Cooling strategies in the context of urban heat - perspectives on heat-related vulnerability

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Diplomarbeit

Cooling strategies in the context of urban heat - perspectives on heat-related vulnerability

ausgeführt zum Zweck der Erlangung des akademischen Grades
einer Diplom-Ingenieurin

unter Leitung von
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E280-06 Forschungsbereich Soziologie
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eingereicht an der Technischen Universität Wien
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Wien, am 19.02.2025

Résumé - FR

Les températures urbaines, considérées avant comme «extrêmes», sont devenues normales au XXIe siècle. Comme l'ont montré des études précédentes, des facteurs tels que l'âge, le milieu socio-économique, l'état de santé physique et mentale ou les structures urbaines influencent fortement la vulnérabilité à la chaleur urbaine. Étant donné que les inégalités sociales structurelles s'entrecroisent avec l'environnement bâti, l'urbanisme joue un rôle clé lorsqu'il s'agit de minimiser les risques liés à la chaleur et d'augmenter les capacités d'adaptation des groupes vulnérables.

Sur la base d'entretiens (en marchant) et d'une analyse de documents, cette thèse de Master a exploré différents aspects de la vulnérabilité locale à la chaleur dans la ville suisse de Lausanne et a étudié diverses stratégies de rafraîchissement. Les résultats montrent que les défis liés à la chaleur sont formés par le contexte local ainsi que par les conditions de vie individuelles des groupes vulnérables. Des solutions proactives et locales au niveau du quartier sont donc nécessaires pour soutenir les capacités d'adaptation des groupes vulnérables. Le développement d'infrastructures accessibles pour rafraîchir à Lausanne est discuté comme un élément central de l'adaptation équitable à la chaleur.

Abstract - EN

Urban temperatures that were considered 'extreme' in the last century have become a normality. Previous studies have shown that factors such as age, socio-economic background, physical and mental health status, or urban design patterns highly influence vulnerability to urban heat. As structural social inequalities intersect with the built environment, urban planning has a key role when it comes to minimising heat risks and increasing adaptive capacities of vulnerable groups.

Based on a qualitative approach, this Master's thesis explored different aspects of local heat-related vulnerability in the Swiss city of Lausanne and investigated various cooling strategies through (walking) interviews and a document analysis. The results show that the challenges in dealing with heat are shaped by the local context as well as the individual living conditions of vulnerable groups. Proactive and local solutions at the neighbourhood level are therefore necessary to support the adaptive capacities of vulnerable groups. The findings suggest that developing affordable and accessible cooling infrastructure is a crucial element of heat equity planning in Lausanne.

Zusammenfassung - DE

Städtische Temperaturen, die bis vor wenigen Jahrzehnten als ‚extrem' galten, sind im 21. Jahrhundert normal geworden. Zahlreiche Studien haben gezeigt, dass demographische, sozioökonomische, physische und psychische sowie stadtstrukturelle Faktoren großen Einfluss auf hitzebezogene Vulnerabilität haben. Aufgrund der Verschneidung von struktureller sozialer Ungleichheit und gebauter Umwelt ist es eine zentrale Aufgabe der Stadtplanung, Hitzerisiken zu minimieren und die Anpassungsfähigkeit von vulnerablen Gruppen zu erhöhen.

Anhand von qualitativen (Walking) Interviews und einer Dokumentenanalyse wurden in dieser Masterarbeit Aspekte lokaler hitzebezogener Vulnerabilität in der Schweizer Stadt Lausanne erforscht und verschiedene Abkühlungsstrategien untersucht. Die Ergebnisse zeigen, dass die jeweiligen Herausforderungen im Umgang mit Hitze vom lokalen Kontext als auch den individuellen Lebensbedingungen geprägt sind. Proaktive und lokale Lösungen auf Nachbarschaftsebene sind daher erforderlich, um die Anpassungsfähigkeit vulnerabler Gruppen zu unterstützen. Die Entwicklung von zugänglichen und leistbaren Infrastrukturen zur Abkühlung in Lausanne wird als zentrales Element einer gerechten Hitzeanpassungsplanung diskutiert.

Thank you. Danke. Merci.

I would like to thank Alexander Hamedinger for his motivating and constructive feedback and his supervision throughout the whole process of writing my thesis. Thanks to all the interviewees who shared their time and knowledge with me. I would also like to thank Luca Pattaroni and the LASUR team for their welcome and support at EPFL during my stay in Lausanne. Special thanks to Raphaela Kogler for methodological advice, Eva Meier for helping with the transcription, Alvie Augustin for working alone together, Amelie Mayer for keeping me motivated, and Nathalie Peeters for editing and helpful remarks. Thanks also to my parents, who made my studies possible and are always there for me. Finally, I would like to thank my husband for his infinite patience and support.

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Fig. 1: Dog bathing in a fountain in Lausanne

1

INTRODUCTION

1.1 Research context

The human-caused climate change and its numerous effects have become a "determinant" (Priemus & Rietveld, 2009) for urban planning. As published in the European Climate Risk Assessment Report (2024), the recorded temperatures were highest in 2023 with the average temperature between February 2023 and January 2024 being 1.5°C above the pre-industrial era.

Over the past few decades, Europe has faced an increasing amount of extreme heat events (European Environment Agency [EEA], 2023; National Centre for Climate Services [NCCS], 2018). Cities have a dual role to play in this, as they are both the main cause of climate change and are particularly affected by it (Intergovernmental Panel on Climate Change [IPCC], 2022; UN-Habitat, n.d.). As two thirds of the world population will live in cities by 2050 (United Nations, 2019), the changing climate in urban regions and the associated rising temperatures will have an impact on the wellbeing of most of the global population. Cities are therefore under pressure to develop strategies to deal with these rising temperatures and their diverse effects.

The Swiss climate adaptation strategy has identified increased heat stress as one of the greatest challenges for spatial development, health, and energy sectors in urban areas (Bundesamt für Umwelt [BAFU], 2012). In Switzerland, the average temperature has risen by around 2.8 °C since pre-industrial times, making the country a core region for increasing extreme heat events (BAFU et al., 2020; Bundesamt für Meteorologie und Klimatologie [MeteoSchweiz], n.d.-f; NCCS, 2018).

The Urban Heat Island (UHI) effect is one significant consequence of the rapidly growing urbanisation and describes the effect, where urban areas experience higher temperatures compared to the surrounding rural areas (Oke, 1973, 1982; Palme et al., 2021). [See chapter 2] In the Lemanic region in Switzerland, the distribution of several cities around Lake Geneva creates an "urban heat archipelago" (Buyantuyev & Wu, 2010, p. 28) that leads to temperature differences up to 2°C during the day and 4°C at night in the cities of Geneva and Lausanne compared to the surrounding areas (Labedens et al., 2018).

The mitigation and adaptation to the increasing heat is one of the major challenges for the current and future spatial development of cities. Urban planners are therefore called upon to consider strategies and measures to cool urban areas and reduce the UHI effect, while also exploring ways to support neighbourhoods and their residents in adapting to the emerging heat challenges. [See chapter 4]

Arguing from an environmental justice perspective, it is crucial to consider “the intertwining of environment and social difference” (Walker, 2011, p. 1) to understand the uneven impacts of climate change and its consequences on different social groups. Previous studies have shown that factors such as socio-economic background, age, physical and mental health status, or precarious living conditions highly influence vulnerability to urban heat (e.g. Ramsay et al., 2024; Schifano et al., 2009; Tupinier Martin et al., 2024; Voelkel et al., 2018; Wilson & Chakraborty, 2019).

Vulnerability to urban heat can be framed as a combination of the exposure to heat stress, the sensitivity to heat and the capacity to adapt to higher temperatures (Wilson & Chakraborty, 2019, p. 1067). [See chapter 3]

As structural inequalities intersect with the built environment (Keith & Meerow, 2022; Wilson & Chakraborty, 2019), urban planning has a key role when it comes to shaping heat risks. If heat-related vulnerability is not primarily understood as an individual problem, but as a result of social inequality and structural injustice, it is essential that a proactive, socially inclusive and just heat-adapted planning is made sensitive to the various vulnerable groups and their living conditions during heat waves.

1.2 Research objective and questions

This Master's thesis is therefore located in the context of urban heat and the (re-) production of social inequality. The Master's thesis aims to improve the knowledge on heat-related challenges for vulnerable groups and their cooling strategies. Furthermore, the thesis examines how heat-adapted urban planning can be aligned with the perspective of vulnerable groups.

The Swiss city of Lausanne was chosen as the empirical study area. As the fourth largest city in Switzerland (approx. 140,000 inhabitants), Lausanne has a characteristically hilly topography and stretches from Lake Geneva (370 m above sea level) to the forests of the Jorat (870 m above sea level) (Ville de Lausanne, n.d.-a). The city's climate plan assumes that the city's climate will become similar to that of Madrid within the next 75 years (Ville de Lausanne Municipalité, 2023, p. 45).

While there have been several quantitative studies on the UHI effect in the city of Lausanne (e.g. Bosch Padros, 2021; Bovay, 2020; Canton & Dipankar, 2024), a research gap is still visible: qualitative investigations of heat-related vulnerability and cooling strategies at a neighbourhood level.

Fig. 2: Lausanne panorama with Saint-Francois Church

While quantitative studies use indices to analyse heat-related vulnerability, this qualitative study is interested in the "differing narratives" (Guardero et al., 2022) that those affected themselves contribute. Thus, the focus of the work is on the exploration of the everyday challenges, cooling strategies and subjective perspectives on heat-related places of vulnerable groups who are particularly affected by heat in the city of Lausanne. The local experiences and practices are then set in relation to strategic planning measures mitigating and adapting to urban heat in Lausanne.

The following research questions form the starting point of the study:

1. **What are everyday challenges for vulnerable groups dealing with heat in Lausanne?**
2. **What cooling strategies do vulnerable groups have?**
3. **Which heat related areas in the neighbourhood are relevant for vulnerable groups?**
4. **How are different vulnerable groups taken into account in strategic planning measures for mitigating and adapting to heat in Lausanne?**

The work is structured as follows:

Chapters 2, 3 and 4 form the theoretical basis. In an introductory chapter on increasing urban heat, key indicators of heat are presented, the Urban Heat island effect is explained, and impacts of heat on urban residents are discussed. Chapter 3 then looks at the conceptualisation of vulnerability and the unequal effects of heat. Subsequently, the strategic approaches mitigating and adapting to urban heat in urban planning are summarised and possibilities of planning for heat equity are discussed in chapter 4. Chapter 5 presents the results of the empirical analysis of the cooling strategies in the city of Lausanne. The final section is a conclusion that includes a discussion of the results and the limitations of research.

1.3 Relevance

In April 2024, the European Court of Human Rights ruled in favour of a complaint by the Swiss climate association of elderly women (Verein KlimaSeniorinnen) that Switzerland was doing too little to combat climate change. Switzerland is therefore in breach of Article 8 of the European Convention on Human Rights, which requires it to take appropriate measures to protect its citizens "from the serious adverse effects of climate change on their lives, health, well-being and quality of life" (European Court of Human Rights, 2024, p. 1). It is therefore a matter of great urgency for political decision-makers in Switzerland to take measures to combat the adverse effects of climate change.

In this area of conflict, urban planning has the important task of developing suitable measures to combat the heat in cities. The specific example of the city of Lausanne empirically illustrates that proactive, differentiated and local solutions are needed.

Since knowledge about the impact of heat on vulnerable groups and their adaptive capacities at the neighbourhood level is still limited (Guardero et al., 2022; Hertel et al., 2024; Voelkel et al., 2018;), the master's thesis contributes to a more differentiated picture of heat-related challenges for vulnerable groups in Lausanne and the possibilities to take them into account in future urban planning.

By focussing on the everyday lives of vulnerable groups in a world of social inequality, this Master's thesis is also intended to contribute to a critical examination of the framework conditions of our coexistence in a changing climate. In terms of a critical understanding of qualitative research (Winter, 2017), the aim is not only to show the negative consequences of the unequally distributed effects of heat, but also the possibilities of a change towards more heat equity in urban planning.

