www.umwelt.steiermark.at

[69] A15, fine dust information, www.umwelt.steiermark.at

[70] A15, Annual Air Report 2013, luis.steiermark.at

3.2.4 Fine dust PM2.5

Fine **dust PM2.5** is the dust fraction that contains 50% of the dust in the size 2.5 µm
Particles of this size can penetrate into the alveoli and are not visible to the naked eye. Another problem with particles of this size is their long residence time in the atmosphere and the resulting possible transport distance of up to 1,000 km. Current WHO assessments indicate the connection between fine dust pollution and serious health effects such as cardiovascular disease[71]

. According to current calculations, around 24% of the population in Styria (Graz metropolitan area and non-Alpine areas) are affected by a reduced life expectancy of around one year.

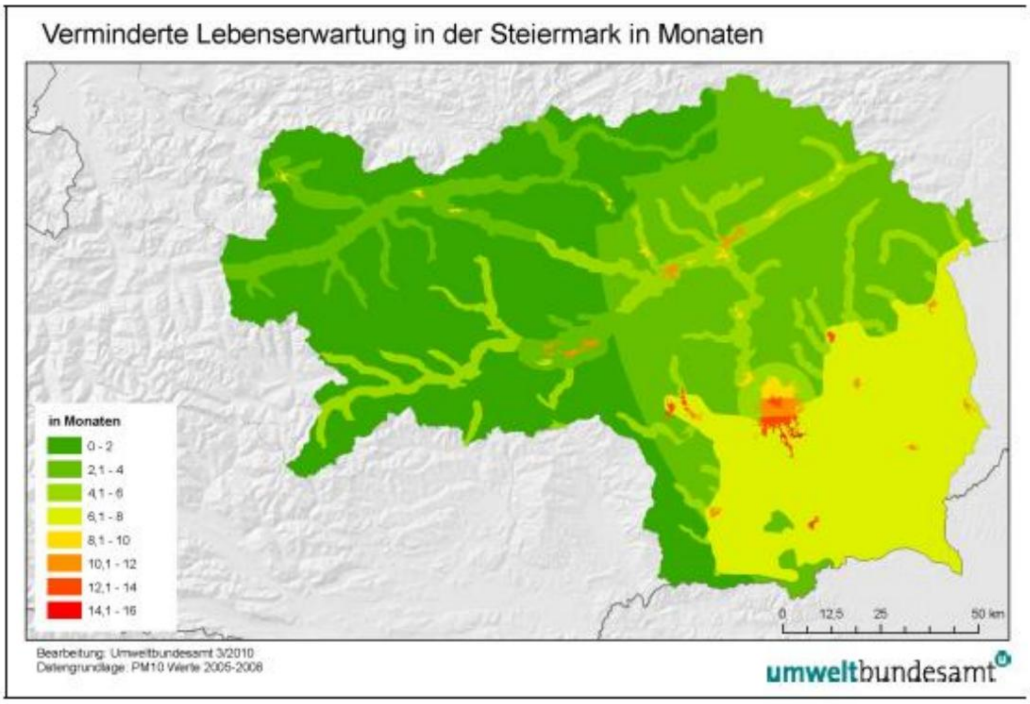


Fig. 31: Reduced life expectancy in months due to particulate matter pollution PM2.5 on average from 2005 to 2008[72]

Despite the improvement in the situation in Styria and Graz, the problem of fine dust is still present. In the summer months, during heat-stress days, air quality has an impact on health in addition to heat stress.

[71] UBA, Feinstaubinformation PM2.5, www.umweltbundesamt.at

[72] UBA, Health effects of PM2.5 exposure in Styria, www.umweltbundesamt.at

Since there are too few PM2.5 measuring points in Styria , the PM2.5 pollution is not measured across the board. The PM2.5 pollution is therefore derived or calculated from the PM10 data. According to IG-L, an annual average of **25 µg/m³** must be maintained from January 1, 2015 .

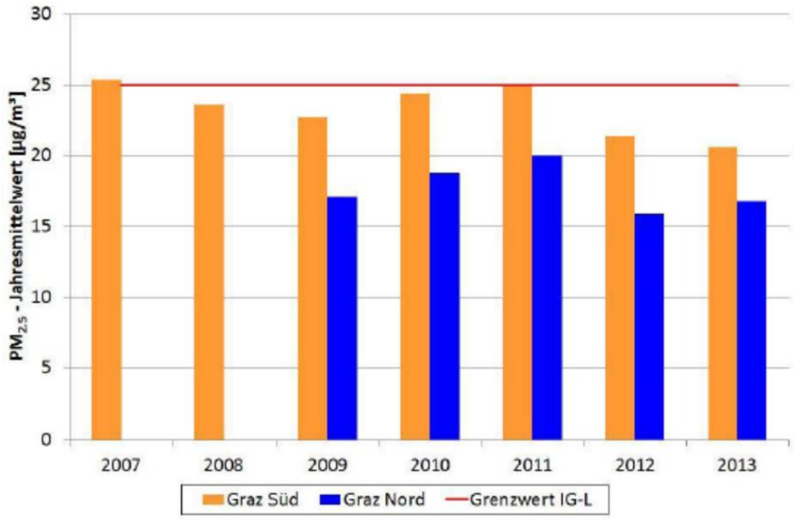
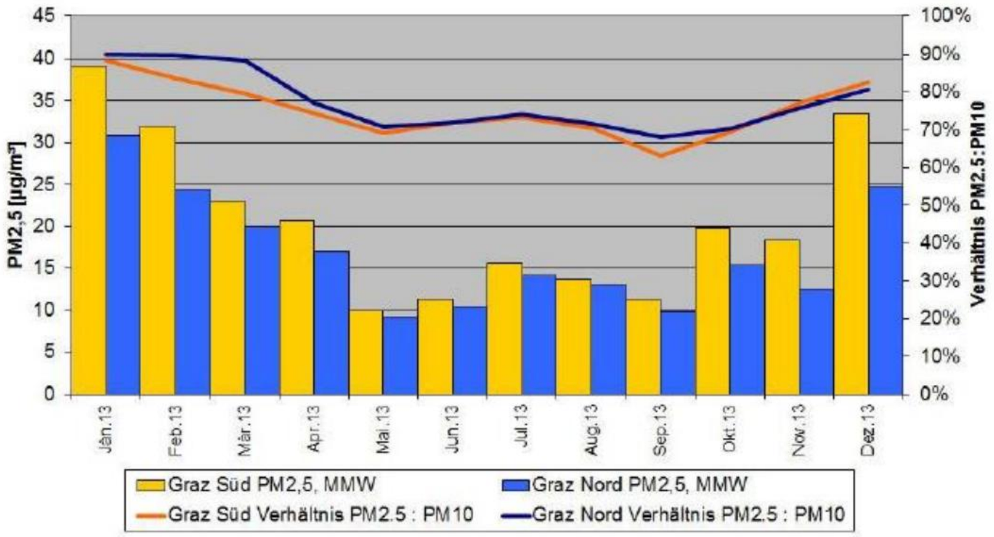


Fig. 32: PM2.5 annual averages 2007 - 2013[73]

As the year progresses, particulate matter levels are naturally higher in winter than in other seasons.

Fig. 33: PM2.5 Annual cycle Graz[74]



Although the legal limit is complied with, the WHO recommendations are relevant from a health perspective. The WHO guidelines are therefore crucial for assessing the risk potential of vulnerable individuals and groups in heat stress situations.

[73] A15, Annual Air Report 2013, luis.steiermark.at

[74] ibid

3.2.5 Limit values – criticism

The EU emission limit values for fine dust are 40 µg/m³ (WHO recommendation 20 µg/m³) for PM10 and 25 µg/m³ for PM2.5 (WHO recommendation 10 µg/m³) in the annual average[75] . Especially for fine dust, setting the limit values by **measuring the weight** of the fine dust fraction is problematic. The limit values for the respective proportions of the respirable fine dust PM2.5 or the ultrafine dust PM1 (size < 0.1 µm) – which can also enter the bloodstream or cross the blood-brain barrier – are not very meaningful on closer inspection due to the low weight of these dusts. A more suitable method would be to measure the **number of particles per unit volume[76] .**

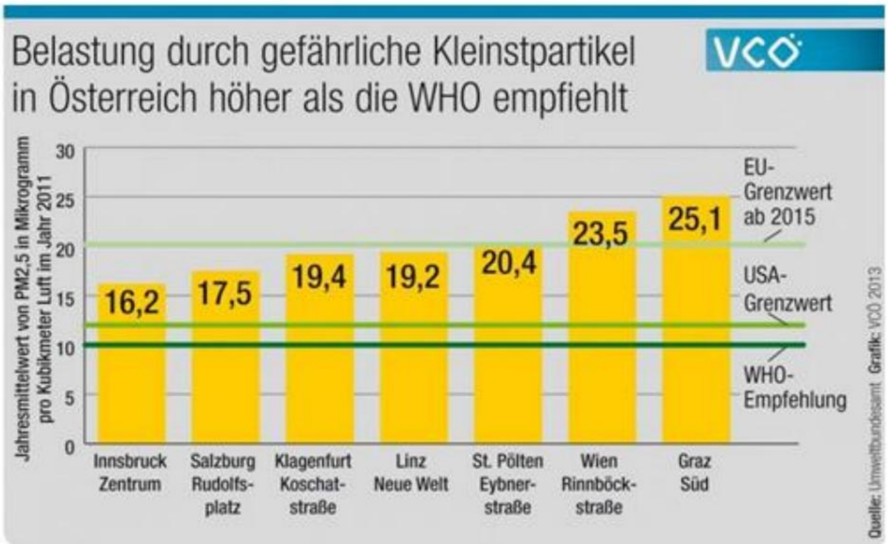


Fig. 34: Annual mean limit value **PM2.5[77]** exceeded

For PM2.5, the above-mentioned annual average value of 25 µg/m³ is applicable in the EU from 2015 (average target value over three years 20 µg/m³)[78]. In the USA this is 12 µg/m³ (low relevance of diesel vehicles). The **WHO ,** on the other hand, recommends a **guideline value of 10 µg/m³ annual average** (25 µg/m³ daily average) and also states that there is **no limit** or threshold range below which no adverse health effects would be detectable [79] .

[75] UBA, limit, target and threshold values, www.umweltbundesamt.at

[76] UBA, Health effects of PM2.5 exposure – Styria, www.umweltbundesamt.at

[77] Austrian Transport Club, Ultra-fine dust makes you sick – Factsheets 2013, www.vcoe.at

[78] UBA, limit values - air pollutants, www.umweltbundesamt.at

[79] WHO, Air Quality Key-facts, www.who.int

3.2.6 Health effects

The harmful effects of fine dust on the human organism are evident. The respiratory system, the central nervous system, the cardiovascular system, blood coagulation, the body's tendency to inflammation, etc. are particularly affected.[80]

In addition, effects on the weight of newborns (reduced fetal growth)81 . Another study82 shows associations between ozone and NOx exposure in the first trimester of pregnancy with a higher probability of premature births (4.4%) and preeclampsia (high blood pressure, etc.) of 4% for every 10 µg/m³ increase in O3 .

In rescue operations involving acute heart disease (in Linz, for example), an increase of 7.1 percent was observed when PM2.5 pollution increased by 10 µm/m³83 .

As can be seen, the EU's annual average limit value of 25 (20) µg/m³, which came into force in 2015, was largely complied with in Graz. From a public health perspective, however, the **WHO** recommendations and thus the much lower guideline value of **10 µg/m³** are primarily decisive.

$PM_{2.5}$, Jahresmittelwerte 2007 – 2013

	$PM_{2.5}$ [µg/m³]	
	Graz Süd	Graz Nord
2007	25,4	
2008	23,6	
2009	22.7	17,1
2010	24,4	18,8
2011	25,1	20,0
2012	21,4	16,0
2013	20,6	16,8

Tab. 2: PM2.5 annual mean values Graz

Source: LUIS Annual Report 2013

Although the long-term effects of particulate matter pollution have not yet been sufficiently researched, the results of the meta-analysis of a research project of the European Commission – **The ESCAPE Project84** (summary of eleven cohort studies from Finland, Sweden, Denmark, Germany and Italy) published in the British Medical Journal in 2014 show a clear connection between air quality and cardiovascular diseases (CVD) and their influence on the

Increase in mortality rate.

According to the results of this meta-analysis, an increase in the annual mean value of PM2.5 by 5 µg/m³ is associated with a 13% increase in heart attacks - for PM10, an increase of 10 µg/m³ causes a 12% increase in heart attacks. People over 60 are particularly affected by high levels of PM2.5.
Stress endangered.

[80] Héroux M., Evidence on Health Effects in support oft the review of the EU Air Quality Policies: The WHO REVIHAAP and HRAPIE Projects, www.umweltbundesamt.at

[81] Dadvand P. et al., Maternal exposure to particulate air poll. and term birth weight, 2013, ehp.niehs.nih.gov

[82] Olsson D., Air poll. exposure in early pregnancy and adverse pregnancy outcomes, 2013, bmjopen.bmj.com

[83] Medical University of Vienna, Air pollutants and cardiovascular risk, www.meduniwien.ac.at

[84] The ESCAPE Project, Long term exposure to ambient air pollution in Europe, BMJ 2014, www.bmj.com

Fine dust	WHO-Guidelines	EU-Limit values	Each increase PM µg/m³	Increase in HKK
PM10	20	40	10	12 %
PM2.5	10	25	5	13 %

Tab. 3: WHO guidelines, EU limits and ESCAPE study results

The results show that even at particulate matter levels **below the limit values** for PM10 (40 µg/m³) and PM2.5 (25 µg/m³), there is a **significant risk** of cardiovascular problems with additional mortality rates similar to those mentioned above. The same effects are also present at even lower exposure levels below the annual average limit values for PM2.5 (< 15 µg/m³) and PM10 (< 20 µg/m³)85 .

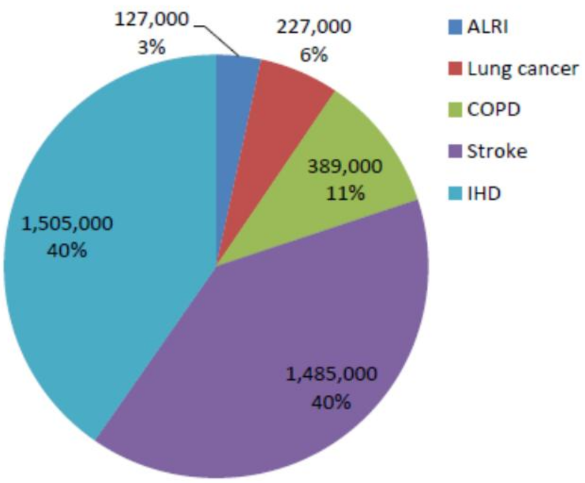
Other WHO research projects such as **REVIHAAP** (Review of evidence on health aspects of air pollution) and **HRAPIE** (Health risks of air pollution in Europe) paint a similar picture. In addition to the stronger effects of long-term exposure on health even at very low PM2.5 levels (<10 µg/m³ annual average), the 24-hour averages or short-term exposure peaks with their effect on mortality on these days (and subsequent days) are also relevant. In addition, physiological changes in organs could be observed even at short-term high levels.

Loads can be demonstrated86 .

According to the WHO, more than 7 million people worldwide died prematurely in 2012 as a result of air pollution, of which around 500,000 were in Europe87. While in developing countries, in addition to air pollution, there is also pollution in living spaces (use of fossil fuels to heat living spaces), the main cause in Europe is outdoor air pollution.

Fig. 35: Ambient Air Pollution – Deaths by Disease88

- ALRI: Acute Lower Respiratory Disease
- COPD: Chronic Obstructive Pulmonary D.
- IHD: Ischaemic Heart Disease



[85] The ESCAPE Project, Long term exposure to ambient air pollution in Europe, BMJ 2014, www.bmj.com

[86] WHO, REVIHAAP and HRAPIE Projects, www.umweltbundesamt.at

[87] WHO, Health Topics – Air Pollution, www.who.int WHO,

[88] Ambient Air Pollution – Results, www.who.int

3.2.7 Economic costs of air pollution

According to the latest WHO report (April 2015), the economic costs of health effects from air pollution in the European Region are

Height of

€1.47 trillion (US$1.6 trillion).

This corresponds to almost one **tenth** of the gross domestic product **(GDP)** of the entire European Union.89 These figures result from the pecuniary assessment of premature deaths (600,000) and the years of life lost as a result, which account for 90% of the total costs, and the general additional burden of disease, which accounts for 10% of the total costs.

Over **90%** of citizens in the EU live with annual long-term outdoor air pollution levels of fine dust **above** the WHO **guidelines.** Premature deaths as a result of heart and respiratory diseases, blood vessel diseases, strokes and lung cancer are around

ÿ 80 % due to outdoor air pollution (482,000 deaths) and around
ÿ 20% on indoor air pollution (117,200 deaths)

Low- to middle-income countries are disproportionately affected. Traffic was once again identified as one of the skin stress factors.