1.4 Methodological approach

The thesis is methodologically located in the field of qualitative social research in a spatial context. In Lefèbvre's sense, this master's thesis assumes that "planning [should be] oriented towards social needs" (Kofman & Lebas, 1996, p. 180). In the context of climate change and rising temperatures, his call for 'The Right to the City' (1968) can also be extended as 'The Right to a cool City for all'. In line with David Harvey's elaborations on 'Social justice and the City' (Wiegand, 2016), calling for the right to a cool city for all must always criticise the neoliberal conditions that constantly (re-) produce inequalities and heat-vulnerability.

An inductive approach was chosen to process and answer the research questions. By conducting qualitative interviews and subsequently analysing them, new hypotheses were generated (Bryman, 2012).

Fig. 3: Climate Seniors at European Court of Human Rights in Strasbourg , 2020

Using qualitative methods, an understanding of heat-related vulnerability and its manifestations in the context of Lausanne was developed by exploring, reconstructing and interpreting subjective perspectives and everyday realities (Helfferich, 2004). The explorative approach means that the course of the research could not be determined from the outset but was adapted and further developed during the field research (Pohl, 1998, p. 99).

The research was understood as a process in which knowledge is "actively constructed" (Holstein & Gubrium, 1995, p. 52). To make the process of this knowledge construction transparent, the methods used, the access to the field and the evaluation strategy are described below.

1.4.1 Method triangulation

Following Richardson (2003), the image of crystals describes the process of method triangulation in this work:

> *«Crystals grow, change, alter, but are not amorphous. Crystals are prisms that reflect externalities and refract within themselves. What we see depends upon our angle of repose.» (Richardson, 2003, p. 517)*

The crystal serves both ontologically and epistemologically as a metaphor: my research assumes that social reality is not a fixed constant and that it is constructed by me as a researcher and my interview partners during the exchange on the topic (Winter, 2017, p. 4). As a form of collaborative knowledge generation, a dialogue was formed between my own academic knowledge and the local understandings (Chamberlain & Hodgetts, 2018, p. 8).

My research work is therefore not in search of a single 'truth', but shows through the visualisation of vulnerable, often marginalised voices that knowledge is "partial, particular and socially situated" [translated by the author] (Winter, 2017, pp. 7-8).

The following qualitative methods were used to explore the different facets of heat-related vulnerability in Lausanne and to answer the research questions:

→ Guideline-based interview:

Guideline-based interviews were a central element of the empirical work. The aim of these interviews was to shed light on the everyday behaviour of vulnerable groups in relation to heat. Three interviews were conducted with social organisations that are in contact with heat-related vulnerable population groups:

- I5: independent association for elderly people
- I6: social service for people in precarious living conditions
- I8: neighbourhood association & neighbourhood management, one person each

Additionally, one interview was conducted with an elderly person who lives in Lausanne and reported on how they deal with heat (I9).

A guideline [see annex] was drawn up for the interviews, which followed the principle of "as open as possible, as structured as necessary" [translated by the author] (Helfferich, 2014, p. 560). The focus was on questions about the everyday lives, challenges and strategies of the vulnerable groups in the heat with whom the interviewees were in contact. Open questions and narrative prompts were combined (Helfferich, 2014, p. 565).

As the organisations also reflected on their own role, strategies and challenges in supporting vulnerable groups during heat in the first few interviews, the guidelines were adapted accordingly.

Each guideline contained an initial section explaining the project and referring to data protection and the signing of informed consent. The guidelines served as support for the flow of the interview, which should be as natural as possible and give the interviewees the opportunity to express themselves as freely as possible. The order of the questions and the exact wording did not have to be adhered to.

Since the “quality of qualitative data follows from the quality of the interaction” [translated by the author] (Helfferich, 2004, p. 22), the specific communication and interaction also played an important role in the interviews. French was spoken in most of the interviews. My position as a foreign student was therefore obvious from a linguistic point of view but was usually able to fade into the background thanks to the personal contact and closer trust during the interviews.

→ Expert interview:

Two expert interviews – as a specific form of guideline-based interviews – were also conducted. To explore the “implicit knowledge and rules of social behaviour” [translated by the author] (Fritzsche & Weitkämper, 2018) in relation to the city‘s heat-related measures, two people from the administration of the City of Lausanne were interviewed:

- I1: Climate and sustainability office, City of Lausanne
- I2: Urban planning department, City of Lausanne

This implicit and contextual knowledge served as a supplement to the results of the document analysis of strategic planning in the city of Lausanne (Pohl, 1998, p. 105).

Here too, guidelines were drawn up which provided a comparatively stronger structure and were aimed more at concise answers (Helfferich, 2014, p. 572). The openness of the questions was nonetheless a high priority.

→ Walking interview:

Walking interviews were used as a further variant of qualitative interviews. Four walking interviews were conducted with different routes and specific guidelines:

- I3_walking & I7_walking: carried out with an urban planner of Lausanne on two different days in different neighbourhoods to look at and critically examine measures and transformations of public spaces in the city directly
- I4_walking: conducted with a young person, living in Lausanne, who described personal strategies and important places in the neighbourhood
- I10_walking: held with a mobile social worker who is in contact with people in precarious living conditions and who showed and explained specific heat-related places in the city during the walk

Guidelines were also prepared for the walking interviews, which contained information about my project and data protection at the beginning. After signing the informed consent, the conversations began with an open narrative prompt and were orientated as closely as possible to the participants' narrative and chosen route.

Conducting interviews while walking as opposed to stationary interviews had several advantages for my work. On the one hand, the walking interviews generated knowledge directly linked to its socio-spatial context: These interviews were particularly informative regarding heat-relevant places and strategies in the public space of vulnerable groups.

This localised knowledge in the context of urban heat underlines the "importance of place as a fundamental category of everyday experience and practice" (Kusenbach, 2003, p. 478). All walking interviews were conducted on hot days in the summer of 2024 and added the experienced temperature to the socio-spatial context.

On the other hand, walking itself was also an important success factor for the interviews: it created a relaxed atmosphere for dialogue and was perceived as pleasant by the participants. Furthermore, the act of walking and talking under the guidance of the interviewees helped to shift traditional research roles between researcher and participant and emphasised the aspect of co-constructing knowledge (Muhr et al., 2025, p. 61).

Overview of conducted interviews:

- I1: Guideline based interview with an expert in city planning (Climate and sustainability office, City of Lausanne)
- I2: Guideline based interview with an expert in city planning (Urban planning department, City of Lausanne)
- I3_walking: Walking Interview with an independent urban planner
- 4_walking: Walking interview with representative of vulnerable group (youth)
- I5: Guideline based interview with a social organisation (elderly)
- I6: Guideline based interview with a social organisation (people in precarious living conditions)
- I7_walking: Walking interview with an independent urban planner
- I8: Guideline based interview with social organisation (neighbourhood association & neighbourhood management)
- I9: Guideline based interview with representative of vulnerable group (elderly)
- I10_walking: Walking interview with social organisation (people in precarious living conditions)

→ Analysis of planning documents:

In addition to the qualitative interview methods, strategic planning documents were analysed to explore the heat adaptation measures for vulnerable groups. No general measures mitigating urban heat were analysed in the scope of this work, but the focus was placed on the consideration of vulnerable groups at a strategic level.

As city planning should act forward-looking and oriented towards the common good, an understanding of social inequalities in the field of urban planning is crucial. To address this issue, a qualitative content analysis based on Mayring (1997) was carried out.

Based on an own desk research and the additional feedback through the expert interviews with the administration of the City of Lausanne (I1 and I2), the following material was determined for the analysis:

- Plan Climat, Rapport-préavis N° 2020/54 du 7 janvier 2021 (Climate plan, strategic vision)
- Catalogue des axes d'action du Plan climat et mesures proposées (2020) (Proposed measures to supplement the climate plan)
- Communiqué Plan canicule (18.07.2022) (Press release on the announcement of the heatwave plan based on cantonal guidelines in July 2022)
- Carte des espaces frais (Fresh places map)
- Plan directeur communal (PDCom): Vision stratégique + Projet territoire, Programmes d'actions (December 2022) (Communal master plan, strategic vision and action plan)

Fig. 4: Document covers from left to right: Plan Climat brochure, Catalogue des Axes Actions, PDcom Vision stratégique + Projet territoire, PDcom Programme d‘actions

Evaluation strategy:

The interviews were recorded and transcribed. All transcripts as well as the documents were inductively analysed in the original language based on a thematic content analysis approach by using the software MAXQDA.

Through the process of open coding (Strauss & Corbin, 1996), categories were developed to analyse the interview data [see coding manuals in the appendix]. Several analysis loops were carried out to stabilise the category system (Mayring, 2014, p. 82). The results were translated into English at the end.

1.4.2 Access to the field

Based on Voelkel et al. (2018), the approach chosen for this work was to seek dialogue with local organisations and residents to explore challenges and strategies on how to deal with urban heat. In accordance with the strategy of theoretical sampling, characteristics and categories of heat-vulnerable groups were identified during the process of data collection and analysis (Abrams, 2020, p. 538).

As the work was produced in the context of an exchange semester, access to the field was a central and resource-intensive task. An exploratory approach was chosen, which is why the field of research was not clearly defined from the outset (Przyborski & Wohlrab-Sahr, 2021, p. 56).

During the research process, local actors were gradually identified. Due to time and resource constraints, it was not possible to carry out a complete research project with only vulnerable groups in this Master's thesis. Therefore, several social organisations were interviewed as representatives of vulnerable groups in Lausanne.

Desk research was used to identify social organisations in Lausanne that are in contact with vulnerable groups (such as sports and cultural associations for young migrants, low-threshold French courses, training and socialisation activities for migrant women in economic and/or social difficulty, soup kitchens etc.) and to request interviews.

Data collection, analysis and theory formed iterative loops throughout the research process (Strauss & Corbin, 1996).

Furthermore, the socio-cultural centres of Lausanne were important access points for the recruitment process: the trust that could be built up here ultimately led to a social network of people, through which I was able to establish further interviews. The fieldwork process therefore required a high degree of flexibility and openness to opportunities (Chamberlain & Hodgetts, 2018).

Fig. 5: Entrance to a socio-cultural centre in Lausanne

Fig. 6: Flyer for recruitment process

IL FAIT CHAUD, NON?

PROJET MASTER

Parle-moi de la chaleur à Lausanne !

DE QUOI S'AGIT-IL?

Pour mon travail de master, je cherche des personnes qui vivent à Lausanne et qui souhaitent me parler de leurs expériences des journées chaudes lors d'une promenade.

POURQUOI ME PARLER?

- Promène-toi dans ton quartier avec moi,
- … partage ta perspective sur la chaleur..
- … aide-moi ainsi à comprendre comment la chaleur t'affecte…
- … et comment la ville doit donc changer pour que nous puissions bien y vivre malgré la chaleur !

MERCI POUR TON AIDE !

fidelia.gartner@epfl.ch

Vulnerable groups are often referred to as ‘hard-to-reach’ in the context of qualitative research (Abrams, 2020; Benoit et al., 2005; Chamberlain & Hodgetts, 2018; Couch et al., 2014; Gombert et al., 2015; Umamaheswar, 2018) as well as in planning contexts, particularly in questions of participation (ElGamal & Altrock, 2024; Matthews et al., 2012; Symons, 2017).

As Chamberlain and Hodgetts (2018) lined out, there are a variety of reasons and circumstances why certain social groups may be not easily accessible for research purposes. However, the term can be criticised in different ways: on the one hand, ‘hard-to-reach’ reflects a hegemonic position that evaluates the accessibility of certain groups in relation to itself as a norm.

On the other hand, the categorisation as ‘hard-to-reach’ can also represent a reversal into “easy-to-ignore” (Matthews et al., 2012). Instead of perpetuating the difficult accessibility of the target group as a deficit of the group itself, it should be understood as a mandate for action.

Chamberlain and Hodgetts (2018), for example, argue that through consultation, participation and flexibility in the research process, so-called ‘hard-to-reach’ groups can be just as accessible as others.

However, with the resources usually available in research and planning projects (financial, linguistic, social, cultural, etc.), it remains easier to continue to ignore these groups than to adapt the process designs to them.

Fig. 7: Die Rakete | Climate change in pictures © Corinne Jolliet/BAFU

2

INCREASING URBAN HEAT

2.1 Central indicators

Climate change is breaking new records year after year. Temperatures that were considered ‘extreme’ in the 1961-1990 reference period have become ‘normal’ since 1990 (BAFU & MeteoSchweiz, 2020, p. 31). Reference periods are used to compare climate data globally. In line with BAFU & MeteoSchweiz (2020), the following reference periods of the World Meteorological Organisation (WMO) and the IPCC are used in the facts and figures in this chapter:

- 1871-1900: reference period for describing the long-term temperature development as an approximation to pre-industrial conditions
- 1961-1990: reference period for changes to the climate
- 1981-2010: reference period when talking about the current climate

The effects of extreme weather conditions such as heat waves, heavy rainfall events or droughts are now part of the new ‘normal’ of spatial planning. The following chapter provides an overview of central indicators of climate change with a focus on Switzerland, the Urban Heat Island effect and the impact of urban heat on residents of cities.

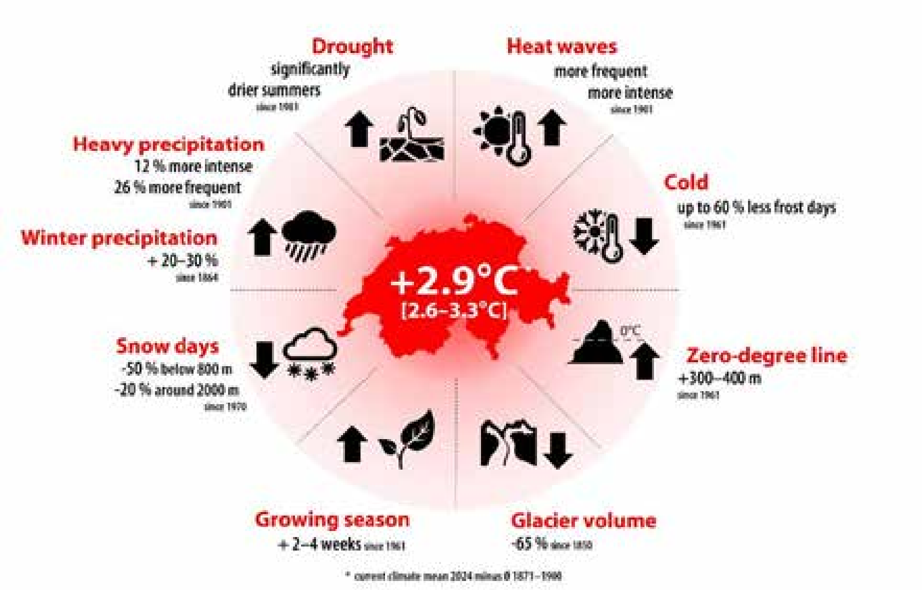


Fig. 8: Major changes in the Swiss Climate, illustrated by MeteoSchweiz

When it comes to facts and figures on climate change, the first parameter usually considered is the changing temperature on Earth. Globally, the years from 2011-2020 were 1.6°C warmer over land than the pre-industrial average of 1850-1900 (MeteoSchweiz, n.d.-f).

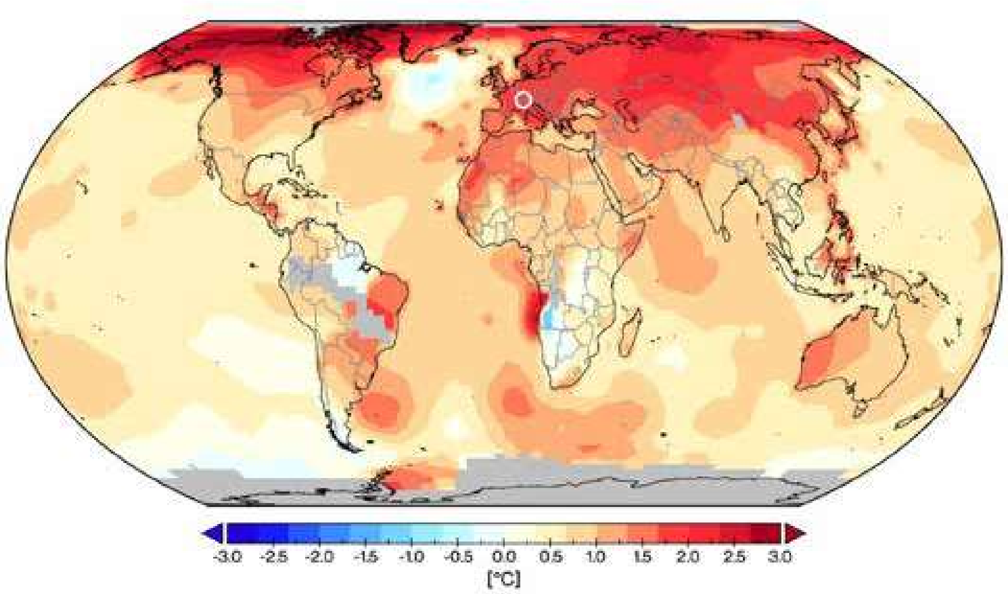


Fig. 9: Global warming. The colours show the difference between the 30-year mean values for 1881-1910 and 1991-2020 in °C (grey-coloured areas: insufficient data), illustrated by MeteoSchweiz

In addition to global warming, more extreme weather events, changes in the water cycle, melting ice masses, rising sea levels, changing ocean currents and ocean acidification also play an important role when describing the complexity of climate change (MeteoSchweiz, n.d.-f). In the following, however, the focus will be on warming.

As a continental country in the mid-northern latitudes, Switzerland is particularly affected by global warming (MeteoSchweiz, n.d.-f). Besides the geographical location, feedback effects also may contribute to the comparatively higher warming in Switzerland: The disappearance of alpine snow reduces its reflection of incoming solar radiation into space (BAFU & MeteoSchweiz, 2020, p. 30).

As a result, the earth‘s surface warms up more. In terms of the seasons, summer months (June, July, August) have warmed the most since 1961 with rates of +0.54° C per decade (in comparison: spring months +0.46° C, winter months +0.31° C, autumn months +0.26° C, each per decade) (BAFU & MeteoSchweiz, 2020, p. 31).

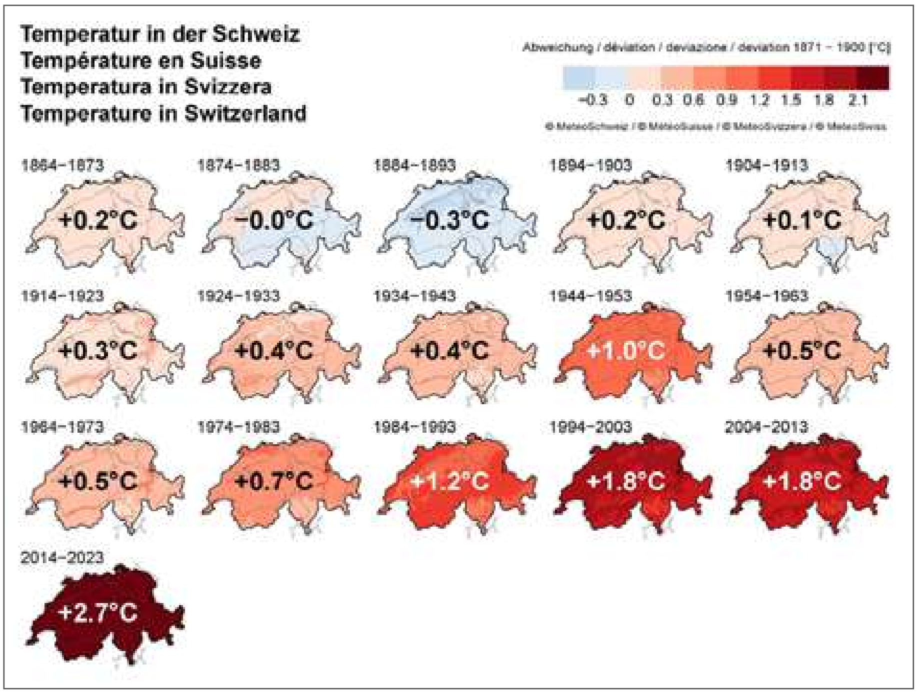


Fig. 10: The temperature in Switzerland for the last sixteen ten-year periods. Deviations from the average 1871-1900 in °C, illustrated by MeteoSchweiz

Climate average in 2024:

already 2.8°C above the pre-industrial average → twice as strong as the global average.

Since the 1960s: every decade has been warmer than the previous one.

Since 2010: 8 warmest measured years.

2022 and 2023: warmest years with a deviation of 3.5 and 3.4 °C respectively from the pre-industrial average.

Before 1900: 4 coldest years in Switzerland.

MeteoSchweiz (n.d.-e)

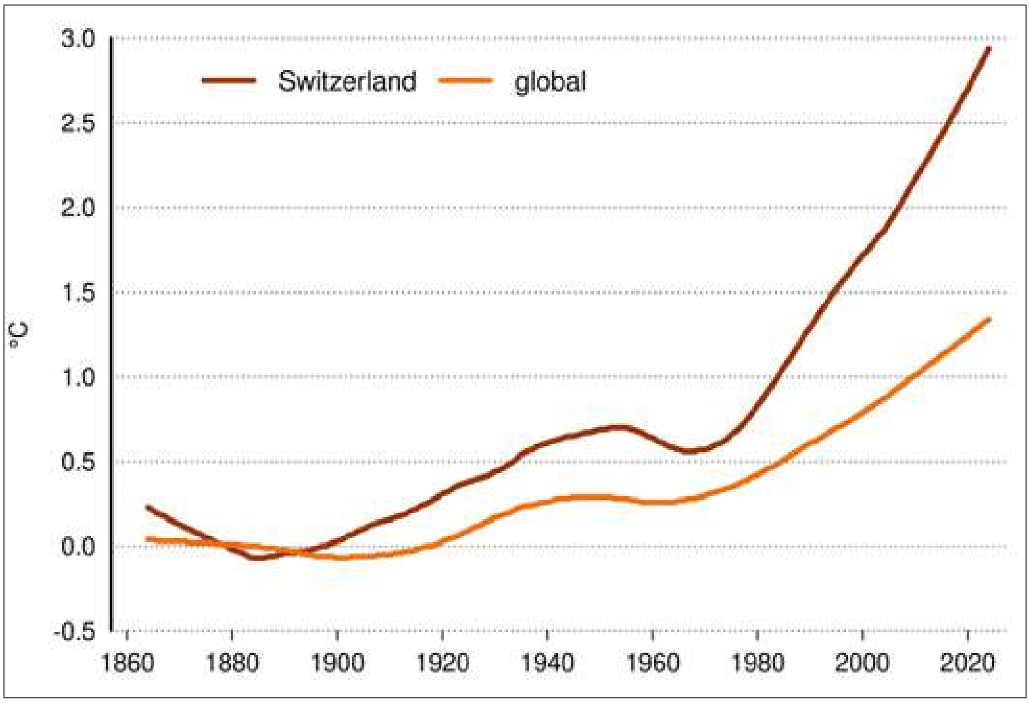


Fig. 11: Near-surface warming of the air in Switzerland and the global mean, illustrated by MeteoSchweiz

Based on the Swiss federal government‘s adaptation strategy from 2012, MeteoSchweiz, ETH Zurich and other institutions under the umbrella of the NCCS regularly develop climate scenarios for Switzerland. The various scenarios calculated and outlined form the basis for Swiss climate adaptation policy. The current climate scenarios ‘Klima CH2018’ were formulated in 2018 and summarise four main effects of climate change in Switzerland: more extreme heat, more extreme precipitation, drier summers and winters with less snow (MeteoSchweiz, n.d.-f).

On this basis, the next version of the climate scenarios for Switzerland (‘CH2025’) has been in development since 2023 and is due to be published at the end of 2025. In addition to the further development of the scenarios on climate extremes in Switzerland, the revision will also address the question of how information from observations and climate models can be made more readily available to users (MeteoSchweiz, n.d.-d).

In addition to rising average temperatures, other indicators related to heat are also relevant to understand the extent of climate change (MeteoSchweiz, n.d.-e):

→ **Summer day:**

A summer day is defined as a day with a maximum temperature of 25°C or more.

→ **Hot day:**

A hot day is defined as a day with a maximum temperature of 30°C or more. The climate scenarios 'Klima CH2018' assume more frequent, more intense, and longer-lasting heatwaves and hot days in Switzerland as a "hotspot for changes in hot temperature extremes" (NCCS, 2018, p. 103).