According to this analysis, the economic costs in Austria amount to

around **€10.5 billion** (US$11,457 million)

This corresponds to a share of around 3.3% of Austrian GDP90

According to consensus and experts from WHO, OECD…, air pollution is currently the greatest environmental health risk. Reducing air pollution is therefore
have top priority.

[89] WHO, Economic costs of air pollution, www.euro.who.int

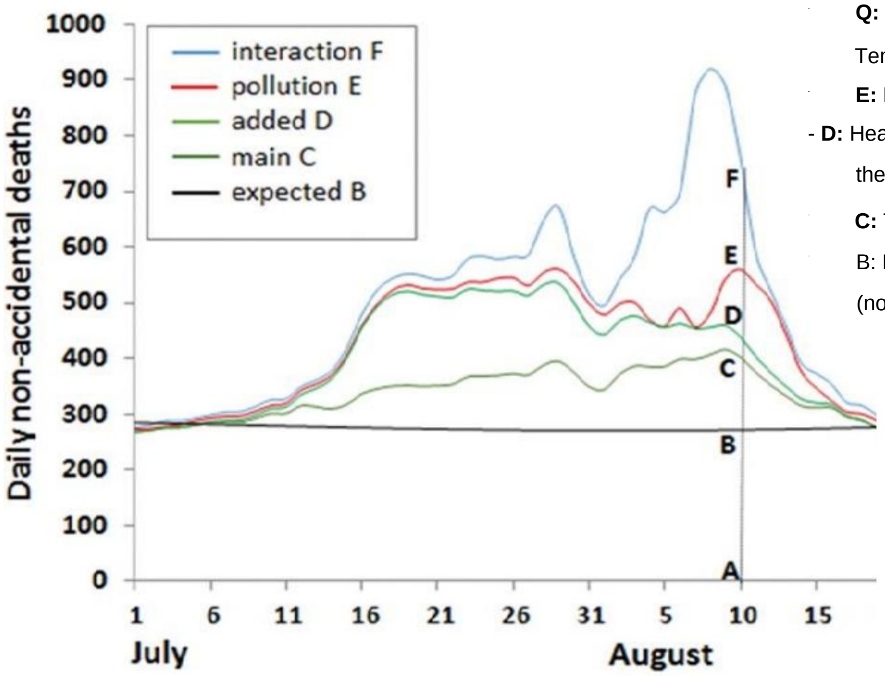
[90] WHO, Economic costs of air pollution – country shares, www.euro.who.int

3.2.8 Multifactorial stress during heat waves

The effects of the interaction of several stress factors such as heat and air pollutants are difficult to assess and are controversially discussed. Nevertheless, there are studies and data analyses that show that the health effects of heat stress can be Ozone and other air pollutants increase. The fact that older people in particular are affected by such situations A meta-analysis of data from several European cities shows that A 54% higher mortality rate was found in the 75-84 age group on days with high ozone levels and an increase of 36% on days with high PM10 levels (106% in those over 85 years of age)91 .

The role of the quality of breathing air in the heat wave stress scenario seems to be underestimated Results from the EuroHEAT Project show that heatwaves have a **greater impact** on people with **respiratory** than on cardiovascular diseases92 .

During the heat wave in Moscow in 2010, the stress situation was drastically exacerbated by additional fires in the surrounding area. In the analysis of the heat wave, the proportions or influence of the individual environmental factors – especially ozone and particulate matter PM10 - examined for mortality.



Q: Interaction of PM10 and Temperature

E: PM10 and ozone

- **D:** Heatwave effect - duration the heat wave

C: Temperature effect

B: Expected value (normal average value)

Fig. 36: Mortality rate Moscow 2010: Shares of factors PM10, ozone and temperature93

[91] Analitis A. et al., Effects of heat waves on mortality: effect mod. and confounding by air poll., ncbi.nlm.nih.gov

[92] D´Ippoliti D. et al., The Impact of heatwaves on mortality in 9 European cities, www.ehjournal.net

[93] Shaposhnikov D. et al., Mortality related to Air Pollution, Moscow Heat Wave 2010, www.ncbi.nlm.nih.gov

3.3 Air pollution index LBI

When creating air pollution indices, several air pollutants are combined and classified into one or more indices. The attempt is made to depict and locate the total pollution of the breathing air, whereby a distinction is made between current short-term pollution situations (1-hour values, daily averages, etc.) and medium to long-term pollution trends (monthly, half-yearly and annual averages).

3.3.1 Short-term air pollution index KLBI

The data provided by all measuring stations are compared with the currently valid limit values (Air Pollution Control Act 2010 – **IG-L)** and also with each other. As part of the state environmental information, a daily air quality report is provided by the A15 created.

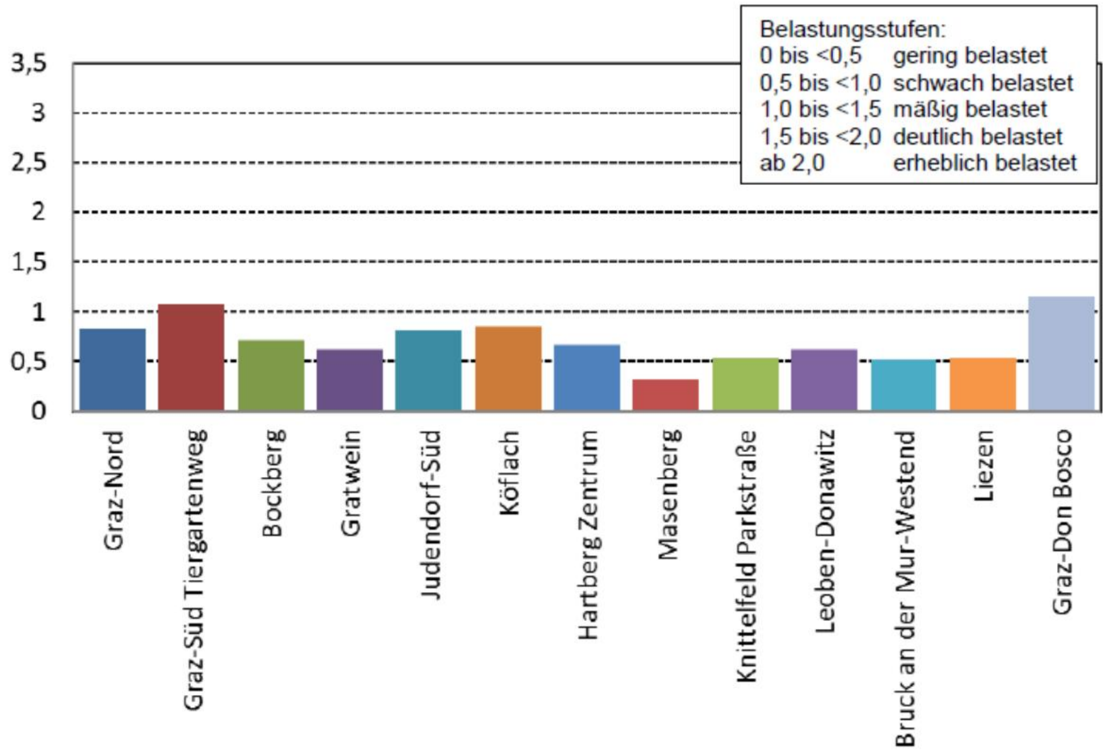


Fig. 37: Daily air quality report LUIS from 27.04.2015

The daily air quality report takes into account the pollutants sulphur dioxide, nitrogen dioxide and fine dust PM10 and shows the current daily pollution levels at the Styrian measuring stations. Ozone pollution is shown separately.

A further daily summary can be found on the online portal of the Central Institute for Meteorology at www.zamg.ac.at

The **GeoSphere** Index **Austria** is involved in the European Air quality index based

www.airqualitynow.eu

and removes all common air pollutants and also ozone in an index using color guide system (Ampelsystem) dar.

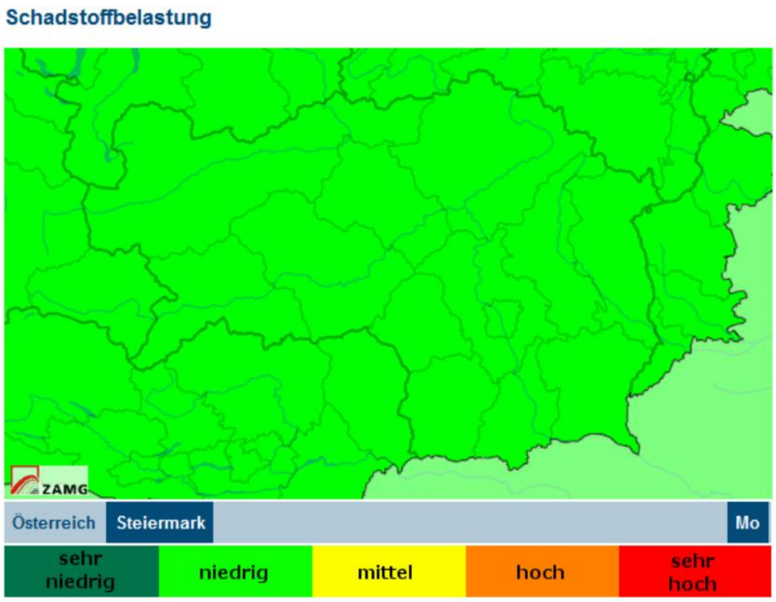


Fig. 38: Air quality index GeoSphere Austria

3.3.2 European directives and air pollution indices

An additional overview of the currently valid limit values and short- and long-term exposure indices is available at www.airqualitynow.eu – an EU body for comparing air data in European cities.

Legende :

Luftverschmutzung	Wert des Index
Sehr niedrig	0 / 25
Niedrig	25 / 50
Mittel	50 / 75
Hoch	75 / 100
Sehr hoch	> 100

Schadstoffe	AKTUELL VERKEHR	GESTERN VERKEHR
NO2	15	46
PM10	24	59
PM2.5	-	-
CO	1	3

Schadstoffe	AKTUELL HINTERGRUND	GESTERN HINTERGRUND
NO2	9	20
O3	24	42
PM10	26	25
PM2.5	-	-
SO2	1	3
CO	-	-

Fig. 39: Air quality Graz

A uniform orientation based on a color-coding or traffic light system creates the basis for easy understanding of the air pollution indices by the general public and thus enables easier assessment of the risk potential of the current air pollution situation for the people affected.

3.3.3 Recommendations for behavior regarding the LBI

LBI Level	Comment	recommendations
Very low	The current exposure is low – no health impairments are to be expected.	To keep air pollution low, use public transport wherever possible or bicycles.
low	The current load is low – Health impairments are unlikely.	All behaviors related to Reducing stress makes sense.
medium	The current load is moderate – health problems can occur.	No special Behavioral measures recommended.
high	The current burden is clear. For **people at risk** such as older People, children and persons with lung and cardiovascular diseases are at risk of mucous membrane irritation or Impairment of lung function by ozone	People at risk should avoid all unnecessary physical and sporting activities during the daytime hours with the highest heat or air pollution in particularly Avoid affected areas.
very high	The current burden is considerable – People at risk are now particularly affected During physical exertion in Free is **25 – 35 %** of the Impairment of lung function is to be expected in the population.	Move outdoor activities to the early morning hours and ventilate living spaces during this time when pollution levels are low. Avoid physical exertion during peak periods. The consumption of tobacco products should be People at risk should be avoided.

Tab. 4: Level demarcations and recommendations for the LBI, based on the KBI Cercl´Air94

People at risk should avoid unnecessary physical exertion during daytime hours with very high pollution levels and temperatures.

[94] Cercl´Air, Recommendation No. 27a on the Swiss Short-Term Air Pollution Index, cerclair.ch

In situations where air pollution levels are low or away from heavily polluted roads, switching to cycling is still recommended – the health benefits here are in favour of physical fitness through exercise and pollutant emissions are reduced95 .

However, during the day when pollution levels are very high on busy roads, the use of bicycles (in order to avoid physical exertion)

only recommended to a limited extent, as the amount of pollutants inhaled is correspondingly higher (4.3 times higher than for car drivers) [96]

3.3.4 Long-term air pollution index

For a long-term view of air pollution, the number of days of the respective pollution class per year is suitable. The air pollution index (LBI) attempts to determine the current short-term

To depict air pollution over time (e.g. annual balance)97 .

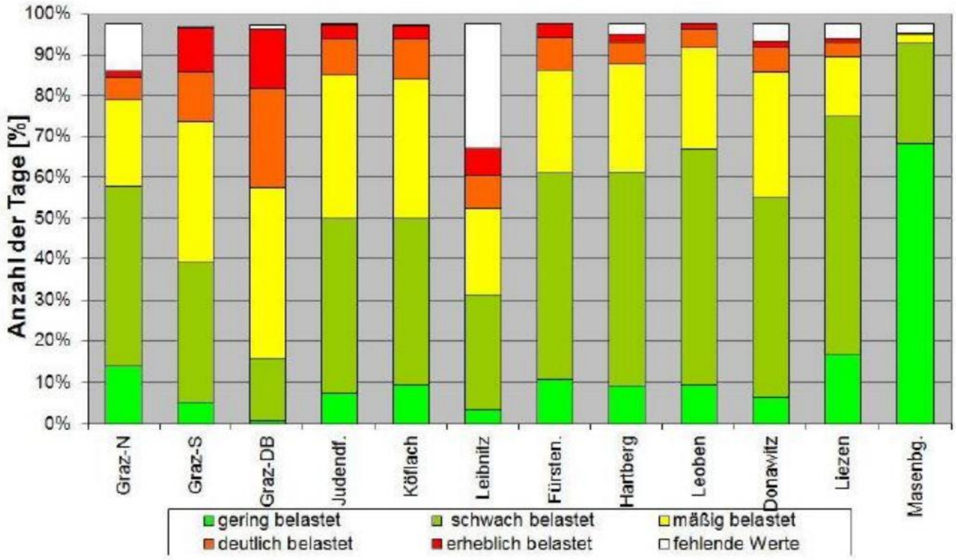


Fig. 40: Long-term air pollution index of Styrian stations, source: LUIS 201398

95 Austrian Public Health Portal, Cycling – healthy but risky?, www.gesundheit.gv.at

[96] Panis L. et al., Exposure to particulate matter in traffic, www.sciencedirect.com

[97] Air pollution index, www.umwelt.steiermark.at

[98] LUIS Annual Report 2012, www.umwelt.steiermark.at

3.4 Effects of UV exposure

UV radiation is one of the causes of skin cancer. Young children, whose skin is not yet fully developed, are particularly in need of protection. Exposure to UV radiation on the eyes can lead to clouding of the lens of the eye - the so-called cataract.

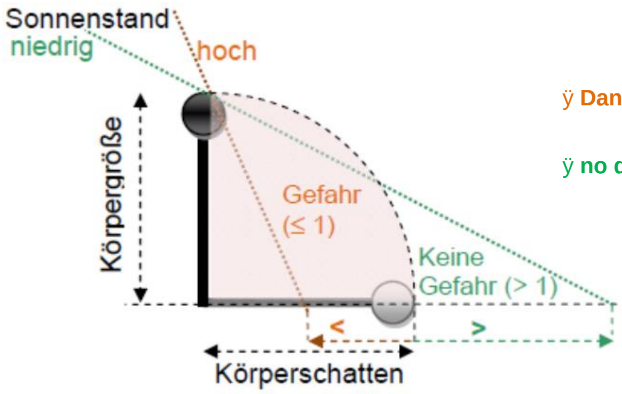
(cataracts) and conjunctivitis[99] .

Depending on the degree of cloud cover, up to 90% of the rays can penetrate the cloud cover. While very dense cloud cover blocks UV rays relatively well, thin veils of clouds or fog can even amplify them through reflection.

UV radiation at	Reduction of UV radiation
Shadow	up to 50 %
light cloud cover	5 – 10 %
heavy cloud cover	30 – 70 %
very heavy cloud cover	up to 90%

Tab. 5: UV radiation under cloudy skies [100]

In the months of May, June and July, when the angle of incidence of the sun's rays is at its greatest, the intensity of UV radiation also reaches its highest levels. The **daily maximum values** and up to two thirds of the UV radiation amount occur between **11** a.m. and **3 p.m.** - i.e. when the sun is high in the sky.
To estimate the intensity, there is the following simplified formula – the **shadow rule[101]:**



ÿ **Danger: short shadow < body height**

ÿ **no danger: long shadow > body size**

Fig. 41: Shadow rule

The shadow rule applies up to an altitude of 1,000 meters above sea level. In addition, an increase in UV radiation of 20% must be taken into account for every 1,000 meters above sea level.

If possible, avoid prolonged **unprotected** UV exposure during this period[102] .

99 Public Health Portal Austria, Effects of UV rays on the body, www.gesundheit.gv.at

[100] BMASK, Occupational Safety and Health Strategy 2007 – 2012, www.arbeitsinspektion.gv.at

[101] ibid

[102] BMLFuW, Factors on which UV exposure depends, www.bmlfuw.gv.at

3.4.1 UV-Index

The UV Index was created by the WHO as part of the Intersun programmes and describes the intensity of UV radiation using different levels according to an internationally valid colour coding system[103].