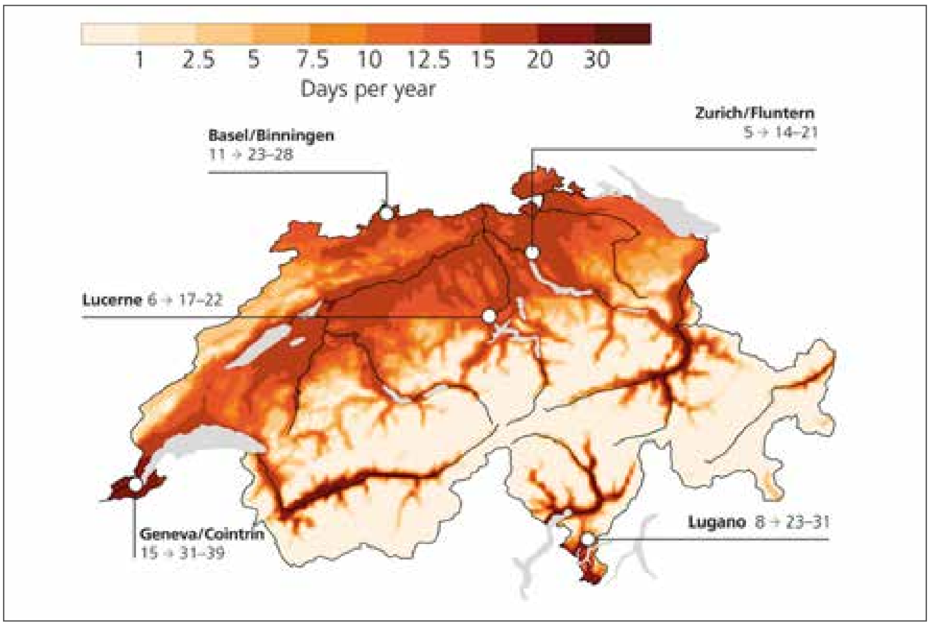


Fig. 12: Increase in the number of hot days in 2060 compared to the 30-year average 1981-2010, illustrated by MeteoSchweiz

→ **Tropical night:**

A tropical night is defined as a night with a minimum temperature of 20° C or more. Tropical nights have increased significantly in Switzerland since 1980 and are particularly common in larger cities (BAFU & MeteoSchweiz, 2020, p. 33).

→ **Heat wave:**

MeteoSchweiz defines a heatwave if the average daily temperature ('Tmean') is greater than or equal to 25° C for at least three consecutive days. Tmean describes the mean value of all measured values from midnight to midnight of the corresponding day and thus also considers increased humidity at night, which influences the night-time temperatures.

Based on the categorisation of the length and intensity of heatwaves into danger levels (level 1 to 4), MeteoSchweiz issues heat warnings to the authorities and the population (MeteoSchweiz, n.d.-c).

→ **Heat stress index:**

The impact of temperature and relative humidity on the human body are combined in the heat stress index. The technical term for relative humidity is 'wet bulb temperature' (TW) and is given in degrees Celsius. Humidity leads to decreasing evaporation, which reduces the cooling effect of perspiration.

Intense heat stress begins for the body at a TW value of 22° C and the maximum tolerable TW for the human body is 35° C which is approximately the usual temperature of the skin (NCCS, 2018, p. 31). More frequent days with heat stress (also intensified by the UHI effect) are projected for Switzerland (NCCS, 2018, p. 103).

→ **Thermal comfort:**

The individual perception of heat also depends on thermal comfort. Thermal comfort is influenced not only by the particular air temperature, but also by humidity, mean radiant temperature (caused by the sun and urban structures like pavements), wind speed, and individual factors such as clothing or acclimatisation capacities (Keith & Meerow, 2022; United Nations Environment Programme (UNEP), 2021).

The presented key indicators of urban heat form the basis for understanding the Urban Heat Island effect discussed in the next section.

2.2 Urban Heat Island effect

The climate in cities is influenced by various factors such as natural and built structures, materials and anthropogenic activities (Grimmond et al., 2010).

Important typological elements that influence the climate of built-up areas can be summarised as follows (Erell et al., 2011):

- House lot, suburban block, city block
- Urban street canyon, suburban road, highway segment, rail corridor section
- Shore line section (by lake, estuary, sea), riverside section
- Courtyard/patio, plaza/small greenspace, large open greenspace
- Parking lot, roof, wall

Grimmond et al. (2010) summarise the following key features of surface conditions when describing urban climates (p. 248):

- Surface roughness length → influences wind flow
- Impervious surface friction → important for energy portioning between heat and moisture exchanges
- Sky view factor → influences solar access and radiative cooling
- Thermal admittance → modulates heating and cooling cycles of materials
- Albedo → measure of the brightness of a surface, influences surface heat absorption
- Anthropogenic heat flux → adds further energy

These elements of urban climates are related to the so-called Urban Heat Island (UHI) effect (Gehrig et al., 2018, p. 1). As "one of the most widely documented climatological effects of man's modification of the atmospheric environment" (Oke, 1973, p. 769) the term describes the phenomenon where the temperatures of an urban area are measured warmer than its rural surroundings.

This effect was discovered as early as 1833 by Luke Howard for the city of London and has since been analysed in numerous studies for various urban areas (Wang, 2022; for an overview of recent UHI studies see e.g. Rajagopal et al., 2023).

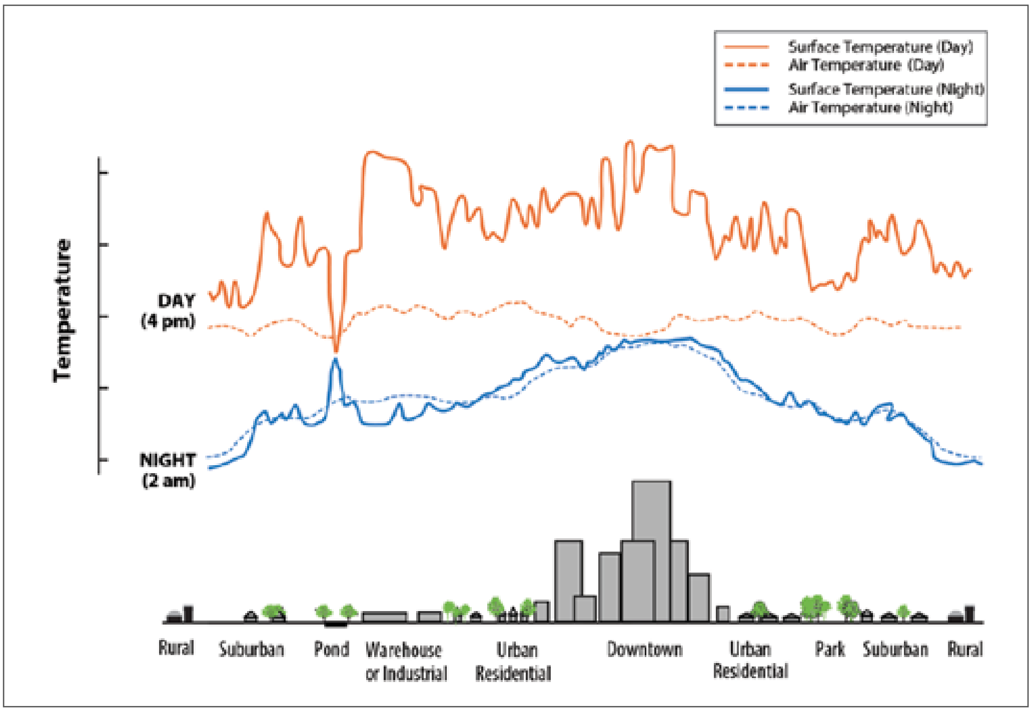


Fig. 13: The UHI effect across different environments, indicated by surface and air temperature differences, illustrated by Keith & Meerow (2022)

According to Stewart (2011), there are considerable differences in the methodological quality of the studies on UHI. Therefore, when reviewing the studies, particular attention should be paid to the controlled process regarding the effects of weather, the relief of the study area and time, and the basic metadata on instrumentation and field site characteristics (Stewart, 2011).

UHI can be measured in different ways: Air or atmospheric UHI are either measured in the canopy layer (CUHI) by meteorological stations or vehicles, or in the boundary layer (BUHI) by tall towers, radiosondes, or aircrafts (Zhou et al., 2019). Less time-consuming and expensive to measure is the surface UHI (SUHI): Satellite thermal remote sensing data can indicate the radiative temperature difference between urban surfaces and their rural surroundings and are available for various spatial and temporal scales (Deilami et al., 2018; Zhou et al., 2019).

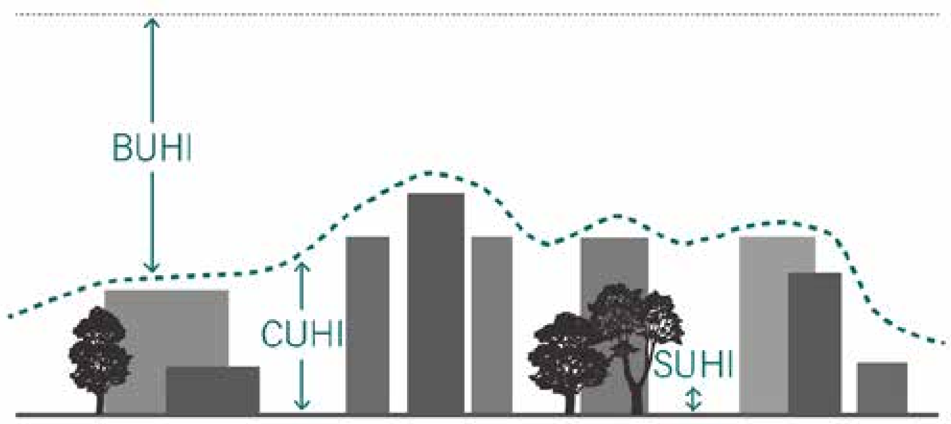


Fig. 14: Different types of measuring UHI, illustrated by Bovay (2020)

When it comes to the perception of heat and its effects on people, however, analysing the air temperature is more suitable than the surface temperature (Keith & Meerow, 2022, p. 27).

The two areas of building infrastructure and transport are considered to be the main sources of producing and emitting urban heat (Buyantuyev & Wu, 2010; Deilami et al., 2018). The intensity of the UHI effect is influenced by the size of the city, land use change and the degree of sealing, the albedo, the building heights and density, the proportion of vegetation, waste heat emissions and the heat capacity of the building materials (Keith & Meerow, 2022; MeteoSchweiz, n.d.-a; Vogt & Parlow, 2011).

Due to the low albedo and the resulting high heat capacity of impervious surfaces (such as asphalt, concrete, roof tops, building walls) the heat energy is only released slowly at night and evapotranspiration (the combined effect of transpiration and evaporation of water from plants and soils) only ensures a low degree of cooling due to the lack of green areas in cities (Gehrig et al., 2018, p. 1).

The UHI effect is therefore more pronounced at night and leads to more tropical nights in cities than in the surrounding areas (Deilami et al., 2018; MeteoSchweiz, n.d.-a). In Swiss cities, differences of 2-7° C compared to their surrounding areas were found (Gehrig et al., 2018).

Forman (2014) argues that the metaphor of the island on cities is no longer up to date, as urban areas merge into suburban areas and do not necessarily represent a dichotomous image of hot city islands and cooler surroundings (see also Wang, 2022). Furthermore, the heterogeneous structures within cities create microclimates at the neighbourhood level (Grimmond et al., 2010). It is therefore crucial to consider both regional and microclimatic scales when addressing the UHI effect (Keith & Meerow, 2022).

In his schematic representation of heat and pollutants over different land uses of city and surroundings, Forman (2014) therefore speaks of an 'amoeboid dome' (p. 134) instead of an 'island'.