According to the recommendations of the WHO are at certain UV

Radiation intensities Protective or precautionary measures

Even at low UV exposure, the use of suitable

Clothing, headgear, Sunscreen and Sunglasses recommended.

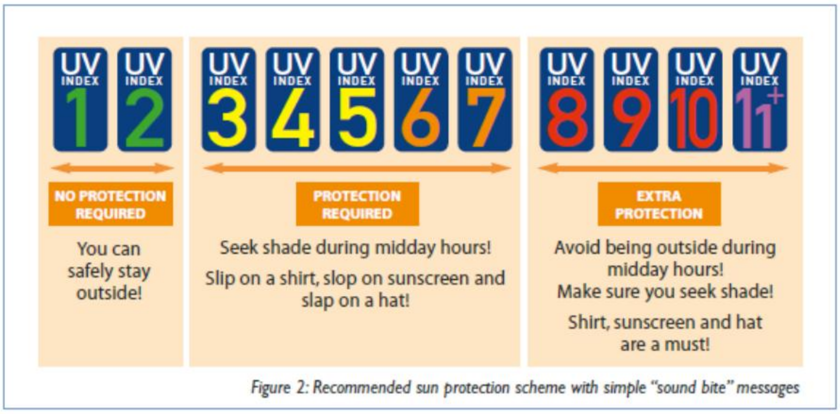


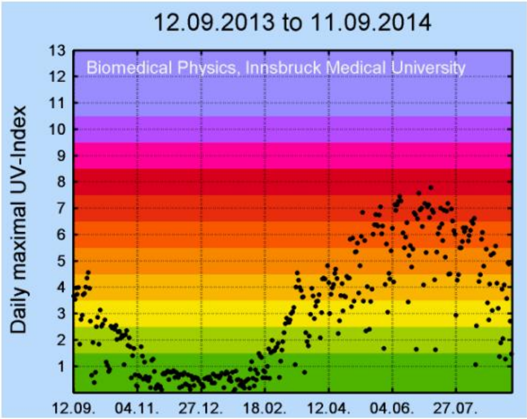
Fig. 42: International colour codes – UV index and recommendations

If the **UV index** is above **8,** unprotected outdoor activity during the midday hours should be avoided if possible or shade should be sought. In Austria, the UV index is determined by the

Medical University of Innsbruck[104].

http://uv-index.at/

Fig. 43: UV index for Graz



All people who spend longer periods outdoors are affected, but especially **babies, children** and people with **light** skin types. The intake of medications that

Sun sensitivity of the skin (various antibiotics) must be taken into account[105].

Wearing headgear that allows air circulation and provides adequate face or nose protection.

It is recommended to provide shade for the neck. Clothing with a sufficiently high fiber density in reflective, light colors is preferable to clothing made of very thin or dark fabrics.

Look for quality sunglasses with CE mark and 100% UV protection up to 400 nm

Wavelength.

[103] WHO, Intersun Progam, www.who.int

[104] Medical University of Innsbruck, uv-index.at

[105] Center for Health, Skin Cancer and Antibiotics, www.zentrum-der-gesundheit.de

3.4.2 Protective measures

The skin can protect itself for a certain period of time without becoming red. This so-called **self-protection time** varies depending on the skin type. The different skin types, their self-protection time and the recommended protection factor of the sunscreen are listed below. The basic formula for the protection time is:

Self-protection time x protection factor = extended sun protection time

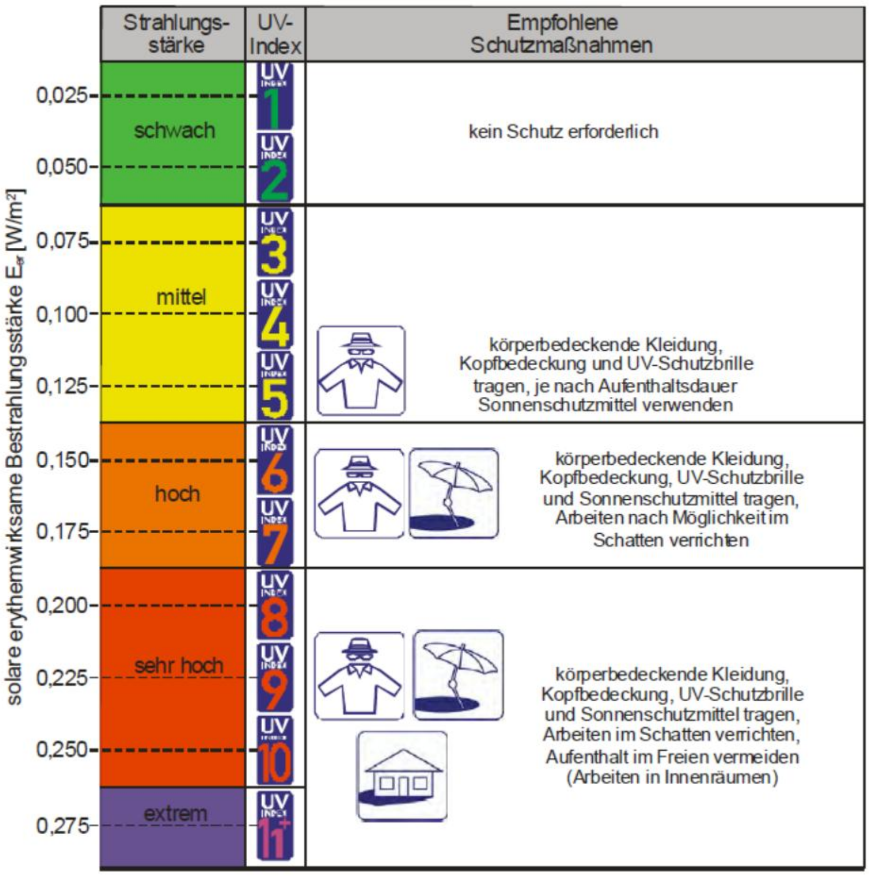
Skin type	Protection factor
Children's skin very light skin – gets unprotected after just 5 – 10 minutes a sunburn	**Recommended minimum factor:** **30 – 50 +** **Example: 5 min. x factor 30 = 150 min. protection time**
Skin type I very fair skin, freckles, light eyes, reddish-blonde hair Self-protection time: 5 – 10 min.	**Recommended minimum factor:** **20 – 50 +**
Skin type II medium-light skin, light eyes, blonde hair, slow tanning, self-protection time: 10 – 20 min.	**Recommended minimum factor:** **15 – 50 +**
Skin type III light brown skin, dark hair and brown eyes, medium to quick tanning, self-protection time: 20 – 30 min.	**Recommended minimum factor:** **10 – 30**
Skin type IV brown skin, naturally brown, dark and less sensitive skin, dark eyes, dark or black hair, fast and deep tanning, self-protection time: 45 min.	**Recommended minimum factor:** **6 – 20** **Example: with factor 20 up to 15 Hours**

Tab. 6: Skin types and recommended sun protection factor106

Applying sunscreen early (20 minutes before exposure) and completely to all exposed parts of the body is recommended. **The protection time is extended by reapplying sunscreen. not extended.**

106 Austrian Public Health Portal, Skin Types, www.gesundheit.gv.at

Fig. 44: Recommended Protective measures against UV Irradiation[107]



One of the positive aspects of UV radiation is that it promotes the production of provitamin D3 in the skin – this is a precursor to **vitamin D3,** which is important for the body in many ways.

To produce the necessary amount of vitamin D3, a relatively short exposure of arms, legs and Face in the sun on a Summer day.

	UV-Index/Richtzeit für Sonnenexposition in Minuten							
Hauttyp	1	2	3	4	5	6	7	8
I	34	17	11	9	7	6	5	5
II	42	21	14	11	9	7	6	6
III	59	30	20	15	12	10	9	8
IV	75	38	25	19	15	13	11	10

Tab. 7: Guideline time for sun exposure

It should be noted that the use of sunscreen largely prevents the synthesis of provitamin D3 , as UVB radiation is filtered out. Likewise, the radiation filtered through window glass. In summer, provitamin D3 can be produced in our latitudes over a period of eleven hours (7:30 a.m. to 6:30 p.m.) . In winter, however, it can only be produced between 11 a.m. and around 1:30 p.m.[108]. A vitamin D3 deficiency in winter is therefore possible.

[107] AUVA, study on UV exposure when working outdoors, www.auva.at

[108] AUVA, guide for outdoor workers, www.auva.at

4. Heat stress in workplaces and when working outdoors

During periods of heat waves, workplaces and outdoor work may experience thermal stress. In all work rooms, workshops and offices that do not have air conditioning or are exposed to sunlight, temperatures outside the comfort range can lead to reduced performance, tiredness, poor concentration and increased circulatory strain. The risk of accidents is also increased.

4.1 Workspaces

Workrooms should have climatic conditions that are optimal for the human organism. **Section 28** of the Workplace Ordinance **(AStV)** [109] provides the following temperature ranges:

Temperature	Air speed	Degree of physical exertion
19 to 25°C	0,10 m/s	Work with low physical strain
18 to 24°C	0,20 m/s	Work with normal physical strain
min. 12°C	0,35 m/s	Work with high physical strain

Tab. 8: Temperature ranges according to AStV

In the warm season, all options should be exhausted to prevent the room temperature from exceeding 25°C (Section 28, Paragraph 2 AStV). This includes measures such as ventilation and the provision of fans as well as shading concepts. Likewise, the above values are specified for the air speed with an averaging period of 200 seconds if appropriate ventilation measures are taken ((Section 28, Paragraph 3). Deviations from the values are permitted if the type of use of the rooms requires them ((Section 28, Paragraph 4). When using an air conditioning system, the **relative humidity** must be kept between **40** and **70%** ((Section 28, Paragraph 5), although the mandatory installation of such a system is not planned.

General measures to reduce physical strain:

ÿ Use night cooling and ensure adequate ventilation in the morning hours

ÿ Consideration of ozone pollution when ventilating

ÿ use additional mobile air conditioning units

ÿ Implement shading concepts

ÿ flexible working hours and break arrangements

ÿ Avoid additional heat sources (lamps, PCs, devices that emit heat…)

ÿ possibly adapt clothing regulations

[109] BMASK, Workplace Ordinance, www.arbeitsinspektion.gv.at

ÿ sufficient consumption of suitable non-alcoholic liquids

ÿ Provide cooling options

ÿ If possible, shower the body

ÿ Cooling the wrists and forearms under cold water

When evaluating the climatic conditions in a workplace, special consideration must be given to different groups of people, such as pregnant women, the elderly and those at risk of health problems. In this context, occupational physicians should be consulted.

4.1.1 Indoor air quality

In reality, the quality of the indoor air will depend on various factors. These should be taken into account when designing and planning workplaces. In addition to air pollutants caused by traffic and other location factors, work spaces can also be exposed to pollution caused by the use of laser printers and copiers, in addition to technical work conditions. In experimental situations, the effects of fine and ultrafine dust from laser printers on lung cell cultures have been demonstrated[110] for the

However, according to the current state of science, laser printers do not pose any potential health risk during normal operation in workplaces.

However, to generally improve air quality, printers and copiers should not be located in offices or at desks if possible.

High-performance devices such as **group printers** should be installed in separate rooms with ventilation Regular maintenance and damp cleaning of the device environment as well as careful removal of paper jams can prevent or even prevent unnecessary stirring up of fine dust.

[110] Tang T. et al., Investigations into the genetic toxicity of emissions from laser printers, Institute for Environmental Medicine – University of Freiburg, www.uniklinik-freiburg.de

4.2 Working outdoors

When working outdoors during a heatwave, several stress factors come together.
In addition to the temperature, the level of UV radiation and the air quality in particular have an influence on the health of those affected and their performance.

4.2.1 Heat

According to studies by the German Social Accident Insurance Institution (AUVA), mental performance and the ability to concentrate can decrease by as much as 25% at temperatures of around 30°C and by as much as 50% at temperatures of 35°C111 .

The main reason for the reduced ability to concentrate is usually a lack of fluids due to heavy sweating and the resulting thickening of the blood. Typical signs of impairment are dizziness, headaches, exhaustion and nausea. In addition to the air temperature and humidity, the stress when working outdoors is also increased by the heat from the sun.

4.2.2 UV radiation

Basic information and recommendations on staying outdoors and exposure to UV radiation can be found in the chapter Effects of UV exposure. It should also be noted that light-coloured surfaces such as polystyrene, metal and concrete, as well as snow and water
which reflect and amplify UV radiation. This particularly affects jobs in the
Construction workers such as plumbers and roofers, but also road workers, track workers...

Material/environmental conditions	Increase in UV radiation
Styrofoam	up to 84%
Zinkblech – walzblank	67 %
Weißaluminium	45 %
Snow	80 %
per 1,000 m above sea level increase	20 %

Tab. 9: Intensification of UV radiation by environmental factors112

In general, the body (face, neck...) should be protected as best as possible by timely use of sunscreen, appropriate clothing and high-quality sunglasses.

Further information on this topic can be found at www.auva.at

111 AUVA, press release, www.auva.at

112 BMASK, Occupational Safety and Health Strategy 2007 – 2012, www.arbeitsinspektion.gv.at

4.2.3 Air quality

When working outdoors on exposed construction sites such as road construction, the people on site are exposed to exposed to a correspondingly high additional burden of air pollutants. You can find more information on this topic in the chapter Air pollutants.

4.2.4 Bad weather regulations - heat

Bad weather according to Section 3 of the Construction Workers' Bad Weather Compensation Act (BSchEG) exists when atmospheric influences that hinder work, such as rain, snow or frost, and since 2013 also heat, fundamentally impair working conditions.

In such a situation, workers are entitled to compensation of 60% of their actual wages if work has to be stopped. The bad weather criteria are determined by the Construction Workers' Holiday Scheme.
& Severance Pay Fund **(BUAK)** in cooperation with the G.

At the **employer** 's discretion, if **temperatures** exceed **35°C,** work may be stopped or the employee may be assigned to reasonable alternative work in a cooler atmosphere.
after 3 hours of waiting on the construction site [113]

As always, setting threshold values is problematic because, for example, at 34.9°C the exposure is the same, but on the other hand work is not stopped because there is no possibility for the employer to refinance with the BUAK. In addition, temperatures on construction sites can, depending on local conditions, be significantly higher than those at general measuring stations at other locations.
Job.

[113] BUAK, bad weather regulations, www.buak.at

4.3 Heat stress when working outdoors – risk assessment

The following is an assessment tool from the Swiss State Secretariat for Economic Affairs[114] (SECO) which can be useful for assessing the exposure to heat stress when working outdoors. This method is only to be used during hot periods and is not suitable for assessing workplace situations in industrial processes (furnaces, etc.) - in addition, some factors such as altitude, wind speed and acclimatization are not taken into account.

Since physical strain depends on several factors, in addition to the measured temperature – similar to the PET index – influencing factors such as air humidity, solar radiation and the degree of severity of the physical work or the necessary protective clothing are taken into account and the **corrected temperature** is determined from this.

This model assumes that the working person is in a normal state of health.

People who are particularly at risk, such as pregnant women, non-acclimatized people (presence < 5 days), people over 55 years of age, and people with reduced performance due to illness, medication, drugs, etc., cannot be included in this assessment. Likewise, work situations in confined spaces (crane cabins, pits...) or those that require special work clothing and protective equipment should be subject to a separate assessment.

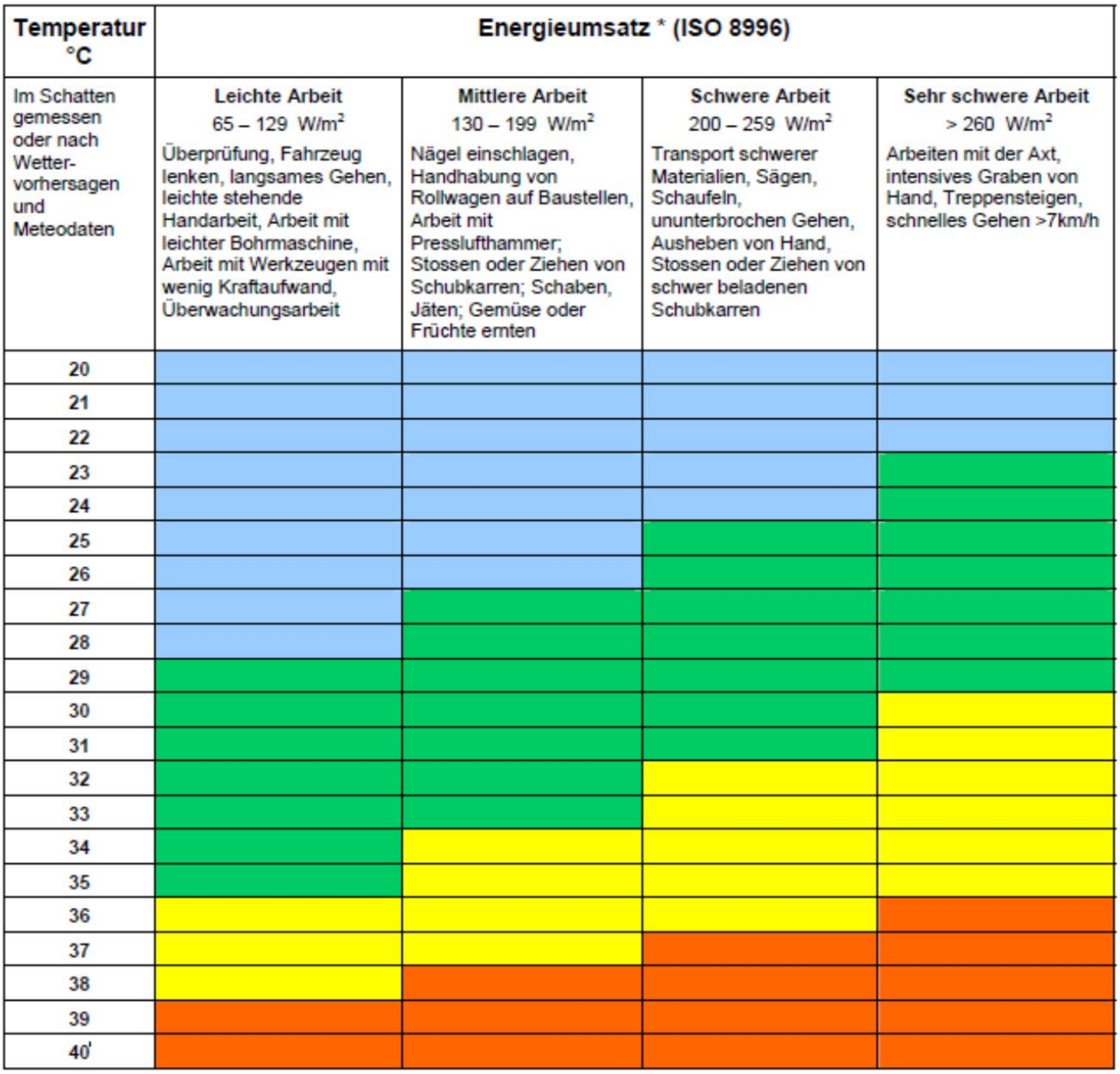
Procedure for determining the load:

- ÿ Measurement of relevant values such as relative temperature and humidity in the shade
- ÿ Comparison with the classification of the stress situation at www.zamg.ac.at
- ÿ Assessment of the severity of physical work
- ÿ Enter the temperature in the table of the assigned activity
- ÿ Determination of correction values taking into account solar radiation, relative Humidity and required work clothing
- ÿ Correction of the table based on the determined values
- ÿ Determination of the risk area and implementation of the resulting measures

[114] State Secretariat for Economic Affairs – SECO, Working outdoors in hot weather, www.seco.admin.ch

4.3.1 Assessment table

For the initial level, a humidity of 30%, full sunlight and light clothing is assumed. In the table, measured air temperature and the severity of the physical work are combined to give the respective stress level, categorised by a colour coding system. The **severity** of the **work** is determined by the **energy turnover** (in W/m²,
Energy expenditure of muscle load during physical activity).



Temperatur °C	Energieumsatz * (ISO 8996)			
Im Schatten gemessen oder nach Wetter-vorhersagen und Meteodaten	**Leichte Arbeit** 65 – 129 W/m² Überprüfung, Fahrzeug lenken, langsames Gehen, leichte stehende Handarbeit, Arbeit mit leichter Bohrmaschine, Arbeit mit Werkzeugen mit wenig Kraftaufwand, Überwachungsarbeit	**Mittlere Arbeit** 130 – 199 W/m² Nägel einschlagen, Handhabung von Rollwagen auf Baustellen, Arbeit mit Presslufthammer; Stossen oder Ziehen von Schubkarren; Schaben, Jäten; Gemüse oder Früchte ernten	**Schwere Arbeit** 200 – 259 W/m² Transport schwerer Materialien, Sägen, Schaufeln, ununterbrochen Gehen, Ausheben von Hand, Stossen oder Ziehen von schwer beladenen Schubkarren	**Sehr schwere Arbeit** > 260 W/m² Arbeiten mit der Axt, intensives Graben von Hand, Treppensteigen, schnelles Gehen >7km/h
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Tab. 10: Assessment table for outdoor work115

The table illustrates the different degrees of stress on the human organism for a given activity and temperature.

115 State Secretariat for Economic Affairs – SECO, Working outdoors in hot weather, www.seco.admin.ch

4.3.2 Additional criteria

Once the level of difficulty of the work has been determined and the ambient temperature has been determined, the activity can be entered into the table. The following additional aggravating factors must be taken into account:

Sun exposure	Clear sky	**No** adjustment	
	Overcast sky	**3** spaces up	↑
	Shadow or evening	**5** spaces up	↑

Relative humidity	30 %	**No** adjustment	
	40 %	**2** spaces down	↓
	50 %	**4** spaces down	↓
	60 %	**5** spaces down	↓
	70 %	**6** spaces down	↓
	80 %	**8** spaces down	↓
	90 %	**9** spaces down	↓

clothing	Light clothing	**No** adjustment	
	Knitted fabric or special clothing	**5** spaces down or separate assessment	↓

Tab. 11: Adjustment criteria for the assessment table[116]

Depending on the situation, taking these additional criteria into account results in a change within the assessment matrix. Now that the effective level of stress when carrying out the work under the given circumstances has been determined, appropriate adjustment measures should be taken.

[116] State Secretariat for Economic Affairs – SECO, Working outdoors in hot weather, www.seco.admin.ch

4.3.3 Adaptation measures

The adaptation measures are color-coded and assigned according to the assessment matrix.

Basismaßnahmen
Zusatzmaßnahmen 1
Zusatzmaßnahmen 2
Alarmmaßnahmen

Basic measures

- Regular measurement or assessment of climate values
- Provision of sufficient drinking water or isotonic drinks
- Regular raising of awareness of the problem among those affected
- Willingness to stop work if symptoms appear
- Ensuring first aid measures are provided
- Compliance with personal protective measures by workers:
  - Light, bright and loose clothing
  - Headgear and sunglasses
  - Sunscreen – taking skin type into account
  - Timely consumption of sufficient quantities of non-alcoholic drinks
  - Break arrangements

Additional measures 1

- Provision of shade for particularly exposed workplaces
- Adjustment of the work schedule taking into account the daily temperature trend
- Consideration of risk group membership or maternity protection[117]
- Increase fluid intake

Additional measures 2

- Limit individual stress by distributing work
- Adjust break schedule
- Work according to daily temperatures
- Increase fluid intake

Alarm measures for risk groups and situations

- Assessment by experts and occupational physicians
- Compliance with the proposed measures
- Temporary cessation of work if the health risk is too high

[117] Federal Chancellery – RIS, Convention on Maternity Protection – Recommendation 191, www.ris.bka.gv.at

Styrian heat protection plan – action plan

5. Basics

The second part of this document provides the basis for the Styrian Heat Protection Plan **(HSPL)** discussed, the most important measures are shown and relevant and useful information is provided. These activities require a general framework that is the basis for the assignability and appropriateness of the measures. This requires, first and foremost, a definition, when one can actually speak of a heat wave.

5.1 Definition of heat wave

A heat wave is defined as a warming of the air or the spread of hot air masses over a certain area for several days or weeks. There is no uniform international definition. This therefore differs from country to country in terms of minimum temperatures, framework conditions and threshold values.

In Central Europe, tropical days are defined as temperatures above **30°C** and tropical nights as above **20°C** (in the more southern countries, these values are correspondingly higher).

The Styrian heat protection plan refers, among other things, to a bioclimatic study on the Styria for the Styrian climate atlas[118] . Several factors such as temperature, air pressure, humidity, season, etc. are included in a meaningful **"bioclimate well-being index"** Depending on the weather conditions, the system of physiologically equivalent temperature **(PET)** presented in Chapter 2 is also incorporated into the forecasts prepared by GeoSphere Austria Styria. Ultimately, the terms used here are simplified and easily understandable for the general public and refer to **low, moderate** and **high** heat stress.

According to the definition of the Styrian heat protection plan, a heat wave occurs when

at least three consecutive days of high heat stress

The term strong heat load refers to possible combinations of temperatures from about 27°C and specific vapor pressure or air humidity from 60%.

[118] Environmental information Styria, Styrian climate atlas, www.umwelt.steiermark.at

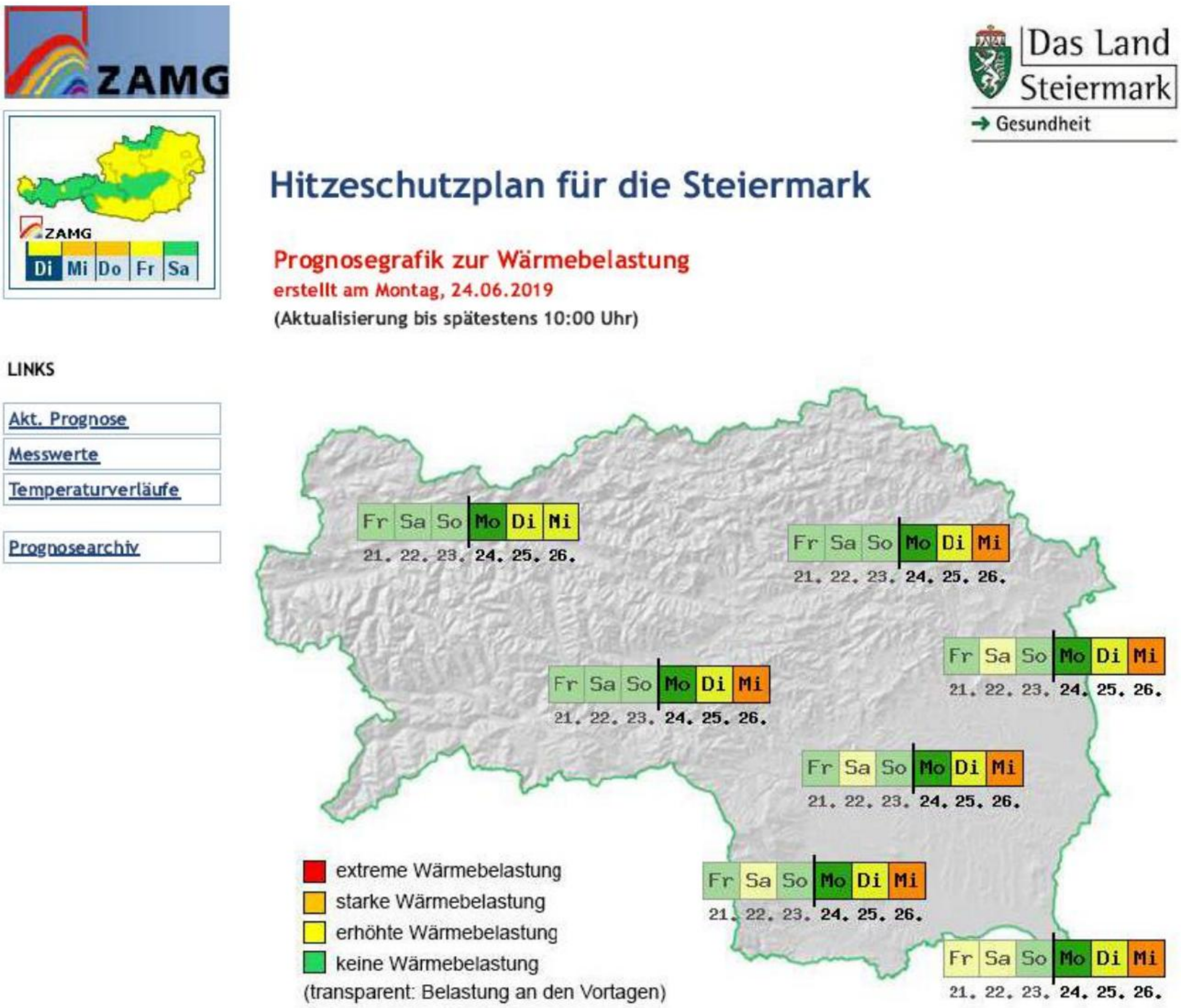

Fig. 45: Example of regional forecasts

This forecast is available at www.wetter-steiermark.at/hitzeschutzplan to find.

The human organism reacts very quickly to heat stress (see Chapter 2), with prolonged periods having a greater impact than individual hot days. Therefore, the Styrian HSPL speaks of a heat wave if it lasts three days or more, and if the **threshold value** is exceeded, the Warning level activated.

The threshold value for the activation of the heat warning level of the Styrian heat protection plan is Cooperation with GeoSphere Austria. Stakeholders who are located in the heat protection plan database will be notified by email as soon as possible when the warning level is activated and will be provided with regional forecasts and corresponding information. This gives the institutions a significant time advantage for planning and coordinating resources in their operations. In addition, awareness of the risk potential of heat waves should be created, strengthened and reactivated - especially during the first early heat waves of the year.

5.2 General medical principles

Hyperthermia is the overheating of the organism (increase in the core temperature of the body) as a result of exogenous factors such as high ambient temperatures, solar radiation, etc.
Above an ambient temperature of 37°C, evaporation or perspiration acts as the sole mechanism for releasing heat and lowering body temperature. In addition, the benefit of evaporation (cooling) is virtually neutralized by the increased heat generation of the underlying metabolic processes. The situation becomes critical when increased physical exertion or muscle work puts additional strain on the metabolism.

The tolerance range of the human core body temperature is approximately 37 - 41°C. A body temperature of 39°C can be tolerated by the human organism for a longer period of time, but above that at temperatures of 40°C there is a risk of circulatory collapse. At core body temperatures of 42°C and above, heat death occurs if the body is exposed to stress for a longer period of time.

The onset of heat stress is characterized by a feeling of humidity. Temperatures of 26°C can occur at 90% humidity or higher in temperature-sensitive people.
have a critical impact.

! Warning signs include a heart rate of 140 per minute or more at rest or a continuous increase after exertion and a core body temperature of over
39,2°C[119] .

[119] Gebbers JO et al., Swiss Journal of General Practice Medicine, PrimaryCare 2004, p. 587ff, www.primarycare.ch

5.3 Symptoms and clinical picture of hyperthermia stages

Heat illness occurs when the mechanisms for heat release are overloaded. In the decompensation stage, general hyperthermia first leads to a state of excitement with increased heart rate and accelerated, deeper breathing and later to an inhibition of

central nervous functions, especially respiratory and circulatory regulation.

Prolonged exposure to heat can lead to heat exhaustion, heat cramps, heat collapse and hyperpyrexia, which – if left untreated – can result in heat death. The consequences of heat stress become extremely serious when the functions of the central nervous system (CNS) and thermoregulation are damaged by the body's excessive core temperature (over 41°C). Heat emission is then further reduced and heat shock (heat stroke) occurs. Headaches, lack of concentration, dizziness, dizziness, nausea and vomiting are symptoms of heat shock.

As the core body temperature and heart rate increase, visual and hearing impairment, dyspnea and cyanosis occur, as well as sunken eyeballs, reduced skin turgor and other signs of dehydration. The most serious complications are extracellular dehydration with increased blood viscosity and a decrease in cardiac output and compensatory tachycardia, and finally oligaemic shock. Vascular insufficiency is the most common complication - death is a consequence of paralysis of the respiratory and circulatory centers and multiorgan failure[120] .

Heat **shock** resulting in death is one of the most common after-the-fact recognized causes of death.

Therefore, the **prevention of heat stress** is one of the most important measures, especially in the care of small children, the elderly and already weakened persons, and should not be underestimated by the facilities and their care staff or the relatives of those affected.

In general, excessive heat stress can be recognized by the following **symptoms :**

- dry mouth, thirst or severe headache
- Feeling of exhaustion or weakness
- Circulatory problems and feeling of restlessness
- Muscle and abdominal cramps
- high body temperature over 39°C
- Clouding of consciousness and unconsciousness

[120] Gebbers JO et al., Swiss Journal of General Practice Medicine, PrimaryCare 2004, www.primarycare.ch

5.3.1 Heat exhaustion and dehydration

Heat exhaustion is a disturbance of the salt and/or water balance in hyperthermia up to approximately 39°C. This occurs in exposed persons after a long period of development and insufficient fluid intake[121] .

Typical **symptoms** of heat exhaustion are

• reddened, pale face and moist, warm or moist, cool skin
• small amount of urine with dark color
• slightly changed body temperature
• Chills
• Dizziness and feeling of exhaustion, • Fainting,
tiredness, insomnia • possibly accelerated pulse

Heat exhaustion due to fluid deficit results in water loss, whereby a loss of

5 – 10 % of body mass to mild temporary disturbances and
15 – 25% can lead to life-threatening conditions.