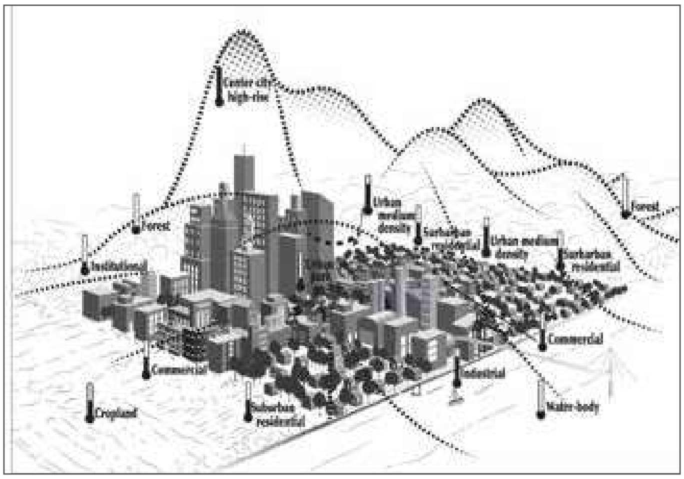


Fig. 15: Airdome of heat and pollutants over different land uses, illustrated by Forman (2014)

2.3 Impact of urban heat on residents of cities

The increasing heat in cities has various effects on the environmental, health and economic well-being of urban residents.

Rising global temperatures in general and the UHI effect in particular are a major burden on ecosystems: the regional climate is changing (BAFU & MeteoSchweiz, 2020), storms and heavy rainfall events are being caused (Romanello et al., 2024), vegetation is under stress (Andjelkovic, 2018; Forman, 2014) and water and air quality are suffering (Elmqvist et al., 2013).

In addition to the massive environmental consequences of heat, there are also increasing effects on human health and well-being. A distinction must be made here between effects that are "acute (sudden and dramatic) and chronic (slowly unfolding and often unnoticed)" (Keith & Meerow, 2022, p. 10). The former refer to the increased mortality rates during extreme heat events. In the two very hot summers of 2003 and 2015, for example, 1000 (= +6.9%) and 800 (= +5.4%) more people died in Switzerland than in other years (BAFU, 2019, p. 28).

Globally, almost twice as many people over 65 died in 2023 in connection with the heat than in the years 1990-1999 (Romanello et al., 2024). Grimmond et al. (2010) therefore speak of heat as an example of "deadly weather-related phenomena" (p. 249).

The higher mortality rates are the most extreme form of the effects of heat on health. Rising temperatures also have numerous other consequences for the human body: The regulation of body temperature through sweating, a higher cardiac output and increased blood flow to the skin becomes a burden, summer smog pollutes the air we breathe, the risk of skin cancer increases due to the higher UV radiation and allergic reactions to grasses, or trees are intensified by periods of drought (BAFU, 2019; BAFU, 2020).

The faster spread of viruses and bacteria in hot weather also leads to more hospital admissions, for example due to infectious diseases, diseases of the urogenital system or the digestive system (BAFU, 2020; Romanello et al., 2024).

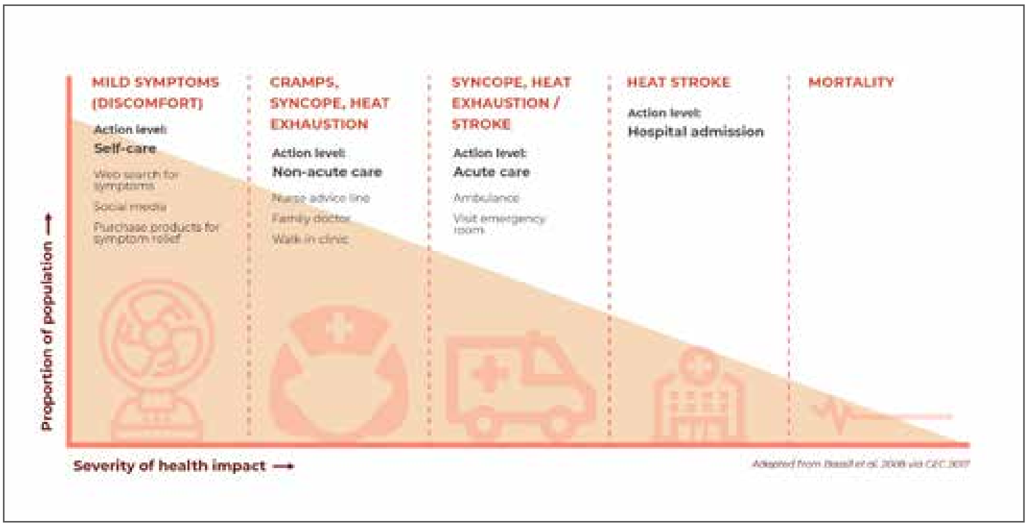


Fig. 16: Spectrum of heat health outcomes, illustrated by Global Heat Health Information Network

The respective activities on a hot day also play an important role in thermal comfort: for instance, outdoor physical activities are limited in hot weather. People who work outdoors (e.g. in agriculture, construction, refuse collection transport, or tourism) are exposed to the heat for more hours and there are more accidents at work (BAFU, 2019; GHHIN, n.d.-b).

Due to the hot temperatures at night, people sleep less and less well and are therefore even more unfocussed and tired on hot days (Romanello et al., 2024).

People who work indoors are also severely affected by the heat: for example, those who work in the care sector are confronted with increased workloads during heatwaves, while at the same time having to deal with high levels of heat themselves (BAFU, 2019).

Mental exhaustion, and physiological and cognitive decline due to heat strain also applies to works in other sectors and activities where room temperatures rise above 24°C (GHHIN, n.d.-b).

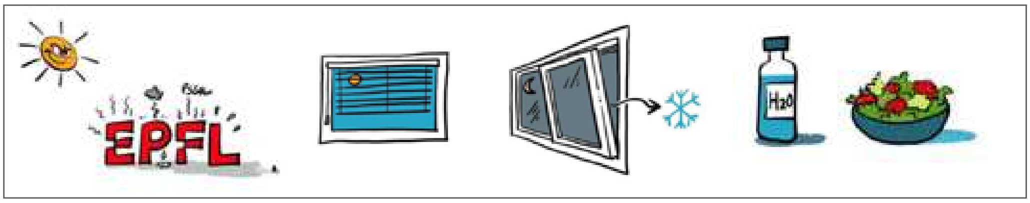


Fig. 17: EPFL heat warning to its employees in July 2024

Economic consequences of the increasing heat can also be observed: the higher workload during hot periods also has a negative effect on labour productivity, the loss of which is estimated at around CHF 665 million per year on average in Switzerland (Stalhandske et al., 2022).

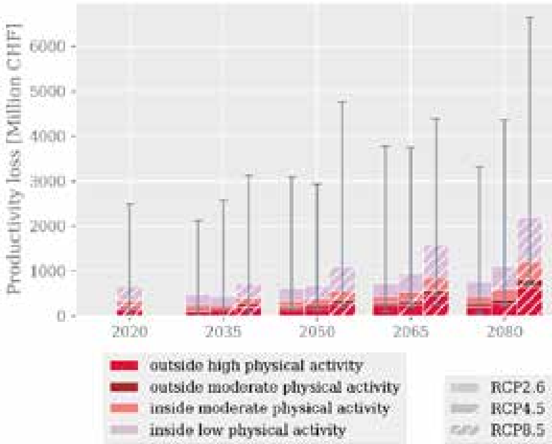


Fig. 18: Median of the labour prductivity losses calculated for Switzerland. Baseline 2020. Illustrated by Stalhandske et al., 2022

Now that the general effects of heat on city dwellers have been discussed, Chapter 3 introduces the concept of heat-related vulnerability and describes the unequally distributed effects of heat.


Fig. 19: An elderly person sits in the shade in a park in Lausanne

3

HEAT-RELATED VULNERABILITY

3.1 Concepts of vulnerability

The concept of vulnerability can be found in various disciplines, including psychology and medicine (e.g., Angel & Vatne, 2017; Wood, 2023), social sciences (e.g., Brown et al., 2017; Spini & Widmer, 2023), law and policing (e.g. Fineman & Spitz, 2024; Williams, 2023), and environmental and climate sciences (e.g., Adger, 2006; O'Brien et al., 2004).

Vulnerability generally describes the susceptibility of an individual or system to harmful influences or stress factors on a physical, psychological, social or ecological level (Wisner et al., 2004).

In the context of climate change, the IPCC (2001) defines vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes". Literature on climate change impacts also uses the term 'biophysical vulnerability' (Brooks, 2003).

Vulnerability can also be theoretically framed through the lens of social inequality and is therefore widely discussed in the literature on justice (Brown et al., 2017). When the focus is on the social, political, institutional or economic structures that make social groups vulnerable to different degrees, the term 'social vulnerability' is also used (Spielman et al., 2020, p. 418).

As this work deals with the living conditions and perceptions of different social groups of heat in Lausanne, heat-related vulnerability is always understood as an intertwining of biophysical and social vulnerability in the following.

The key descriptive variables of vulnerability are the specific stress to which a system is exposed, the individual sensitivity and the capacity to adapt (Adger, 2006):

→ **Exposure:**
Regarding heat vulnerability, the degree of exposure depends on the physical factors of the scope, frequency and duration of heat days and tropical nights (Lung et al., 2013).

→ **Sensitivity:**
While exposure is related to the global climate, sensitivity is based on demographic factors, socio-economic conditions and local land-use (Lung et al., 2013, p. 523). The sensitivity parameter thus describes the extent to which people are affected by heat in relation to individual living conditions and their spatial environment.

→ **Adaptive capacity:**
Depending on how well individuals or systems can adapt to heat, they can mitigate exposure or sensitivity and cope with the consequences (Voelkel et al., 2018).

Numerous determinants of the adaptive capacity have been investigated, ranging from economic capital to gender and social networks (for an overview see e.g. Siders, 2019). Kahlenborn et al. (2023) use the following six dimensions when analysing the adaptive capacity in the context of climate change: 1) knowledge, 2) motivation and acceptance, 3) technology and natural resources, 4) financial resources, 5) institutional structures and human resources, and 6) legal framework and political strategies.

Closely linked to the adaptive capacity is the concept of resilience, which is a measure of the resistance of a system and describes the potential to overcome disruptions or changes without fundamental losses (Greiving, 2018, p. 2065).

To use the concept of vulnerability as an analytical tool, its operationalisation is a central task (Brown et al., 2017; Spielman et al., 2020).

The Heat Vulnerability Index (HVI) is an example of a quantitative method for determining the different levels of susceptibility to heat. Vulnerability is a latent variable, meaning it cannot be measured directly. Accordingly, different indices (e.g. age, income, population density, etc.) are developed through an inductive process to approximate the complex phenomenon of vulnerability (Kahlenborn et al., 2023; Wolf & McGregor, 2013).

There is a wide range of studies that focus on the quantitative analysis of vulnerability and its spatial representation in mappings of various cities (e.g. Johnson et al., 2012 for Chicago; Setiawati et al., 2022 for several provinces in Indonesia; Wolf & McGregor, 2013 for London). As a quantitative tool, the HVI can provide the database for urban planning strategies in form of spatially based mitigation and adaptation measures [see chapter 4], prioritised for certain social groups (Brown et al., 2017, p. 503).

Another key factor when describing and researching vulnerable groups is that social, economic and political conditions are always in flux (Adger, 2006, p. 274). The phenomenon of vulnerability is not static, and Luna (2009) therefore speaks of “layers [of vulnerability] not labels” that can simply be applied.

Hence, the complexity of vulnerability requires not only addressing the restrictions and negative effects of disruptive events for certain social groups but also shedding light on individual perceptions, embodied knowledge and respective needs and concerns. From a feminist perspective, recognising vulnerable groups also means addressing the role of caring practices (Brown et al., 2017). Accordingly, the call for environmental justice can also be framed as a call to a “care-full justice in the city” (Williams, 2017).