In infants, young children, the elderly and people with pre-existing conditions, dehydration can lead to serious health problems.

Measures to **treat** heat exhaustion:

ÿ Take the affected person to a cool and shady place
ÿ take off and cool down
ÿ Administer (mineral) water and rehydration salts orally (ORS) in small sips
ÿ Only give liquid when the patient is conscious (risk of swallowing into the windpipe)
ÿ (semi-)isotonic solution or physiological NaCl solution iv with 5% glucose (dextrose) ÿ lying position and stop any exertion

If fluids are consumed too quickly, overhydration may occur, resulting in brain swelling or fluid accumulation in the lungs[122] .

If in doubt, seek **medical** advice

[121] Belgian Federal Public Service, “Heatwave Action Plan 2008”, Chapter 5.5 www.dglive.be
[122] Federal Environment Agency Austria, www.klimawandelanpassung.at

5.3.2 Word collapse

In heat stroke, the brain is no longer supplied with sufficient oxygen via the bloodstream. This can result in short-lasting vasomotor reactions when standing or sitting. Due to the reduction in arterial blood pressure, it can occur after precursors such as

- Dizziness, visual disturbances (in the form of flickering scotoma) and tinnitus

Sudden loss of consciousness may occur, which quickly disappears when lying down.

Although the thermoregulation of the organism is still fine, there is a risk for the person due to possible respiratory problems.

ÿ Therefore, check the breathing as well. If this is not working properly,
Immediately begin mouth-to-mouth resuscitation and cardiac massage.
ÿ Place the person in a recovery position.

! Call **emergency services immediately on 144**

5.3.3 Heat shock or heat stroke

The warning signs of the transition from heat exhaustion and heat collapse to heat shock are:

- warm, reddened and dry skin
- Dehydration – no perspiration
- high fever and rapid, strong pulse
- Dizziness and headaches
- Confusion, loss of consciousness, nausea and vomiting
- Dissolution of the muscles
- poor circulation in the face and extremities
- pale cyanotic appearance (gray stage)

A characteristic warning sign is the reduced or cessation of sweat secretion on the trunk. This is already a late symptom and the result of thermal damage to the thermoregulation centers. In high outside temperatures, the organism absorbs more heat than it can release, causing the body temperature to rise to 41/42°C within a short time - which can be life-threatening. Even with adequate reduction of the body temperature and intensive therapy, heat shock is often fatal (in around 50% of cases).

Survivors usually suffer from long-lasting neurological disorders[123] .

[123] Gebbers JO et al., Swiss Journal of General Practice Medicine, PrimaryCare 2004, www.primarycare.ch

From a core temperature of 41/42°C, in addition to loss of consciousness, complications of the Vascular and renal insufficiency or jaundice after 24 hours[124] .

Treatment of heat shock:

- ÿ check breathing or place the person in the recovery position
- ÿ Clear airways, oxygen therapy
- ÿ all cooling techniques - cooling by evaporation is the most effective
- ÿ Administration of water or (semi-)isotonic solution, physiological NaCl solution iv with 5% glucose (dextrose) in a ratio of 1:1 (avoid too rapid infusion), 50 ml 50% dextrose iv if glyc. < 3 mmol/liter

- ÿ Physiological NaCl solution iv, for several hours

Call **emergency services immediately on 144**

For thermolabile individuals, climatic conditions with no wind, humidity of 90 to 100% and temperatures above 26°C can already be considered critical.

5.3.3.1 Sunstroke

Sunstroke is the result of the direct impact of long-wave solar radiation on the bare head and is a special form of heat shock. This leads to an additional warming of the already hyperthermic brain tissue by 1 to 2°C, so that meningeal irritation symptoms can also occur before hyperpyrexia develops[125]. The most important characteristics are:

- severe headache, stiff neck
- Nausea, vomiting, high fever
- Drowsiness, possibly loss of consciousness
- sometimes superficial burns on the skin
- occasional heat cramps of the muscles, especially in the abdomen and limbs

5.3.4 Vocabulary

Death occurs at core body temperatures above 42°C due to paralysis of the respiratory and circulatory centers as well as due to a general state of shock and multiple organ failure.
Fatal heat shock is one of the most frequently unrecognized causes of death[126] .

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[124] Belgian Federal Public Service, "Heatwave Action Plan 2008", Chapter 5.5 www.dglive.be

[125] Gebbers JO et al., Swiss Journal of General Practice Medicine, PrimaryCare 2004, www.primarycare.ch

[126] ibid

5.3.5 Sunburn and heat rash

Sunburn occurs when the skin is exposed to strong sunlight for a long period of time without protection. The symptoms are usually relatively mild and disappear within a week - however, if the skin is seriously damaged, medical treatment may be necessary. In addition to damage to the skin, damage to the eyes can also occur - more information on this topic on protection from sunlight can be found in the chapter

Effects of UV exposure.

Heat rash is an irritation of the skin due to excessive sweating in hot, humid climates in the neck, chest and groin area - which can lead to itching. The skin in the affected areas should be kept dry and cool or treated with talcum powder.

5.3.6 Fluid loss and performance

Dehydration due to heat exposure is increased by the consumption of alcoholic, caffeinated and sugary drinks. It is therefore highly advisable to drink enough fluids without these ingredients during periods of high heat stress. The following physical

Stress values and symptoms are accompanied by a corresponding loss of fluid (approx. 85% of the mass) of the body:

Weight loss	**Mass loss at 70 kg**	**Performance and symptoms**
1 %	**0,7 kg**	full performance, thirst
2 %	**1,4 kg**	maintaining performance under great exertion
3 %	**2,1 kg**	Performance loss 5%, extreme fatigue
4 %	**2,8 kg**	Performance drop 10%, individual performance interruptions
5 %	**3,5 kg**	Performance drop 15%, exhaustion, high performance interruption frequency
6 %	**4,2 kg**	Loss of performance 20%, muscle cramps, coordination problems
10 %	**7,0 kg**	Loss of performance, reduction of renal blood flow and Urine production reduced to 50%, disorientation, coordination disorder
15 %	**10,5 kg**	**Unconsciousness, danger to life**

Tab. 12: Fluid loss and decrease in performance during sports127

Heat cramps can occur during strenuous physical activity outdoors –
The main cause here is a lack of fluids and minerals.

[127] Gebbers JO et al., Swiss Journal of General Practice Medicine, PrimaryCare 2004, www.primarycare.ch

5.4 The risk group

Heat stress and symptoms related to heat and air pollution, such as ozone peaks, can occur in at-risk groups as well as in healthy individuals. The health risk is greater for certain population groups due to predispositions and previous illnesses. These people therefore require special attention.

5.4.1 Babies and toddlers

Babies and young children are particularly at risk because their fluid reserves are insufficient –
Furthermore, they do not drink enough on their own. Exposure to the sun or staying in a closed and too warm environment (cars...) can quickly lead to dehydration and heat stroke. Children with respiratory diseases and symptoms such as diarrhea or fever are particularly at risk. Babies and small children should therefore always be supervised by adults. Air pollution - especially high ozone levels - is particularly harmful to small children because their respiratory tract is not yet fully developed.

5.4.2 Older people

Due to the aging process in humans, mental and physical changes or limitations occur, which increase the strain on the organism during heat stress.
In general, the group of people over 65 years of age has been found to have an increased mortality rate at very high temperatures[128] . Single women over 75 years of age are particularly affected. The reasons for the vulnerability are:

- Older people often suffer from chronic diseases that increase vulnerability to major Intensify temperature fluctuations.
- Taking some medicines can have a negative effect on the body's ability to thermoregulate – see chapter 5.5.
- Difficulty swallowing can limit food and fluid intake.
- Older people feel and realize heat stress less when they are exposed to suffer from mental disabilities and are socially isolated.
- Low-income seniors can benefit from structural measures in their residential and Living spaces such as air conditioning, insulation, etc. can hardly afford it.
- People with reduced mobility have difficulty leaving overheated apartments.
- The rapid onset of heat stress has a particularly strong impact on socially isolated people.

- Sweat glands do not function as well as we age, which leads to evaporation and Cooling is less efficient.

[128] Diaz J. et al.; Effects of extremely hot days on people older than 65 Years in Seville (Spain) from 1986 to 1997, Int. J. Biometeorology, 2002, www.springerlink.com

Studies show that there are gender-specific differences (Chapter 2.2) with regard to the age groups affected by heat stress. Although men are generally at slightly higher risk, women tend to be at higher risk from the age of 55[129] .

5.4.3 Chronically ill

In addition to all diseases that can affect the body's thermoregulation system, there is an increased risk, particularly for people with chronic diseases of the cardiovascular system and respiratory organs[130] .

5.4.4 Socially isolated persons

These are considered to be people at risk. In addition to the lack of ability to self-diagnose with reduced contacts, there is also no possibility of timely diagnosis of heat symptoms by those present, relatives, etc.

5.4.5 Heavy physical exertion

Persons who are subjected to strenuous physical exertion in the course of their work or other outdoor physical activities should, in accordance with the information provided by the public authorities, behavior. For more information, see Chapter 4.

5.4.6 Specific predispositions

Persons who are subject to any form of mental and/or physical impairment that impairs their judgment, thermoregulation and physical ability to compensate for heat:

- severely overweight people
- mental impairment of the central nervous system due to Alzheimer's, dementia, Parkinson's…
- Impairment due to consumption or withdrawal of alcohol, nicotine and drugs such as Amphetamine, Cocaine…

5.4.7 Immobile persons

Immobile people have difficulty escaping heat-related environmental stress and are therefore exposed to a higher risk potential if exposed to prolonged heat stress.

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[129] Fouillet A. et al., Excess mortality related to the August 2003 heat wave in France. International Archives of Occupational and Environmental Health 80, 2006, link.springer.com

[130] Kälin P. et al, CURRICULUM, Switzerland Med Forum 2007, p. 645, medicalforum.ch

5.5 Effects of drugs

The effects of taking certain medications on the organism while simultaneously being exposed to high levels of heat should always be assessed **by the treating physician,** taking into account personal risk factors and existing illnesses.

An **evaluation** of the benefit-risk profile of the drugs and the consequences when weaning for the duration of the heat period is recommended.

The dehydration status of patients at risk should generally be monitored more closely. In addition, the It is advisable to create a list of **medications** (both prescription and non-prescription) for each high-risk patient so that emergency services have this information immediately available in an emergency. It must be ensured that this information is accessible and up-to-date.

When taking the following medications during heat stress situations, possible **Interactions** must be considered[131] .

5.5.1 Drugs affecting hydration and electrolyte balance

- Diuretics (loop diuretics)
- Non-steroidal anti-inflammatory drugs, ASA in doses over 500 mg/day, COX-2 inhibitors
- ACE-Inhibitor
- Angiotensin-II-Rezeptorantagonisten (AIIA)
- certain antibiotics (see product information)
- certain antiviral drugs used for antiretroviral HIV combination therapy

5.5.2 Medicines whose effect is influenced by dehydration

- Lithium
- Antiarrhythmika
- Digoxin
- Antiepileptic drugs
- certain oral antidiabetics (biguanides and sulfonamides)
- Statins and fibrates

[131] Kälin P.et al., CURRICULUM, Switzerland Med Forum 2007, p. 646ff, medicalforum.ch

5.5.3 Medicines and addictive substances that increase heat stress

- Antihypertensives and drugs for the treatment of angina pectoris
- All drugs and addictive substances that affect attention

5.5.4 Medicines affecting heat balance

- Neuroleptics and serotonin agonists
- Tricyclic antidepressants
- First generation H1 antihistamines
- certain Parkinson's drugs (e.g. biperiden)
- certain antispasmodics (oxybutynin, tolterodine, trospium chloride)
- Pizotifen
- peripherally effective, systemically administered vasoconstrictors (e.g. triptans)
- Beta blockers
- Thyroid hormones
- SSRIs and other antidepressants (imipramine, MAO inhibitors, venlafaxine)
- Buspirone

In addition to involving the attending physician in the preparation and evaluation of medication intake, it is also important to ensure that medication is stored properly and to keep a medication list available for emergency personnel.

6. Heat protection plan – framework conditions

The observation period **(OZ)** for the heat protection plan from May to September inclusive is limited to those months of the year in which heat waves can occur. As can be seen in the following graphic, the probability is highest in the core months of June, July and August. However, recent years have shown that heat waves can also occur very early in the year, which pose a particular risk due to the lack of acclimatization - therefore the observation period has been extended.

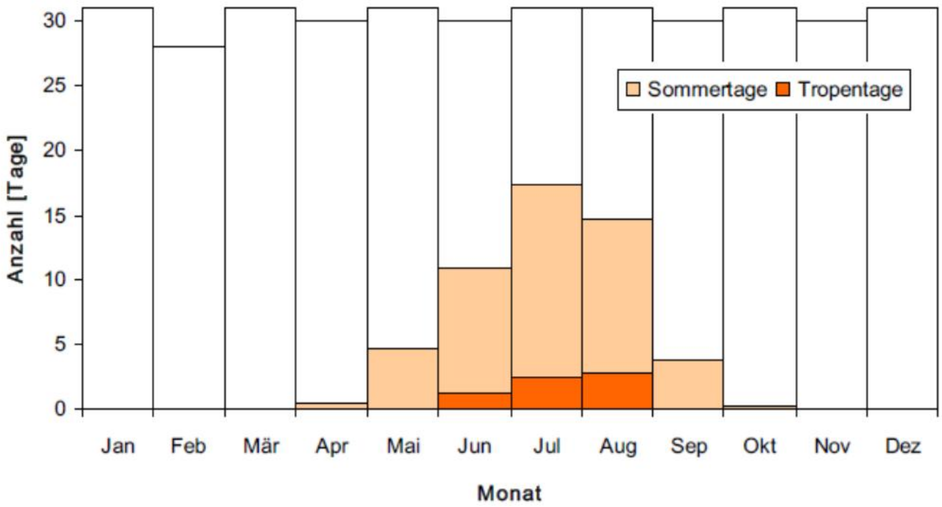


Fig. 46: Average number of summer and tropical days, Climate Atlas of Styria132

The continuous development of the plan, the updating of stakeholders and the incorporation of new topics on the current state of science are the basis of the Styrian heat protection plan in the sense of preparedness. In addition, two stages apply during the BZ:

Preparedness	Planning, preparation, evaluation and further development	
Early warning level	Periods below the threshold	**B.Z.Mai** until **September**
Threshold	**strong heat stress**	
Warning level	Predictable heatwave of **at least three days** and correspondingly **high burden** for **risk groups**	

The threshold value **for severe heat stress** is determined through cooperation with GeoSphere Austria certainly.

[132] Environment Styria, Climate Atlas Styria, www.umwelt.steiermark.at

The **warning level** of the Styrian heat protection plan is activated when a

Period of at least **three days** with a **strong heat stress**

according to the equivalent temperature of the bioclimate index[133] or physiologically equivalent temperature according to the PET system.

- ÿ When the warning level is activated, the population is informed about the general stress situation and to inform about rules of conduct.

- ÿ By activating the Heat Warning System (HWS), data located in the HSPL database are Institutions and persons at risk will receive an email from GeoSphere Austria as soon as possible with a regional heat stress forecast and the most important information in the form of information sheets.

- ÿ In addition to the direct approach and communication of the institutions, there is also the general media preparation a corresponding online offer on the website of the State Health Directorate under

www.verwaltung.steiermark.at

The fastest possible communication gives the affected institutions (nursing homes, kindergartens, mobile services, emergency services...) time to take the necessary
Measures such as adjusting duty rosters, organising additional care staff, carrying out technical activities, and temporarily setting up call services to carry out check-in calls to people living alone should be taken.

A considerable added value for public health lies in raising awareness of the risks of heat waves among those affected and at-risk groups and in
This enables timely, adequate adjustment, preparation and adaptation to the stress situation.

[133] Harlfinger O. et al., Klimatlas Steiermark – Chapter 9, www.umwelt.steiermark.at

6.1 Preparedness & early warning level

Preparedness & Development	
Planning and Preparation	- Development of the heat protection plan for Styria - Identification of risk groups and persons - Identification of stakeholders (nursing homes, mobile services...) - Preparation of information for individual target groups - Creation of information material for the media - Developing awareness and expertise among those affected regarding heat-associated problems and disease progression
Styria ENT – Information work	- Heat protection plan available for download online - Information sheets for target groups and persons at risk online - General recommendations on preventive protection measures - Recommendations for relatives of people at risk - Related Links
Styria Tools & Measures	- General information work and preparatory information for particularly affected facilities such as: retirement homes, hospitals, schools and kindergartens, mobile facilities... - Establishment of the early warning system (HWS) in cooperation with GeoSphere Austria - Evaluation, development and adaptation of the HSPL

Early warning level heat protection plan	
Observation period	Frequent occurrence of summer days and tropical nights with **moderate** to **strong heat stress** in the months of **May** to **September**
Steiermark ÖGD Information work	- Online availability of the heat protection plan and information sheets - Media preparation of relevant information on general rules of conduct regarding cooling the body, Avoid dehydration and be aware of the symptoms of heat-related illnesses - Recommendations for people at risk and their relatives

6.2 Warning level

Warning level heat protection plan	
Basis for activation	A **heat wave** is characterized by at least characterized by **severe heat stress lasting three days .**
Steiermark ÖGD Information work	- Media preparation of information for the population - Information sheets: General rules of conduct, recommendations for Relatives of persons at risk and other information - Request to avoid strenuous outdoor Activities for people at risk
Styria Measures	- Activation of the early warning system (HWS) - Communication between all stakeholders - Recommendation to activate internal plans

6.3 Organisation and partnership

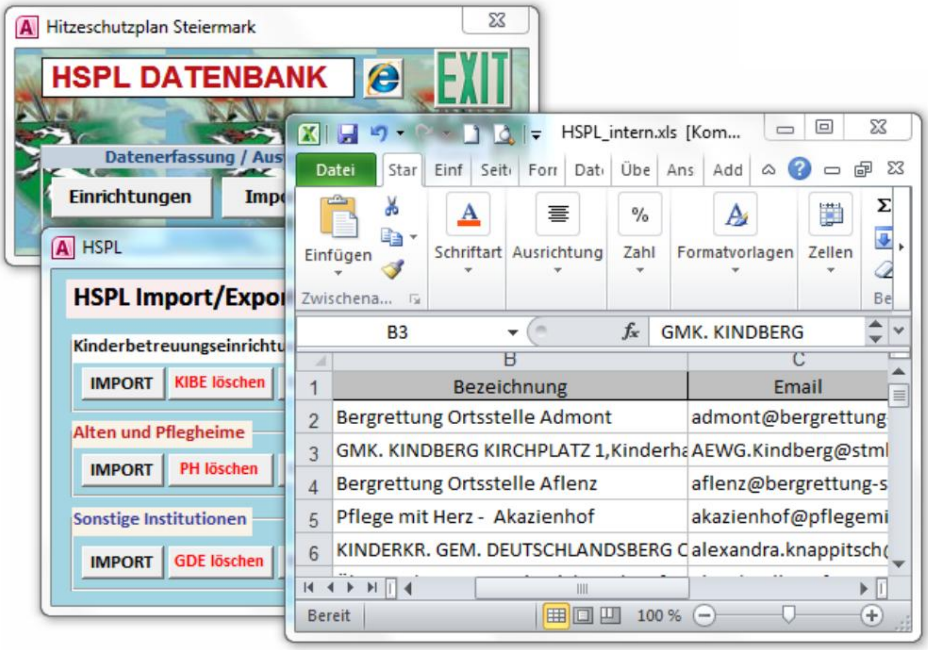
For the Styrian heat protection plan, a cooperation with GeoSphere Austria was initiated to install an early warning system. Naturally, this area of responsibility involves appropriate communication and cooperation with the civil protection authorities, the
State warning center, the emergency services… The cooperation with other authorities and institutions is currently being further developed within the framework of Styria's climate adaptation strategy.

6.3.1 Heat warning system (HWS)

As a basis for the warning system, the contact details of the most important institutions and persons affected are acquired and stored in a database. This data pool is set up, checked and maintained by the State Health Directorate. It includes the most important organizations from the following areas:

- Nursing homes, hospitals
- Childcare facilities, schools
- Other social and disability care facilities
- Emergency and blue light organisations
- Administrative authorities

Fig. 47. HSPL database



Once the research is completed, the data set will be made available to GeoSphere Austria as a distribution list for sending heat warning emails.

Das Land Steiermark → Gesundheit in Kooperation mit ZAMG

Zentralanstalt für Meteorologie und Geodynamik
Kundenservice Steiermark
Klusemannstraße 21, 8053 Graz
Tel.: +43 316 242200
Fax: +43 316 242300
Email: graz@zamg.ac.at
Internet: http://www.zamg.ac.at

Hitzeprognose fuer betroffene Einrichtungen - Warnstufe

Sehr geehrte Damen und Herren!
Die **Zentralanstalt fuer Meteorologie und Geodynamik** (ZAMG) erstellt folgende Prognose:

Prognose:
Nachdem bereits am Wochenende die Hoechsttemperaturen in der Steiermark teilweise bei ueber 30 Grad lagen, erreicht die Hitzewelle in den kommenden Tagen ihren Hoehenpunkt. Die Temperaturen steigen verbreitet ueber die 30 Grad-Marke und werden stellenweise sogar bis zu 35 Grad erreichen. Dabei ist in der gesamten Steiermark mit starker oder maessiger Waermebelastung zu rechnen. Besonders im Grossraum Graz bleiben auch die Naechte aussergewoehnlich warm.

Tendenz:
Bis zumindest Freitag bleibt die starke Waermebelastung erhalten, lokale Hitzegewitter bringen nur eine voruebergehende Entspannung der Situation.

Grossraum Graz:	Starke Waermebelastung
Weststeiermark:	Starke Waermebelastung
Suedoststeiermark:	Starke Waermebelastung
Oststeiermark:	Starke Waermebelastung
Murtal:	Maessige Waermebelastung
Muerztal:	Maessige Waermebelastung

The facilities will receive an email at the beginning of the season with general information about the heat protection plan.

When the **warning level** is activated will be carried out as soon as possible before the predicted start of a heat wave with strong heat stress for at least three days an emailed forecast including leaflets with regional and other important information

sent as an attachment.

Fig. 48: Example notification email warning level

In addition, the forecasts are also available online:

www.wetter-steiermark.at

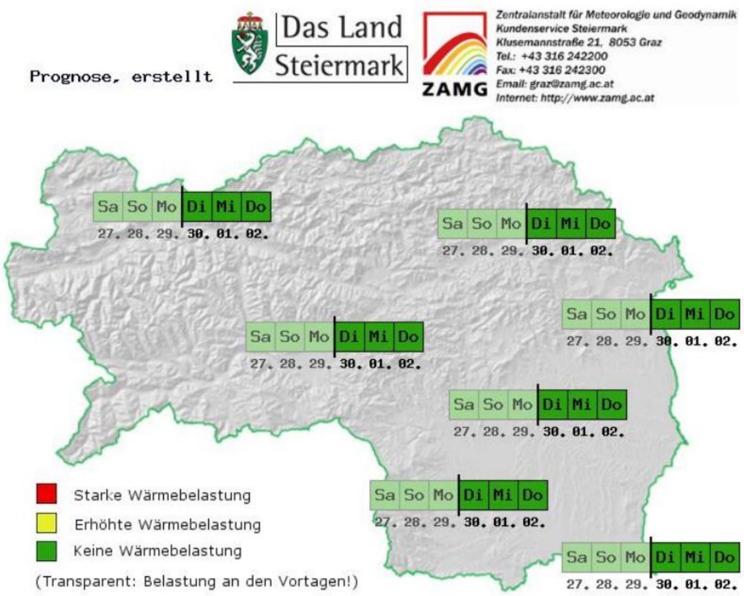


Fig. 49: Example forecast for heat stress in Styria

The evaluation of the German information systems on climate change and health has shown that people at risk who are familiar with the information systems do not protect themselves better in stressful situations than those who are not familiar with these systems. The newsletter systems mostly contain little or no instructions for action. It is therefore recommended that behavioral recommendations be formulated as specifically as possible in order to guide those affected as far as possible towards health-related action competence134 .

As part of the Styrian heat warning system, a comprehensive information package is sent out together with the heat warning. Below is an example of a heat warning email:

steirischer Hitzeschutzplan

Das Land Steiermark
→ Gesundheit

in Kooperation mit

ZAMG
Zentralanstalt für Meteorologie und Geodynamik:
Kundenservice Steiermark
[illegible]
Tel: +43 316 242300
Fax: +43 316 242300
[illegible]

Hitzeprognose für betroffene Einrichtungen - Warnstufe

Sehr geehrte Damen und Herren!

Die **Zentralanstalt für Meteorologie und Geodynamik** (ZAMG) erstellt folgende Prognose:

Prognose:
Eine weitere Hitzewelle im heurigen Sommer kündigt sich an. Erneut ist in weiten Teilen der Steiermark über mehrere Tage hinweg mit Temperaturen von über 30 Grad zu rechnen. Die Wärmebelastung ist zunächst mäßig, steigt aber von Tag zu Tag an, sodass ab Donnerstag bzw. Freitag mit einer starken Wärmebelastung zu rechnen sein wird. Die Höchstwerte liegen dabei zwischen 30 und 35 Grad.

Tendenz:
Am Samstag im Südosten weiterhin starke Wärmebelastung, im Nordwesten der Steiermark könnten Gewitter vorübergehend für einen Temperaturrückgang sorgen. Aus heutiger Sicht ist aber im weiteren Verlauf mit keiner merklichen Abkühlung zu rechnen, vielmehr dürfte es auch in der nächsten Woche heiß weitergehen. Diesbezüglich wird es aber eine Aktualisierung der Prognose in den kommenden Tagen geben.

Großraum Graz:	Starke Wärmebelastung
Weststeiermark:	Starke Wärmebelastung
Südoststeiermark:	Starke Wärmebelastung
Oststeiermark:	Starke Wärmebelastung
Murtal:	Starke Wärmebelastung
Mürztal:	Starke Wärmebelastung
Ennstal:	Starke Wärmebelastung

Aufgrund der für die nächsten Tage zu erwartenden Hitzebelastung wird die Warnstufe des **Steirischen Hitzeschutzplanes** aktiviert. Umfassende Informationen können von folgenden Internetadressen heruntergeladen werden:

www.verwaltung.steiermark.at

www.zamg.ac.at

134 Federal Environment Agency Germany, Evaluation of information systems on climate change and health, www.umweltbundesamt.de, Summary p. XVII

steirischer Hitzeschutzplan

Empfehlungen für Spitäler, Pflegeheime, Mobile Dienste

- Risikopatienten identifizieren
- Räumliche Gegebenheiten analysieren, Maßnahmen zur Abhilfe festlegen (Lüftungsmöglichkeiten, Klimaanlagen etc.)
- Mögliche Kapazitätsengpässe z.B. Pflegepersonalbedarf identifizieren
- Interne Überwachungspläne aktivieren
- Sicherstellen des Informationsflusses - Vorwarnservice, Organisation etc.

In der Regel werden Ihre Betreuungseinrichtungen bestens auf die Bedürfnisse Ihrer Klienten eingestellt sein, dennoch kann es im Verlauf von länger anhaltenden Hitzeperioden zur Überlastung der hausinternen Ressourcen kommen. Von daher ist es wichtig die Kapazitäten des eigenen Hauses richtig einschätzen zu können, insbesondere die gestiegenen Anforderungen an das Betreuungspersonal.

Hitzewelle & Tropentage/-nächte

Nicht nur ältere Menschen, chronisch Kranke, behinderte Menschen und Kinder sind besonders betroffen. Für Jeden ist das Befolgen einiger nützlicher Ratschläge nicht nur wohltuend, sondern auch gesund!

Allgemeines Verhalten & Sofortmaßnahmen

! Trinken Sie mindestens 2 - 3 Liter pro Tag, am besten Mineralwasser oder Fruchtsäfte

! Vermeiden Sie alkohol-, koffein- und stark zuckerhaltige Getränke

! Tragen Sie lockere Kleidung, eine Kopfbedeckung und kühlen Sie Ihren Körper

! Suchen Sie kühle Räume auf, vermeiden Sie körperliche Anstrengungen im Freien

steirischer Hitzeschutzplan

Was ist bei der Einnahme von Medikamenten zu beachten

Medikamente können die Körpertemperatur und den Elektrolythaushalt des Körpers beeinflussen. Besondere Achtsamkeit ist geboten bei:

- Diuretika (Entwisserungsmittel)
- Sedativa (Beruhigungsmittel), Antidepressiva
- Alle die Aufmerksamkeit einschränkende Medikamente
- Bestimmte Antibiotika

Bei Fragen kontaktieren Sie bitte Ihre(n) behandelnde(n) Ärztin /Arzt

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Erste Warn-Zeichen bei Hitzestress

- Starkes Schwitzen, Leistungsverlust, Schwindel
- Herzklopfen - erschwertes Atmen
- Pulsierender Kopfschmerz - Verwirrtheit
- Trockene Haut - Muskelkrämpfe
- Erbrechen, Durchfall

Sonnenstich und Hitzestau

Sonnenstich als Folge von zu langer direkter Sonneneinstrahlung bewirkt heftige Kopfschmerzen bis hin zum Bewusstseinsverlust...

! Hinlegen - Körper kühlen, Flüssigkeit trinken

Hitzeschlag und Hitzeschock

Der Hitzeschock ist lebensbedrohlich bei Körpertemperaturen über 40 °C sowie Störungen des Zentralnervensystems, Delirium... bis hin zum Koma.

! Arzt verständigen - Hinlegen - Körper kühlen - Flüssigkeit trinken

Für weitere Informationen besuchen sie die Websites der A8 bzw. der ZAMG

6.3.2 Affected parties & stakeholders outside the HWS

Heat warning systems are often unable to reach some groups of people by email, as many of them have no internet affinity. Caring for these people, who are particularly at risk during a heatwave - especially if they are over a certain age or have other socioeconomic, physical and mental limitations - is often the responsibility of relatives and neighbours when trained mobile service staff or street workers are not available. It is particularly important for these carers to create awareness of the vulnerability of relatives, those being cared for and clients during heatwaves.

Despite a close-knit care network in Austria, some of the elderly people be on your own during a heatwave. People who live alone are at particular risk because, in addition to their existing limitations, they are unlikely to be able to adequately assess their own hydration level. Moral courage is particularly important here.

Dedicate to single, elderly and sick people in the neighborhood
Pay special attention during a heat wave.

7. Information & Recommendations

All of the following information and recommendations on the Styrian heat protection plan can also be found on the A8 website at www.verwaltung.steiermark.at

7.1 General information content

In general, it is important during periods of strong or extreme heat stress drink **enough fluids** such as water and juices.

The minimum amount is 1.5 liters per day - but more depending on the activity. These liquids should be consumed in a timely and regular manner - i.e. before **you** feel thirsty.

In addition, the following **general behaviors** are appropriate during a heat wave:

ÿ Regular cooling of the body (showers, swimming pools…) ÿ
Staying in cool rooms or in the shade (parks) during the hottest hours
ÿ Restriction of non-essential physically demanding outdoor activities
ÿ Wear light and bright clothing, headgear and sunglasses
ÿ Protection against UV radiation – sunscreen etc. (Chapter 3.4)
ÿ Avoid alcoholic, sugary and caffeinated drinks
ÿ Preference for refreshing foods such as salads etc. ÿ
Adequate supply of minerals

7.2 Recommendations for relatives and care at home

Relatives, caregivers and neighbors of single elderly people and other people at risk should pay special attention to them during a heat wave.

In addition to monitoring the general physical condition, particular attention should be paid to dehydration. In addition, the following recommendations should be considered and measures taken:

ÿ Organisation of daily telephone calls or visits for monitoring purposes if necessary
of physical condition
ÿ Clarification of alternative care options through emergency services ÿ
Ensuring the supply of suitable food and drinks ÿ Provision of emergency
telephone lists with emergency numbers and contact persons such as
Relatives, neighbors, family doctors…
ÿ Creation of medication lists (in consultation with the attending physician) for further
use and documentation for emergency physicians, emergency services…

7.3 Contents – Inpatient facilities, nursing homes, hospitals…

As a rule, the individual inpatient facilities are well prepared to care for and support their clients' needs.

Awareness of the **vulnerability** of those **being** cared for must be developed among all those involved and **reactivated** annually (high risk potential of the first early heat wave)

During prolonged periods of heat, internal resources may become overloaded – it is therefore important to correctly assess the capacity of your own company in order to be able to plan and implement adaptation measures.

ÿ Creation of an in-house action plan for heat stress
ÿ Identification of high-risk patients ÿ
Analysis of the spatial conditions, planning or implementation of necessary measures
such as shading concepts, ventilation options, air conditioning systems…
ÿ Determination of nursing staff requirements and identification of possible
Capacity bottlenecks – planning vacation times
ÿ Ensuring the flow of information in the building ÿ
Forwarding information from the heat protection plan and early warning service
ÿ Training of care staff

7.4 Mobile services and volunteer organizations

During periods of extreme heat stress, continuous care for elderly people living alone and those who are otherwise at risk is particularly necessary. If they cannot be cared for by relatives or neighbors, mobile services and volunteer services are the most important contacts for people at risk.

In addition to the technical requirements and the above-mentioned recommendations for caring for people at home, the focus in the future will be on networking the relevant care facilities. Existing care platforms could be expanded and networked with newly implemented registers of people at risk and relatives in order to enable efficient coordination of the deployment of care staff and the involvement of volunteers and relatives.