In summary, the following graphic shows the discussed determinants of heat-related vulnerability:

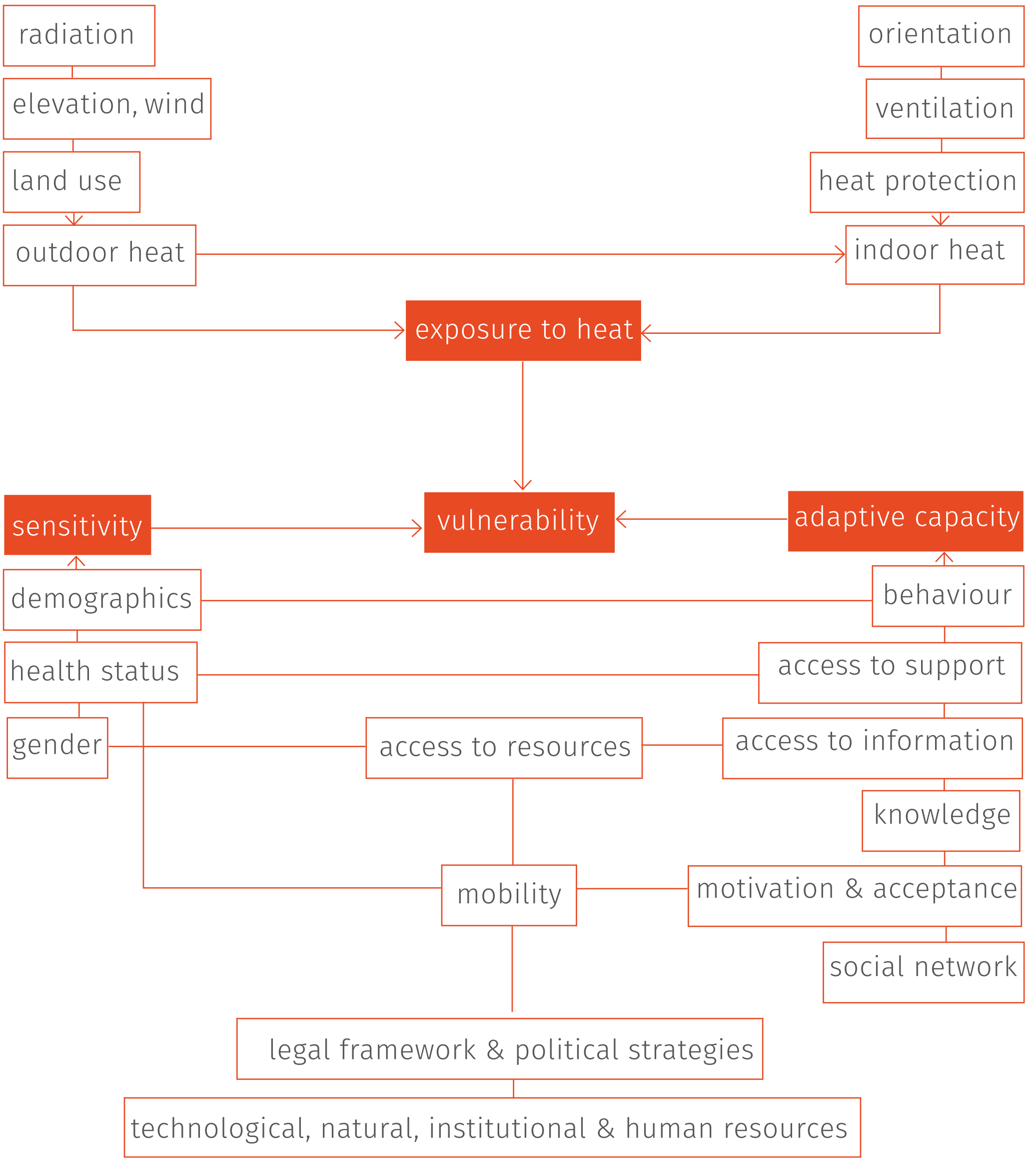


Fig. 20: Conceptualisation of heat-related vulnerability, based on Wolf & McGregor (2013) and Kahlenborn et al. (2023)

3.2 Unequal impacts of heat

Because the temperatures that the human body can withstand are limited, vulnerability in the context of urban heat can also be framed as a universal human experience. In contrast to the "autonomous and independent subject asserted in the liberal tradition" (Fineman, 2008, p. 2), humans generally have limits when it comes to coping with and adapting to urban heat.

Nevertheless, "personal, economic, social and cultural circumstances within which individuals find themselves at different points in their lives" (Brown et al., 2017, p. 498) can mean that some people are more sensitive to heat than others or their adaptive capacity is limited. There are numerous unequal impacts of urban heat that are caused by physiological, social-economic and situational factors.

Demographic aspects are usually the first to be listed when regarding the sensitivity of certain population groups: foetuses, newborns and children as well as older adults (< 65 years) are considered particularly vulnerable (GHHIN, n.d.-a; Schifano et al., 2009). Extreme heat can have a negative impact on the course of pregnancies and births as well as on the health of newborn babies. It also affects children who are not yet able to protect themselves from heat (GHHIN, n.d.-a).

Elderly people are more susceptible to heat due to impaired heat regulation and dehydration of the body, resulting in symptoms like fatigue, dizziness, and breathing difficulties (BAFU, 2019, p. 27). Additionally, reduced mobility at hot temperatures can lead to muscle loss and has negative impacts on their physical and mental health (BAFU, 2019, p. 32).

When it comes to chronic illnesses, there are a variety of negative influences of heat: They range from altered effectiveness of certain medications (CDC, 2024) to effects on respiratory and heart problems (GHHIN, n.d.-a), worsened multiple sclerosis symptoms (Christogianni et al., 2022), increased strokes (Bao et al., 2021) and influences on psychosis (Tupinier Martin et al., 2024) as well as other mental, behavioural, and cognitive disorders such as depression or dementia (Hansen et al., 2008).

Overweight people can also be more affected by heat, as their thermoregulation is restricted (IFRC, 2020, p. 18).

There are also several socio-economic factors that make people more susceptible to heat. Various studies indicate that people with lower incomes (Voelkel et al., 2018), living in poor conditions (Ramsay et al., 2024) or who are experiencing homelessness (Gabbe et al., 2023) are particularly exposed to heat.

The poor socio-economic conditions not only have an impact on the higher sensitivity to heat in the form of overheated living or working conditions or residential locations near urban heat islands such as major roads (UNEP, 2021; Voelkel et al., 2018), but also on adaptive capacity. For example, access to cooling facilities is often unaffordable for people on low incomes, or they live in neighbourhoods with few green spaces (Pham et al., 2012; Rajagopal et al., 2023).

The unequal distribution of green spaces intersects not only with poverty but also with belonging to marginalised ethnic groups: Previous studies have shown that marginalised ethnic groups are more likely to live in hot areas of the city, have less access to cooling facilities and receive less information about heat risks due to language barriers (Allex et al., 2018; Sanchez & Reames, 2019; Voelkel et al., 2018).

How cities are designed has a major effect on exposure, sensitivity and adaptive capacities in relation to heat. The next chapter takes a closer look at the measures that urban planning can use to mitigate and adapt to heat and the forms that planning for heat equity can take.

Fig. 21: Unsealing and greening of a square surrounded by a kindergarten, a school and a neighbourhood centre in Lausanne

4

HEAT IN URBAN PLANNING

4.1 Strategic approaches

The effects of climate change that have taken place to date can no longer be reversed and even if future climate targets are achieved, cities and their inhabitants will have to adapt to the new conditions (EEA, 2024; IPCC, 2001).

In Switzerland, the cantons, cities and municipalities bear the responsibility for the measures considering adaption to the increasing heat, while the federal government provides support in the form of information and working aids and issues regulations on guideline and limit values (Schweizerische Eidgenossenschaft, 2020, p. 34).

The Swiss Federal Office for the Environment summarises the following seven strategic approaches to reducing heat stress in cities (BAFU, 2012, pp. 29-32):

→ **'Ad-hoc-approach':**
implementing local measures without an overall strategy

→ **Overarching goals and guidelines for heat prevention:**
formulating generally applicable guidelines for a specific city or municipality

→ **Specific strategy for selected urban areas:**
combining general and sub-spatial strategies on a neighbourhood level

→ **Broad integral strategy for a whole region:**
developing measures with indicators, instruments and actors based on general guidelines and action approaches

→ **Partial strategy for an entire area:**
focusing on a specific field of action within the heat topic (such as tree planting strategies) in an agglomeration, city or municipality

→ **Detailed integral overall strategy for an entire area:**
coordinating small-scale measures for an entire municipal area with all relevant departments, institutions and stakeholders

→ **'Back-door-approach':**
integrating heat prevention into other spatial planning instruments such as urban development concepts or masterplans

Besides these strategic approaches, the literature in the field of urban planning identifies two key principles to addressing climate change in general and to increasing heat in particular. On the one hand, mitigation strategies to reduce the causes of climate change and the intensity of heat phenomena in the long term; on the other hand, adapting to direct consequences of heat and its local impact on people and ecosystems.

While mitigation in the form of CO_2 savings has been discussed at the global level since at least the adoption of the Kyoto Protocol in 1997, climate change adaptation and its localised opportunities and challenges have received comparatively less attention (BAFU et al., 2020; Birkmann et al., 2010). In 2022, an analysis of almost 12.000 climate action plans of European cities showed that 82% of these plans addressed mitigation strategies but only 18% included adaptation measures (EEA, 2024, p. 17).

The main urban planning guidelines for mitigating and adapting to heat are explained below. Finally, planning principles for heat equity are discussed.

4.2 Mitigation

Based on the IPCC (2001), mitigation attempts are defined as "[a]n anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases" (p. 990). At 32.4%, transport accounts for the largest share of greenhouse gas emissions in Switzerland (BAFU, 2020, p. 12). The Swiss Federal Office for the Environment assumes that half of the expected climate change in Switzerland could be avoided by 2050 if global greenhouse gas emissions were drastically reduced (BAFU, 2020, p. 44).

In addition to the global reduction of CO_2 emissions, the main aim of mitigation strategies at local level is to reduce heat sources in cities and minimise the overall UHI effect. As explained in chapter 2, cities impact urban heat by various factors such as natural and built structures, materials and anthropogenic activities (Grimmond et al., 2010).

According to Keith & Meerow (2022), there are four key areas in urban planning to cool cities: land-use planning, urban design, urban greening, and waste heat reduction.

Considering heat factors in land-use planning

As a central task of urban planning, land use and the development of neighbourhoods have a decisive effect on exposure to heat. Forward-looking planning helps to ensure that land is used sustainably and urban sprawl, which further reinforces the UHI effect (Stone et al., 2010), is avoided.

However, compact urban structures without vegetation cover generate further heat storage and heat release (Saleem et al., 2020). Strategic urban development must therefore integrate the numerous cooling strategies from urban design, urban greening and waste heat reduction (as discussed below).

To improve the microclimate in cities, land-use planning must also pay attention to wind corridors so that the air can circulate and thus provide additional cooling (Deilami et al., 2018; Ren et al., 2018). Further, spacious, asphalted roads and numerous car parks in cities make a major contribution to the UHI effect due to their low albedo and high heat storage. Urban planning must therefore find solutions to reduce the dominance of cars in cities and ensure that car parks are drastically cooled (BAFU, 2018; Keith & Meerow, 2022).

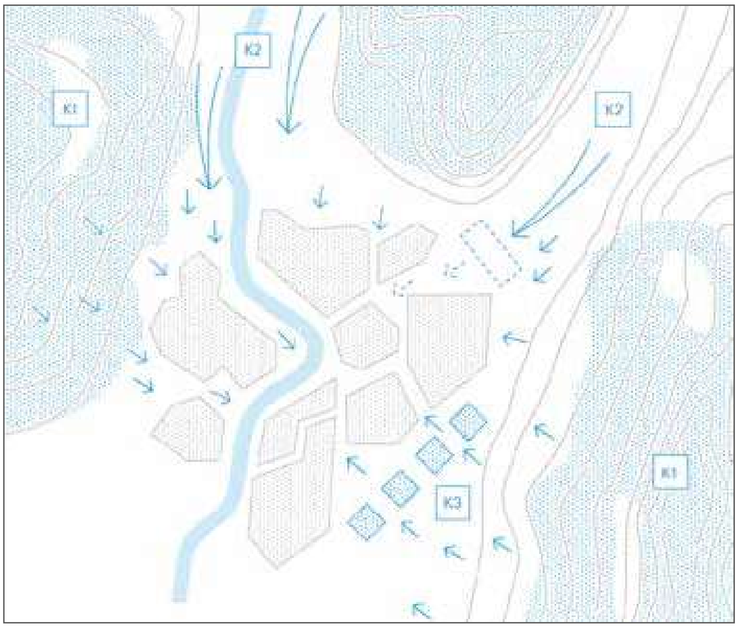


Fig. 23: Schematic illustration of measures for ventilation. K1: safeguard cold-air circulation areas
K2: keep fresh-air corridors and cold-air conduits free
K3: implement climate-optimised building development. Illustrated by Kanton Aargau, BVU

Cooling cities through urban design

At the level of urban design, there are numerous ways to support the cooling of cities. Street and building orientation significantly influence heat exposure by determining solar radiation and wind flows: north-south oriented streets are shaded comparatively longer during the day than east-west oriented streets (Jamei et al., 2020; UNEP, 2021).

Additionally, buildings should be oriented lengthwise along the main ventilation direction to optimise airflow (BAFU, 2018, p. 36). Accordingly, understanding the patterns of solar radiation on the built environment and taking it into account in urban design is key to creating cool microclimates (Keith & Meerow, 2022, p. 54). Street and building orientations in already existing neighbourhoods can be optimised integrating this knowledge in greening strategies (see next section).

Building shape and massing also influence human thermal comfort: tall, slender buildings with green open spaces offer climatic advantages over wide, sprawling buildings, due to better air circulation and the connection of different green spaces (BAFU, 2018, p. 36).

Providing shadow is another central element of heat mitigation strategies: trees, buildings or built shade structures (such as textile shade sails or wooden canopies) are different means to install “the right shade in the right place” (Middel et al., 2021, p. 1806).

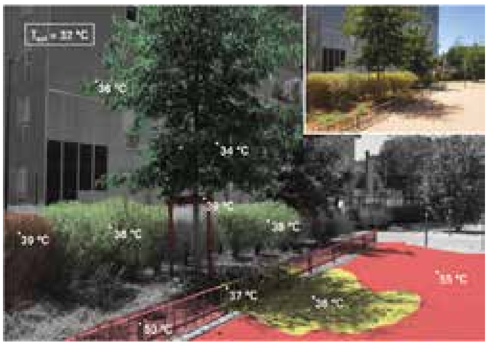


Fig. 24: Influence of tree shade on the surface temperature

Fig. 25: Wooden canopy in Lausanne

Finally, high-albedo materials (e.g., lighter-coloured pavements) are being discussed in the literature on heat mitigation as they reflect solar radiation and can lower asphalt or concrete temperatures by 3-5° C (Deilami et al., 2018; UNEP, 2021). However, there is also criticism of the use of highly reflective materials, because they can irritate people and animals or have other unintended effects (Wang, 2022).

Improving the microclimate through urban greening

Urban greening strategies - also discussed under the keyword Nature based Solutions - offer a variety of possibilities for heat mitigation. The measures range from planting trees, upscaling parks and green open spaces, installing green roofs and facades to integrating water features such as fountains or misting systems (Keith & Meerow, 2022).

All these elements have significant positive effects on the reduction of urban heat but also the improvement of air quality, the mental health of urban residents, the enhancement of soil functions and the better management of storm water run-off (UNEP, 2021, p. 80).

Through transpiration, large green spaces like urban forests and parks cool their surroundings, with effects up to 800 meters outside the green space (UNEP, 2021, p. 81). During the day, green spaces cool neighbourhoods through shading and evaporation, while at night, cool air formed above green areas flows into adjacent areas and helps to lower overall air temperatures (BAFU, 2018, p. 42).

Fig. 26 & 27: ‘Canopy objective‘. Tree planting strategy, City of Lausanne: 30% canopy cover by 2040

Green roofs offer another possibility to create spaces for water retention and simultaneously heat reduction due to evapotranspiration, the combined effect of transpiration and evaporation of water from plants and soils (Kanton Aargau Department Bau Verkehr und Umwelt (BVU), 2021, p. 64). Vertical greenery in the form of façade greening also provides additional cooling potential where no other form of green structures is possible (BAFU, 2018, p. 66).

Fig. 28 & 29: Green roof and vertical greenery in the Flon area in Lausanne

Reducing waste heat

The last area of spatial heat mitigation measures to be discussed in this thesis is that of waste heat reduction. Together, the buildings and transport sectors account for almost a third of Switzerland's domestic greenhouse gas emissions (BAFU, 2020, p. 12). Accordingly, there is great potential to reduce both emissions and the UHI effect in these two areas. By increasing building energy efficiency, waste heat and greenhouse gas emissions can be drastically reduced (Keith & Meerow, 2022, p. 59).

In the transport sector, waste heat is released through combustion engines and batteries as well as parking cars (VCÖ, 2024). As active mobility is often reduced during hot days, car use as well as energy consumption for air conditioning are increased, generating even more heat and greenhouse gas emissions (UNEP, 2021).

Reducing vehicle use through alternative transportation modes should therefore be promoted to significantly decrease vehicle-generated waste heat and mitigate the urban heat island effect, while simultaneously enhancing air quality (Keith & Meerow, 2022, p. 60).

4.3 Adaptation

As climate change and rising temperatures can no longer be prevented, adaptation measures are becoming increasingly important (BAFU, 2020). In the context of climate change, adaptation describes the "[a]djustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2001, p. 982).

Mitigation and adaptation strategies overlap and complement each other (EEA, 2024; Hirschfeld et al., 2023). Many measures that can be assigned to climate adaptation also enhance mitigation processes and vice versa. Planting trees, for example, has a cooling effect on the UHI and at the same time provides an adaptation option for staying in the shade in hot weather.

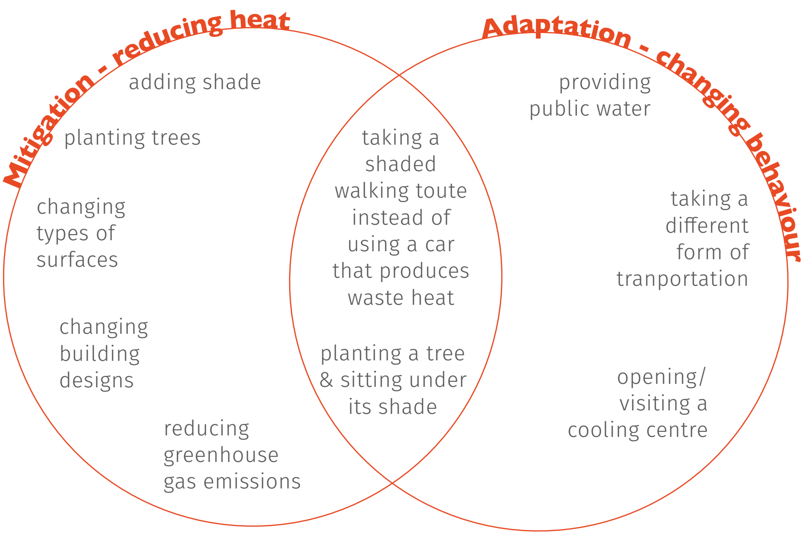


Fig. 30: Intersection of mitigation & adaptation strategies, based on Messerschmidt et al. 2019

It is therefore not always possible or useful to classify measures strictly to one or the other approach. The following planning guidelines therefore focus primarily on adaptation measures in urban planning regarding heat that improve coping strategies with the already existing heat.

Establishing warning systems for heatwaves

Tools like health alerts, warning systems, heat-health hotlines, and Heat Action Plans can help cities to prepare for extreme heat events (UNEP, 2021, p. 158). Heat Action Plans aim to promote health and heat-resilient living conditions, often based on WHO guidelines or national recommendations (Hertel et al., 2024, p. 249). Warning systems and care systems represent short-term responses to acute heat events.

In Switzerland, heat action plans are the responsibility of the cantons and are announced when certain temperature limits are exceeded (Ragettli & Röösli, 2021). As a specific measure, for example, municipalities create lists to contact and visit elderly people during heatwaves (BAFU, 2019, p. 40).

Expanding the blue-green infrastructure

Blue and green infrastructure refers to a city's water and green space facilities. As already explained in the context of mitigation strategies, urban greening significantly improves the micro-climate of cities. In terms of adaptation, designing bus and train stations with shading, vegetation and water features can contribute to enhance thermal comfort while walking and waiting in public spaces (BAFU, 2018). By greening and cooling public transport stations without gaps, a system of micro-cooling spaces could be created, each microspot enhancing the next, creating a bigger effect than isolated microspots.

Water is a central element in creating cool urban climates through evaporation and improving human well-being in public spaces (BAFU, 2012). Moreover, blue infrastructure such as retention ponds or blue-green roofs help mitigate flood risks (EEA, 2024). The reintegration of natural water flows by re-naturalising covered canals is another example of expanding the blue infrastructure in cities (EEA, 2024).

Besides natural bodies of water, public water features, such as the installation of fixed drinking water dispensers or other hydration stations in public spaces are important components of a city's blue-green infrastructure for human health and mental well-being (Ragettli & Röösli, 2021; UNEP, 2021).

By involving community knowledge, free water distribution sites can be strategically placed in parks, near public transport stops or other highly frequented areas (UNEP, 2021, p. 154). Further water features for recreational purposes such as spray parks, splash pads or misting stations can help to relieve heat stress directly on the body and are especially attractive to children (Messerschmidt et al., 2019).

Fig. 31: Redesigned playground with water features for kids in Lausanne: the fountain is operated manually to avoid wasting water and also serves as a play element

Advancing public cooling infrastructure

Besides blue-green networks throughout the city, community cooling centres can help to adapt to higher temperatures: existing air-conditioned buildings such as libraries, senior or community centres can provide temporary relief and safety from extreme heat (UNEP, 2021).

As part of a broad heat-related infrastructure strategy these local cooling spaces can be managed by municipalities or social organisations. As "community-based interventions" (Yoon et al., 2025, p. 14), cooling centres meet the needs of specific neighbourhoods and complement the network of other outdoor cooling options in an urban area.

4.3 Planning for heat equity

From an environmental justice perspective, it is crucial to consider heat equity as "the right of all community members to have thermally safe indoor and outdoor environments" (Keith & Meerow, 2022, p. 34). Therefore, urban planning must address specifically heat-vulnerable groups fostering their "right to cool" (Yoon et al., 2025, p. 1).

An analysis of the uneven distributed heat risks forms the basis for tailoring mitigation and adaptation strategies to the needs of the most at-risk residents without imposing additional burdens on them (EEA, 2024; UNEP, 2021). Their experiences, local practices and everyday realities should be considered when developing heat adaptation measures (EEA, 2024; Guardero et al., 2022).

Realising adaptation with affordability in mind

By providing shade and improving thermal comfort particularly in low-income and minority neighbourhoods, urban greening plays a key role in heat equity (Keith & Meerow, 2022). As marginalised and low-income populations are significantly more exposed to heat and often have lower adaptive capacities, these areas should be the top priority for unsealing and greening (Voelkel et al., 2018). However, Nature based Solutions can also represent a form of gentrification processes, namely "green gentrification" (Checker, 2011; Meishar, 2018).

Consequently, active community engagement in heat adaptation programmes is crucial to ensure that hot areas benefit from greening without entailing displacing processes (UNEP, 2021, p. 156).

Due to poor housing conditions, lower-income and marginalised neighbourhoods often face higher heat stress (Keith & Meerow, 2022; Voelkel et al., 2018). Affordable and high-quality living space is therefore not only a question of social housing policy but also a major challenge for urban planning in terms of heat equity.

Creating accessible cooling centres at a neighbourhood level

The community cooling centres can also contribute to more heat equity through various criteria: proximity to heat-vulnerable groups and easy accessibility are important factors when placing cooling centres in neighbourhoods.

The involvement of vulnerable groups is therefore of great importance in the strategic planning and placement of cool places in the neighbourhood (EEA, 2024). Additional bus stops at these cool places can help people with limited mobility to reach them more easily (UNEP, 2021, p. 153).

As large street networks and parking lots contribute significantly to the UHI effect, disproportionately affecting vulnerable groups (Voelkel et al., 2018), transportation systems are critical to achieving thermal equity (Keith & Meerow, 2022). Shaded streets and “cool corridors”, for example, can reduce heat exposure and improve accessibility to cooling resources for pedestrians and cyclists (Keith & Meerow, 2022, p. 35).

Information on the cooling centres should be widely disseminated and available in different languages (Voelkel et al., 2018).

Furthermore, access to cooling infrastructure should be at no cost; vouchers for public transport or for food to access restaurants are other measures to include low-income groups in heat adaption strategies (UNEP, 2021, p. 153).