7.5 Emergency numbers and contact points

General emergency numbers:

Organisation	Times	Phone number
Red Cross	24 hours	144
Emergency medical service Graz	Weekdays from 7 p.m. to 7 a.m., Saturdays, Sundays and holidays 24 hours	141
Emergency medical service Styrian **Municipalities** (ÄK-Stmk.):	Weekdays from 7 p.m. to 7 a.m., Saturdays, Sundays and holidays 24 hours	Area code + 141
Pharmacies Night and Emergency service:	24 hours	1455 Teletext S. 649
Pediatric emergency service Graz:	Fri. 2pm to 11pm | Sat., Sun. and holidays 8 a.m. to 11 p.m.	0316 / 691 512
Further information at **www.gesundheit.steiermark.at**		

Mobile services in Styria

- Caritas Steiermark
- Styrian Relief Organisation
- Mobile Services SMP-HKP
- Red Cross Styria
- People's Aid Styria

Tel.: 0316 / 908 501 170 Tel.:
0316 / 813 181 Tel.:
0316 / 817 300 Tel.:
050 / 144 510 202 Tel.:
0316 / 89 600

www.caritas-steiermark.at
steiermark.hilfswerk.at
www.smp-hkp.at
www.roteskreuz.at
www.stmk.volkshilfe.at

Internet

• A8 Science and Health
• Social server of the state of Styria
• Citizens' service of the municipalities • Volunteer web platform • Styrian Chamber of Pharmacists • Styrian Chamber of Doctors

www.verwaltung.steiermark.at
www.soziales.steiermark.at
www.gemeinde.steiermark.at
www.freiwilligenweb.at
www.apotheker.or.at
www.aekstmk.or.at

8. Economic effects of heat warning systems

As part of the interdisciplinary research project COIN (Cost of Inaction; Climate Change Center Austria – CCCA), the effects of climate change in Austria were estimated and economic evaluation for all areas135. The assumption was an average Warming scenario up to 2050 within the 2-degree zone. In addition to partially positive effects for agriculture in Austria, climate change is causing increasing costs due to damage caused by extreme weather events for agriculture and buildings, health damage, refugee flows... Since the costs of health damage as a result of climate change in urban areas are difficult to estimate due to the complex interaction of several factors, the costs of prevention - to reduce the occurrence of heat islands by building additional parks - were used.

8.1 Costs due to consequential health damage

The COIN study found that in the period up to 2030, around € 127 million (2031 to 2050: € 107 million) would have to be spent annually in Austria to compensate for the consequences of climate change – with two thirds of the costs being due to poor ventilation due to urban growth and only one third to climate change itself136 . With an average temperature increase of 1°C in the moderate scenario, in the six countries examined

Austrian cities will need 195 hectares of additional parking space and 4,300 newly planted trees by 2030 to maintain temperature comfort. In the period 2031 to 2050, 143 hectares and 4,500 new trees would be needed. The costs are highest for Vienna (approx. €4 billion) due to its size, Innsbruck or Klagenfurt would be fine with less than €100 million and the investment costs for Salzburg, Linz and Graz would be around twice as high.

The amount of investment costs is of the course of climate change and the temperatures. Other Urban Heat enhancing Factors other than forecast Urban growth will not taken into account, since their causal relationships are difficult to evaluate and difficult to translate into costs. can be pressed.

Tabelle 1: Durchschnittliche ökonomische Auswirkungen pro Jahr eines zusätzlichen Bedarfs an Grünflächen in Österreichs Städten (in Mio. €) .

Zukünftige ökonomische Auswirkungen*			Klimawandel		
			schwach	moderat	stark
Ø 2011-2030	Sozio-ökonomische Entwicklung (Sensitivität**)	mittel	-108	-127	-166
Ø 2031-2050		mittel	75	-107	-172

* Zukünftige ökonomische Auswirkungen: negative Zahlen bedeuten Netto-Verluste, positive Zahlen bedeuten Netto-Gewinne.
**Ergebnissensitivität hinsichtlich der sozioökonomischen Eingangsparameter.

Tab. 13: Average costs for Green space expansion

135 CCCA, COIN, www.ccca.ac.at

136 CCCA, COIN – Factsheet Urban Spaces, coin.ccca.at

As can be seen in the table, the costs of compensating for climate change by expanding green spaces vary considerably depending on the scenario. The existing problems in urban areas are exacerbated by population growth, the general health of the population and the increasing ageing of society.

Due to the more frequent occurrence of heat waves and their increasing intensity, up to 1,300 additional deaths per year are to be expected among the growing group of older people in Austria for the period 2036 – 2065. When estimating **extreme years** and taking into account vulnerable population groups (chronically ill people, etc.), the health effects can be expected **to increase sixfold137 .**

Socioeconomic factors such as an ageing population, use of air conditioning, etc. were taken into account for climate change scenarios of varying degrees. These factors only change the number of heat deaths in the scenarios by 20 – 30%, whereas the climate assumptions themselves influence the result by 150 – 180%.

In an average year,
According to climate assumptions, up to 3,000 deaths
cases **(strong scenario)** due to
Heat waves expected.

Tab. 14: COIN – Climate Change Event spaces and Mortality138

Durchschnittliche jährliche hitzebedingte Todesfälle an aufeinander folgenden Hitzetagen für unterschiedliche klimatische und sozio-ökonomische Entwicklungen.

Hitzebedingte Todesfälle pro Jahr Relativ zu Ø 1981-2010			Klimawandel		
			schwach	moderat	stark
Ø 2016-2045	Sozio-ökonomische Entwicklung (Sensitivität*)	gering	540	370	1010
		mittel	580	400	1100
		hoch	640	430	1200
Ø 2036-2065		gering	640	920	2280
		mittel	730	1060	2610
		hoch	830	1200	2960

Since the health costs of climate change are difficult to assess directly, the model approach uses losses in life expectancy and evaluates them using the Life-Years-Lost **(LYL)** system .

The arguments for the costs of health consequences caused by heat waves are and statements on future developments are scientifically verifiable and reliable and can therefore be easily estimated **(moderate scenario).**

Tab. 15: Damage in Austria without global repercussions

Schaden in Millionen €, Ø pro Jahr (zu Preisen 2010)		
B) Zusätzliche zukünftige Schäden	**2016–2045**	**2036–2065**
Nicht-marktliche Schäden:		
Hitzebedingte vorzeitige Todesfälle	**95 bis 255**	**570 bis 1.300**
Bewertung mittels Value of Life Years Lost (€ 63.000 pro LYL)	95 [82 bis 580]	570 [285 bis 1.840]
oder Bewertung mittels Value of Stat. Life (€ 1,6 Mio. pro SL)	255 [210 bis 1.535]	1.300 [640 bis 4.350]

137 CCCA, COIN – Overview, coin.ccca.at

138 Ibid., COIN Factsheet Health, coin.ccca.at

8.2 Use of heat warning systems

The Styrian heat protection plan has not yet been evaluated in detail. As part of the analysis
The cost-benefit efficiency of the German heat warning systems (HWS) was examined and evaluated as part of the measures of the **German climate change adaptation strategy .** The calculation of the damage costs of heat waves according to Hübler and Klepper139 was used. As in the COIN analysis (LYL), premature deaths were calculated using a "Value of Life Year" concept.

(VOLY) rated.

In addition to reducing harm by preventing premature deaths, the implementation of HWS also has a direct impact on the costs of the public health system such as hospitals, general practitioners and emergency services. The effectiveness of heat warning systems in preventing heat-related health damage is estimated at **30%.**

estimated140 .

By reducing the number of hospital admissions, there is a potential saving of EUR 165 million.

Euro in **Germany** per year for the forecast period.

Tab. 16: Benefits of

Heat warning systems in Germany141

Vermiedene Hitzetote	
Nach VOLY-Konzept (59.000 Euro pro Jahr, Verlust von 8 Lebensjahren)	472.000 Euro pro vermiedenen Hitzetoten
für 5.000 vermiedene Hitzetote in Mrd. pro Jahr	2,36 Mrd. Euro/a
Krankenhauseinweisungen	
Anzahl (2071-2100) (heute: 24.500)	150.000
Kosten pro Einweisung	3.300 Euro
Kosten pro Jahr	495 Mio. Euro/a
Vermeidung von 30% durch Hitzewarnsystem möglich	165 Mio. Euro/a
Gesamt	**2,5 Mrd. Euro/a**

Not taken into account in this list are the avoidance of other costs such as the reduction in the number of emergency services, emergency medical interventions…

If the results of the analysis of the German climate change adaptation strategy are broken down to the situation in Austria in relation to the number of inhabitants with the same Central European standards of health systems, the hypothetical benefit would be approximately
one tenth of the above-mentioned potential benefits of heat warning systems for Austria and around **15%** of that for Styria.

139 Hübler M. , Klepper G., University of Kiel, Institute for World Economy, Costs of Climate Change, www.ifw-kiel.de

140 Tröltzsch J. et al., Costs and benefits of climate change adaptation measures, www.umweltbundesamt.de

141 ibid

9. Conclusions & Outlook

One of the directly noticeable consequences of climate change is the increase in the frequency and intensity of heat waves. Depending on how the overall situation develops (RCP scenarios), more or less severe warming can be expected in the future. For example, the number of tropical days with temperatures over 30°C per year in Graz has increased from around 10 to around 30 since 2004.

The 2003 heat wave with 70,000 additional deaths and the 2010 heat wave in Russia with

An estimated 55,000 deaths have once again highlighted the potential danger of periods of prolonged heat stress. The risk groups already mentioned are particularly affected, but so are all other people who have a pre-existing physical condition. The danger of heat stress is generally underestimated.

Due to additional reinforcing factors,
Heat waves especially in **urban** areas

A significant increase in heat waves with extremely hot days and nights has been observed worldwide. A study of the period from 1973 to 2012 shows that heat waves have become more frequent in the last decade.

Compared to rural areas, the situation in the cities is also worsened by

partially reduced wind activities.

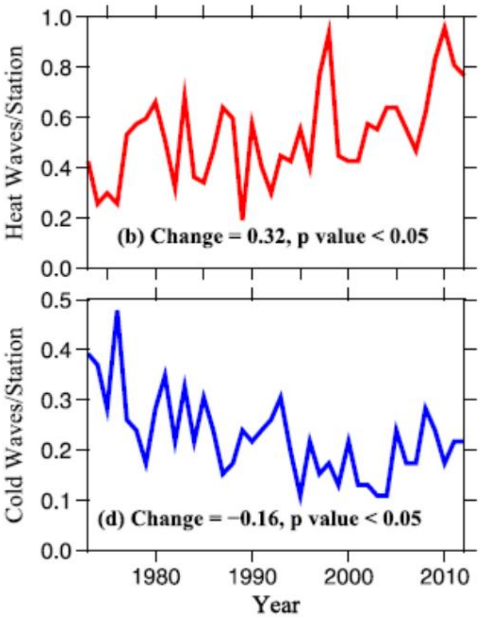

Fig. 50: Development of the frequency of heat and cold waves, source142

Cities and urban living spaces are more severely affected by heat waves for a variety of reasons. The interaction of several factors is leading to an increase in heat islands in cities (Chapter 3.1). One of the most effective long-term adaptation measures to compensate for heat stress in urban living spaces is the creation of additional green spaces, as parks are 3 to 6°C cooler than built-up and sealed spaces143 .

The heat waves of recent years have highlighted the trend of climate change. There are also now sufficient scientific studies on the health consequences of heat waves and their impact on society. For this reason, national heat action and protection plans have been drawn up in recent years in western industrialized countries (Belgium, Denmark, England, France, Italy, Luxembourg, the Netherlands, Portugal, Spain). In Austria, this has so far only been done in a rudimentary manner at the federal level.

[142] Vimal Mishra et al., Changes in observed climate extremes in global urban areas, iopscience.iop.org

[143] CCCA, COIN – Factsheet Urban Spaces, coin.ccca.at

Heat action plans usually contain short-term packages of measures to prevent immediate health damage as a result of heat stress. In France, for example, the municipalities create lists of people at risk and set up voluntary registration and care registers for them in order to extend the reach of the heat warning systems (HWS). In Portugal, for example, heat deaths must be reported. In addition to the individual measures to reduce the immediate danger to risk groups, the long-term strategic orientation to the changing environmental conditions is also important. This affects climate protection in general, but also spatial planning, urban development measures, the expansion of green spaces, shading concepts in building design...

The improvement of the general health of the population, also in view of the ageing of society and its associated vulnerability to heat stress, must not be neglected.

Heat warning systems are highly relevant for the protection of public health and generate a relatively high benefit for society in relation to the low expenditure. They are not in competition with other objectives or measures. In this respect, there are no arguments or reasons that speak against the implementation of a HWS, especially because the benefits of HWS increase disproportionately with the increasing frequency of heat waves and the costs (after a one-time implementation) are relatively low - regardless of how often a HWS is activated.

Basically, HWS have a medium effectiveness – this could be achieved by a comprehensive Increase the location of single people, the implementation of appropriate volunteer registers and more active monitoring as well as direct care of those at risk; provided that the stakeholders are appropriately networked.

In addition to comprehensive preparation, adequate monitoring of heat-related diseases and climatic changes as well as the identification of bioclimatic stress areas important in order to be able to adequately implement the measures of the public health service within the framework of the heat action plans. Existing HWS will be adapted to the respective requirements and networked with other care platforms and systems of these facilities. An expansion of the existing systems in the form of supporting apps for mobile communication is also to be aimed for in the medium term. The HWS should be supplemented by a corresponding volunteer registration register to record individual persons at risk who are not otherwise cared for or reachable.

Low costs, potentially high benefits, the need to adapt to climate change and the realisation that heat stress is not sufficiently anchored in the public consciousness as a cause of mortality justify the usefulness of developing heat action plans and taking adequate measures to prevent health problems.

consequential damage or premature death.

Attachment

List of abbreviations

ASS	Acetylsalicylic acid
AStV	Workplaces regulation
BSchEG	Construction Workers' Bad Weather Compensation Act
BREAK	Construction Workers' Holiday & Severance Pay Fund
BZ	Observation period
CCCA	Climate Change Center Austria
COIN	Cost of Inaction
EEA	European Environment Agency
HK	Cardiovascular diseases
HKA	Cardiovascular and respiratory diseases
HS	Heat stress
HSPL	Heat protection plan Styria
HWS	Heat warning system
IG-L	Air Pollution Control Act 2010
IPCC	Intergovernmental Panel on Climate Change
KGT	Cooling degree days
KS	Cold stress
LBI	Air pollution index
LYL	Life-Years-Lost
ORS	Oral Rehydration Solution
PET	Physiologically equivalent temperature
PM	Particulate Matter
RCP	Representative Concentration Pathways
RIS	Legal information system of the Federal Chancellery
RKI	Robert Koch Institute Berlin
DRY	Swiss State Secretariat for Economic Affairs
SSRIs	Selective serotonin reuptake inhibitors
THG	Greenhouse gases
VOLY	Value-of-Life-Year-Konzept
ZNS	Central nervous system

For better readability, personal terms in this document which refer to both women and men are generally only given in the generic masculine form.

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Analitis A. et al., Effects of heat waves on mortality: effect modification and confounding by air pollutants, PubMed 2014 Jan 25(1):15-22, ncbi.nlm.nih.gov

Federal Chancellery of Austria, Legal Information System – RIS, Convention on Maternity Protection, Recommendation 191- Item 6, ris.bka.gv.at

Dadvand P. et al., Maternal exposure to particulate air pollution and term birth weight, EHP doi: 10.1289/ehp.1205575, ehp.niehs.nih.gov

Diaz J. et al., Effects of extremely hot days on people older than 65 Years in Seville (Spain) from 1986 to 1997, International Journal of Biometeorology 2002, Vol. 46, Nr. 3 S. 145-149, www.springerlink.com

EEA-Report, Impacts of Europe´s changing climate, eea.europa.eu

Fiedler J. et al., Release of fine and ultrafine particles from laser printers under real-world conditions, Hazardous Substances Air Quality Control 3/2009, www.gefahrstoffe.de

Filleul L. et al., The Relation Between Temperature, Ozone, and Mortality in Nine French Cities during the Heat Wave of 2003, Environ Health Perspectives, Sep 2006, 114(9): 1344–1347, ncbi.nlm.nih.gov

Fischer E. M., Schär C.; Consistent geographical patterns of changes in high-impact European Heatwaves, Nature Geoscience, doi: 10.1038/NGEO866, 2010, iac.ethz.ch

Fischer P. H. et al., Air pollution related deaths during the Heatwave 2003 - Netherlands, Atmospheric Environment, Vol. 38 (8), March 2004, www.sciencedirect.com

FOUILLET A. et al., Excess mortality related to the August 2003 heat wave in France, International Archives of Occupational and Environmental Health, Volume 80 – Number 1, 16-24, 2006, www.springerlink.com

Gabriel K.; Diss.: Health risks due to heat stress in urban areas – an analysis of heat wave events with regard to mortality in the Berlin-Brandenburg region, Humboldt University of Berlin, edoc.hu-berlin.de

Gebbers JO, Frei M.; Report on the seminar A1 at the 6th KHM training conference, Lucerne June 2004, Swiss Journal of General Practice Medicine – PrimaryCare 2004 – 4, No. 29-30, pp. 585-591 www.primarycare.ch

Grass D. and Cane M., The effects of weather and air pollution on cardiovascular and respiratory mortality in Santiago, Chile during winters of 1988 – 1996, Int. J. Climatol. 28, 1113 – 1126 (2008), onlinelibrary.wiley.com

Pilger H., Wakonigg H., Climate atlas Steiermark – Chap. 2 temperature, verse. 2.0, umwelt.steiermark.at, p. 102

Pilger H., Harlfinger O., Klimatlas Steiermark – Chapter 9, Vers. 2.0, umwelt.steiermark.at

Heudorf U, Meyer C; Health effects of extreme heat – the example of the heat wave and mortality in Frankfurt am Main in August 2003, Das Gesundheitswesen 67: 369-374 (2005), www.thieme-connect.com

Héroux M., Evidence on Health Effects in support oft the review oft the EU air quality policies: the WHO REVIHAAP and HRAPIE Projects, www.umweltbundesamt.at

Hübler M., Klepper G. Costs of climate change, University of Kiel, Institute for World Economy 2007, www.ifw-kiel.de

IPCC, Climate Change 2014 - Fifth Assessment Report, www.ipcc.ch

Ippoliti D. et al., The impact of heat waves on mortality in 9 European cities: results from the EuroHEAT Project., Environ Heath 2010, www.ehjournal.net

Ippoliti D. et al., Effects of heatwaves on mortality – effect modification and confounding by airpollutants, Epidemiology 2014 Jan, 25(1):15-22 (PubMed), ncbi.nlm.nih.gov

Kälin P., Kondo Oestreicher M., Pfluger T.; CURRICULUM, Switzerland Med Forum 2007- 7, No. 31-32, pp. 644-648, medicalforum.ch

Koppe Christina, Health-relevant assessment of thermal stress taking into account the short-term adaptation of the population to local weather conditions, dissertation Albert-Ludwigs-University Freiburg i. Brsg. 2005, freidok.uni-freiburg.de

Koppe Ch., Jendritzky G., Pfaff G.; The effects of the 2003 heat wave on health, DWD Climate Status Report 2003, www.dwd.de

Kuttler Willhelm, Climate change in urban areas: Part 1 – Effects, Environmental Sciences Europe 2011, 23:11, enveurope.com

Marktl W., Muthers S., Koch E., Matzarakis A., Climate influences mortality, Austrian Medical Journal (2010), Vienna, www.aerztezeitung.at

Muthers Stefan, Investigation of the relationship between thermal bio-climate and mortality in Austria based on measurement data and regional climate models, University of Freiburg 2010, freidok.uni-freiburg.de

Orru H. et al., Impact of climate change on ozone-related mortality and morbidity in Europe, European Respiratory Journal 2013: 285-294, erj.ersjournals.com

Olsson D., Air pollution exposure in early pregnancy and adverse pregnancy outcomes, British Medical Journal Open 2013, doi: 10.1136/bmjopen-2012-001955, bmjopen.bmj.com

Panis Luc et al., Exposure to particulate matter in traffic: a comparison of cyclists and car passengers, Athmospheric Environment, Vol. 44, Issue 19, June 2010; www.sciencedirect.com

RKI, Climate Change and Health – a Status Report, Robert Koch Institute Berlin 2010

Pilger H. et al., Klimatlas Steiermark, Vers. 2.0, umwelt.steiermark.at Cap. 2, p. 102

Robine JM. et al., EU Community Action Program for Public Health: Report on excess mortality in Europe during summer 2003; ec.europa.eu

Ruidavets Jean-Bernard et al., Ozone Air Pollution is associated with acute Myocardial Infarction, American Heart Association, circ.ahajournals.org

Sartor F. et al., Mortality in the elderly and ambient ozone concentration during the hot summer, 1994, in Belgium; Environmental Research Feb. 1997, Vol. 72, http://www.sciencedirect.com

Shaposhnikov D. et al., Mortality Related to Air Pollution with the Moscow Heat Wave and Wildfire of 2010, Epidemiology. 2014 May; 25(3): 359–364, www.ncbi.nlm.nih.gov

Stedman J. et al.: The impact of the 2003 Heatwave on daily mortality in England and Whales and the use of rapid weekly mortality estimates, Eurosurveillance, Volume 10, Issue 7, 01 July 2005, www.eurosurveillance.org

Tao Tang et al., Investigations on the genetic toxicity of emissions from laser printers in A549-Cells in the Vitrocell® Transwell exposure system, Institute of Environmental Medicine – University of Freiburg, www.uniklinik-freiburg.de

The ESCAPE Project, Long term exposure to ambient air pollution and incidence of acute coronary events: prospective cohort study and meta-analysis in 11 European cohorts from the ESCAPE Project, British Medical Journal 2014, 348:f7412 doi, www.bmj.com

Tröltzsch J. et al., Costs and benefits of adaptation measures to climate change, analysis of 28 adaptation measures in Germany, Ecologic Institute Berlin, www.umweltbundesamt.de

Weblinks:

Stand May 2015

General Accident Insurance Institute: http://www.aushang.at/Prot/Infomat/Arbeiten_im_Freien.pdf American Heart Association: http://circ.ahajournals.org/content/111/5/563.abstract Doctors' newspaper: http://www.aerztezeitung.at/archiv/oeaez-2010/oeaez-10-25052010/originalarbeit-klima-affected-mortality.html

British Medical Journal, ESCAPE Project: http://www.bmj.com/content/348/bmj.f7412 BUAK: https://www.buak.at/servlet/ContentServer?pagename=BUAK/Page/Index&n=BUAK_3.4 Federal Chancellery Legal Information System: http://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20003631 Federal Ministry of Labour, Social Affairs and Consumer Protection:

http://www.arbeitsinspektion.gv.at/NR/rdonlyres/9A9189E3-8396-4679-9227- 12E722D79B9F/0/LeitfadenGefahrenevaluierungfürnatürlicheoptischeStrahlung.pdf http://www.arbeitsinspektion.gv.at/NR/rdonlyres/9A9189E3-8396-4679-9227- 12E722D79B9F/0/LeitfadenGefahrenevaluierungfürnatürlicheoptischeStrahlung.pdf Caritas Styria, Mobile Services: http://www.caritas-steiermark.at/hilfe-einrichtungen/fuer- seniorinnen/betreuung-zuhause/mobile-dienste-fuer-aeltere-menschen/ CCCA, Climate Change Center Austria: http://www.ccca.ac.at/nc/de/news/news-detail/article/coin-cost-of-inaction-projekt-abgeschlossen/ http://coin.ccca.at/sites/coin.ccca.at/files/7_cityurban_final_v14_15012015.pdf CerclÁir - Swiss Society of Air Hygiene Professionals: http://cerclair.ch/empfehlungen Department for Environment, Food & Rural Affairs: http://uk-air.defra.gov.uk/assets/documents/reports/cat12/0405261522_7_targa.pdf German-speaking Community of Belgium: http://www.dglive.be/PortalData/2/Resources/downloads/gesundheit/plan_HOP_DE.pdf Document and publication server of the Humboldt University of Berlin: http://edoc.hu-berlin.de/docviews/abstract.php?lang=ger&id=30740 Document server University of Freiburg: https://www.freidok.uni-freiburg.de/data/1802/ EEA: http://www.eea.europa.eu/publications/climate_report_2_2004 Federal Commission for Air Hygiene: http://www.ekl.admin.ch/fileadmin/ekl- dateien/dokumentation/Sommersmog_D_2011-07-18.pdf Environmental Health: http://www.ehjournal.net/content/9/1/37 ETH Zurich: http://www.iac.ethz.ch/people/fischeer/fischer_schaer_2010.pdf European Respiratory Journal: http://erj.ersjournals.com/content/41/2/285.long European Environment Agency: http://www.eea.europa.eu/data-and-maps/figures/number-of-reported- deaths-and-minimum-and-maximum-temperature-in-paris-during-the-heatwave-in-summer-2003/fancybox.html Geoportal of the City of Graz: http://www.geoportal.graz.at/cms/dokumente/10223258_ 5414865/69720572/Stadtklima_KLIMATOPKARTE.pdf Hamburg Education Server: http://wiki.bildungsserver.de/klimawandel/index.php/RCP-Szenarien Styrian Relief Organisation: http://steiermark.hilfswerk.at/

IFW – University of Kiel: https://www.ifw-members.ifw-kiel.de/publications/2kosten-des-klimawandels-die-wirkung-steigender-temperaturen-auf-gesundheit-und-leistungsfahigkeit/
Kosten%20des%20Klimawandels%20WWF%20IfW.pdf IOPScience: http://
iopscience.iop.org/1748-9326/10/2/024005/

Climate and Energy Fund Austria: https://www.klimafonds.gv.at/news/klimastatusbericht-oesterreich- 2018/

Climate Change Adaptation Austria: http://www.klimawandelanpassung.at/fileadmin/inhalte/ kwa/bilder/
Newsletter10/A4-quer_Cctalk_Broschure_A5_KindergaertnerInnen.pdf

State of Styria, A8 – Heat protection plan: http://www.verwaltung.steiermark.at/cms/ziel/74834789/DE/

State of Styria, Social Affairs – Directory: http://www.soziales.steiermark.at/cms/ziel/10024850/DE/

State of Styria, Statistics, http://www.statistik.steiermark.at/cms/beitrag/11682476/103034960/

State of Styria, Environmental Education Centre: http://www.ubz-stmk.at/upload/ documents/
cms/304/Unser_Lebensmittel_Luft.pdf

State of Styria, A15 Environmental information – AIR:
http://app.luis.steiermark.at/berichte/Download/Jahresberichte/Jahresbericht_2013_C.pdf
http://www.umwelt.steiermark.at/cms/beitrag/11023498/19222537/
http://www.umwelt.steiermark.at/cms/ziel/2277576/DE/
http://www.umwelt.steiermark.at/cms/beitrag/11921526/19221910/
http://www.umwelt.steiermark.at/cms/beitrag/10469589/12682810/
http://www.umwelt.steiermark.at/cms/beitrag/10703612/16178332/
http://www.umwelt.steiermark.at/cms/ziel/18155635/DE/
http://www.umwelt.steiermark.at/cms/dokumente/11678675_75236689/0a848902/KWF-Szenarien-Report%20NEU.pdf
http://www.umwelt.steiermark.at/cms/dokumente/11678675_75236689/f804bf83/KWF-Factsheets%20Bezirke.pdf
http://www.umwelt.steiermark.at/cms/dokumente/10741538_16178332/a2673d5b/9_BIOKLIMA%20-%20Vers_2.0.pdf

Ministry of Life:
http://www.bmlfuw.gv.at/umwelt/luft-laerm-verkehr/luft/uv-strahlung/UV-Faktoren.html
http://www.bmlfuw.gv.at/dms/mat/umwelt/ klimaschutz/kyoto- prozess/
wissenschaftliche_grundlagen/ipccbericht2014/ Jacob_Klimawandel-in-Europa_IPCC-28-04-2014/Jacob_Climate%20Change%20in%20Europe_IPCC%2028-04-2014.pdf
http://www.bmlfuw.gv.at/dms/lmat/umwelt/klimaschutz/klimapolitik_national/anpassungsstrategie/Anpass ungsstrategie/
VulnerabilitaetsberichtII-Dez2010.pdf

Medical University of Innsbruck: http://uv-index.at/

Medical University of Vienna: http://www.meduniwien.ac.at/homepage/3/news-und-topstories/?
Fsize=0&tx_ttnews%5Btt_news%5D=1707&cHash=ed0c076ce7

National Center for Biotechnology Information:
http://www.ncbi.nlm.nih.gov/PMc/articles/PMC1570046
http://www.ncbi.nlm.nih.gov/PMc/articles/PMC3984022/ http://www.ncbi.nlm.nih.gov/pubmed/24162013

Nature Geoscience: http://www.nature.com/ngeo/journal/v3/n6/abs/ngeo866.html

Public health portal of Austria: https://
www.gesundheit.gv.at/Portal.Node/ghp/public/content/wie_uv-strahlen_wirken1.html
https://www.gesundheit.gv.at/Portal.Node/ghp/public/content/hauttypen.html

https://www.gesundheit.gv.at/Portal.Node/ghp/public/content/radfahren-risikobilanz.html Ozone Info Switzerland: http://www.ozon-info.ch/index.php?id=33

Primary Care, Swiss Journal of General Practice Medicine: http://www.primary-care.ch/docs/primarycare/archiv/defr/2004/2004-29/2004-29-273.PDF Red Cross Styria: http://www.roteskreuz.at/stmk/pflege-betreuung/mobile-pflege-betreuung/ Switzerland Med Forum: http://medicalforum.ch/docs/smf/archiv/de/2007/2007-31/2007-31-185.pdf Swiss Accident Insurance Fund: http://www.suva.ch/factsheet-sommersmog-ozon.pdf Science Daily, Science News: http://www.sciencedaily.com/releases/2010/06/100611145451.htm Science Direct, Journal of Atmospheric Environment: http://www.sciencedirect.com/science/article/pii/S1352231003010197 http://www.sciencedirect.com/science/article/pii/S1352231010003225 Social medical nursing service and home nursing: http://www.smp-hkp.at/ Ministry of Social Affairs Volunteer Web: http://www.freiwilligenweb.at/index.php?id=CH0530&organisation=&bundesland=Steiermark&thema%5B%5D=19&form_submit=Search+start SpringerLink:
http://link.springer.com/article/10.1007/s00484-002-0129-z http://link.springer.com/article/10.1007%2Fs00420-006-0089-4

State Secretariat for Economic Affairs SECO:
http://www.seco.admin.ch/dokumentation/publikation/00009/00027/02113/?lang=en StartClim, StartClim 2005: http://www.austroclim.at/fileadmin/user_upload/reports/StCl05gesamt.pdf StartClim, StartClim 2008 A: http://www.austroclim.at/fileadmin/user_upload/reports/StCl08A.pdf Thieme Publishers: https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-2004-813924 Environmental Education Center Styria: http://www.ubz-stmk.at/upload/documents/cms/304/
Unser_Lebensmittel_Luft.pdf Federal Environment Agency Germany:

http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/umwelt_und_gesundheit_03_2015_evaluation_von_informationsssystemen_band_1_0.pdf Federal Environment Agency Austria:
http://www.umweltbundesamt.at/umweltsituation/klima/klimawandel/klimaszenarien/ http://www.umweltbundesamt.at/umweltsituation/luft/luftguete_aktuell/grenzwerte/ http://www.umweltbundesamt.at/umweltschutz/luft/luftguete_aktuell/ozonbericht/?&wai=1 http://www.umweltbundesamt.at/umweltsituation/luft/luftschadstoffe/staub/PM10/ http://www.umweltbundesamt.at/umweltsituation/luft/luftschadstoffe/staub/PM25/ http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0283.pdf http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/luft/Heroux_Workshop_Gesunde_Luft_13110 7.pdf University of Freiburg: http://www.freidok.uni-freiburg.de/volltexte/7920/ University of Innsbruck: http://uv-index.at/
International Association for Urban Climate:

http://www.urbanclimate.net/matzarakis/papers/BIOMET7_Muther_Matzarakis_Koch_1_229_234.pdf US Environmental Protection Agency: http://www.epa.gov/heatisland/about/index.htm Austrian Transport Club: http://www.vcoe.at/de/publikationen/vcoe-factsheets/details/items/ultra-feinstaub-macht-krank

http://www.vcoe.at/de/publikationen/vcoe-factsheets/details/items/belastung-durch-stickoxide-ist-in-oesterreich-zu-hoch

Volkshilfe Styria: http://www.stmk.volkshilfe.at/Fachbereich_Sozialzentren

WHO:

http://www.who.int/mediacentre/factsheets/fs313/en/ http://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/pre-2009/heathealth-action-plans

http://www.euro.who.int/__data/assets/pdf_file/0005/78647/E91843.pdf

http://www.who.int/uv/intersunprogramme/activities/uv_index/en/

http://www.euro.who.int/en/countries/the-former-yugoslav-republic-of-macedonia/publications3/heat-health-action-plan-to-prevent-the-heat-wave-consequences-on-the-health-of-the-population-in-the-former-yugoslav-republic-of-macedonia

http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications

http://www.euro.who.int/de/media-centre/sections/press-releases/2015/air-pollution-costs-european-economies-us$-1.6-trillion-a-year-in-diseases-and-deaths,-new-who-study-says

http://www.euro.who.int/__data/assets/pdf_file/0009/276957/PR_Economics-Annex_de.pdf?ua=1

Central Institute for Meteorology and Geodynamics:

http://www.zamg.ac.at/cms/ de/klima/informationsportal-klimawandel/klimazukunft/europa/extremereignisse

https://www.zamg.ac.at/cms/de/klima/news/oesterreichisches-klimabulletin-2018

Center for Health: http://www.zentrum-der-gesundheit.de/hautkrebs-antibiotika-ia.html