Cooling centres can also be tailored to specific groups, such as low-income families, outdoor workers, or homeless people (UNEP, 2021; Yoon et al., 2025). Partnerships between municipalities, social organisations and other stakeholders can help to ensure that cooling infrastructures meet the needs of the different vulnerable groups, e.g. providing drinking water, food or medical supplies (German Red Cross, 2024).

Given the diverse characteristics of vulnerable groups (as seen in chapter 2 and chapter 3) and the built structures and cities in which they live (explained in chapter 4), it is essential to consider planning for heat equity in the local context. Based on the theoretical foundations now discussed, the next chapter presents the results of the research of specific heat-related challenges and local cooling strategies in the City of Lausanne.

Fig. 32: Cooling off in the water in the Ouchy area in Lausanne

5

COOLING STRATEGIES IN LAUSANNE

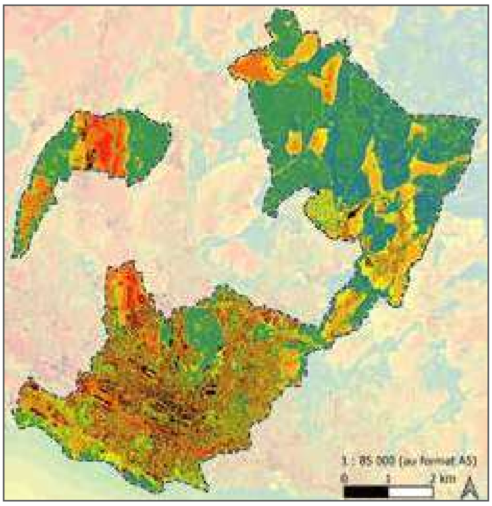
Fig. 33: Municipal territory. Urban area and ‘zones foraines‘: districts outside of Lausanne (mostly woodland). 1 : 50‘000

5.1 Facts about heat in Lausanne

To contextualise the results from the empirical analysis of cooling strategies in Lausanne, the following summarises key facts about heat in Lausanne.

Hot days, tropical nights and heat stress

Lausanne recorded an average of 8-10 hot days per year in the period 1991-2020 compared to 4-6 hot days per year in the 1961-1990 reference period (MeteoSchweiz, n.d.-g). The National Centre for Climate Services assumes that Lausanne will experience more than 30 hot days per year by 2085 unless drastic measures are taken (NCCS, 2018, p. 253).



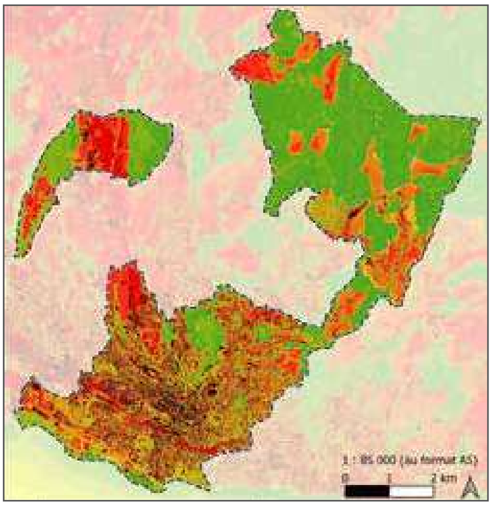


Fig. 34: Daytime heat stress in Lausanne now & Fig. 35: Assumed daytime heat stress for 2060. Blue: thermal comfort; green: light heat stress; yellow: moderate heat stress; red: high heat stress; dark red: extreme heat stress. Illustrated by GEO-NET Umweltconsulting.

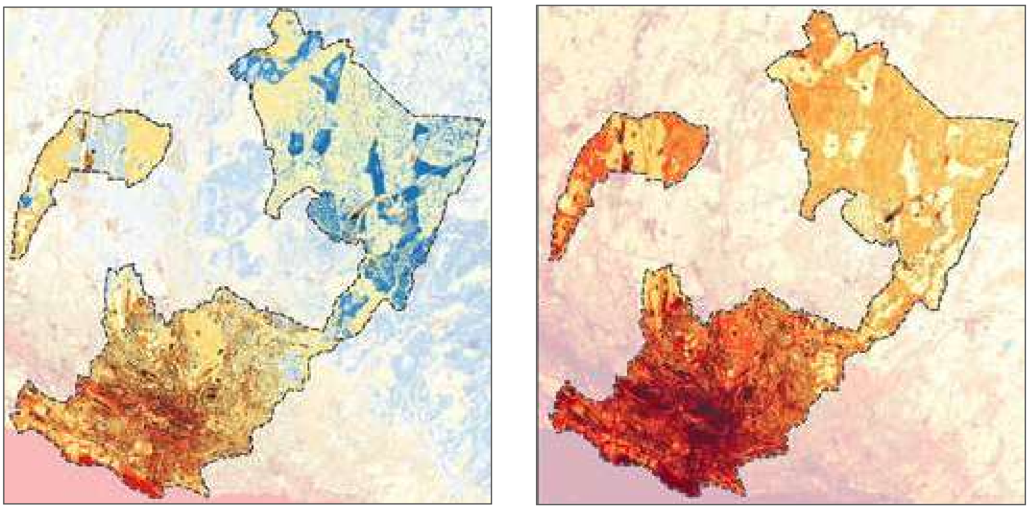


Fig. 36: Nighttime heat stress in Lausanne now & Fig. 37: Assumed nighttime heat stress for 2060. Blue: thermal comfort; green: light heat stress; yellow: moderate heat stress; red: high heat stress; dark red: extreme heat stress. Illustrated by GEO-NET Umweltconsulting.

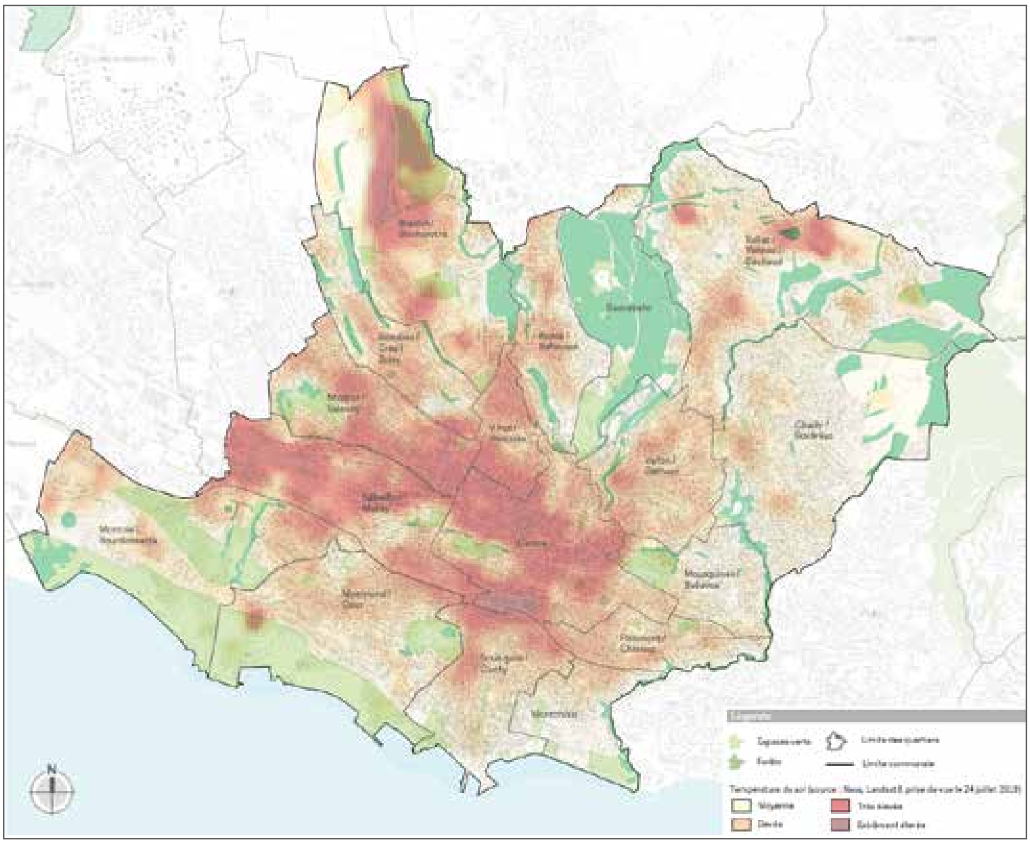
Tropical nights could rise to over 30 per year by 2085 (NCCS, 2018, p. 114). Temperatures above 20°C at night are mainly concentrated in the area around the railway station, the old town, the Sebéillon/Malley district along major rail and road infrastructures and the harbour area Ouchy. While the night-time temperature in the harbour of Ouchy is around 20°C, it is almost half as high in the Parc Naturel du Jorat at 11.5°C (Ville de Lausanne. Direction du logement, de l'environnement et de l'architecture. Bureau climat et durabilité [Ville de Lausanne], 2024, p. 14).

Urban Heat Island effect

Compared to the surrounding areas, temperature differences up to 2°C during the day and 4°C at night in the city of Lausanne were found (Labedens et al., 2018, p. 1). On hot nights with light winds, differences of as much as 10°C have been measured (Plan Climat, 2021, p. 17).

Even though Lausanne is considered a green city with 360 hectares of public green space and thus 26 m² of green space per inhabitant (PDcom, p. 15), there are also inner-city UHI effects: Particularly sealed areas in the old town, in the Sebéillon/Malley district, around the airport and along major car and rail axes create urban heat islands at neighbourhood level.

Fig. 38: Surface temperature in Lausanne. Yellow: medium; orange: elevated; red: highly elevated; dark red: extremely elevated. Illustrated by Ville de Lausanne



5.2 Aspects of heat-related vulnerability in Lausanne

The first crucial part of the empirical research was to understand how heat-related vulnerability is understood by social organisations who are in contact with vulnerable groups in Lausanne. To which extent are people vulnerable to heat in Lausanne and what are the characteristics of heat-related vulnerability in the local context?

5.2.1 Who is vulnerable to heat?

The group most frequently mentioned in the interviews was the elderly. They appear to be most present in people's minds when it comes to heat and its effects (I4_walking, I5, I6, I8, I9, I10_walking). Another age-related group are children, who were particularly mentioned in the context of hot school buildings and schoolyards (I5, I8, I9).

In many of the interviews, people in precarious living situations were a central group mentioned in relation to heat, e.g. people who live from one day to another, people who live on the streets, who don't have a cooler place to stay in/at, or people who cannot act autonomously for economic reasons or due to a precarious residential status (I6, I8, I9, I10_walking).

Some people are also confronted with multiple vulnerabilities, take for example an elderly person living on the street. (I6, I10_walking). People who consume alcohol or drugs while living on the streets were emphasised as particularly vulnerable: drinking alcohol instead of water and not recognising its de-hydration effects was assessed as a high-risk during heat waves (I5, I6, I8).

People with physical or mental illnesses (I5, I6) and overweight people (I9) were also described as vulnerable to heat. Another group were people who live in building blocks without green spaces or trees or who live in hot apartments (I8, I9). People who work outside on construction sites, public spaces and infrastructure facilities were also seen as part of the groups particularly vulnerable to heat (I5).

Even if these categories are largely congruent with the literature, it was important in the discussions to go through the different concerned groups to assess the awareness of certain living conditions and subsequently gain a more comprehensive picture of local concerns in relation to heat.

The categorisation of different levels of concern in relation to heat was also viewed critically in the interviews: As everybody is individual, it was emphasised that it is not possible to speak of globality and that generalisations should be avoided (I5, I6, I9, I10_walking).

In accordance with the definition of heat-related vulnerability (exposure to heat, sensitivity of the individual body and capacity to adapt), the participants saw these categories more as tendencies than as fixed groups. The phenomenon that different bodies have individual sensitivity to heat that can change over a lifetime is related to the fact that heat itself is also changing as a result of climate change (I9). Accordingly, heat-related vulnerability is not a rigid categorisation system and can evolve over time.

5.2.2 Perception of heat in Lausanne

Some participants also directly addressed their perception of the heat in Lausanne, describing it as “unbearable” (I4_walking), “invasive”, “exhausting” and “demanding for a lot of people” (I9). It was also mentioned that heat prevents many elderly people from going out and that it’s risky for elderly people to walk outside when there is no shade (I5). The condensing heat in the inner city was also described as a “funnel” (I4_walking).

As the interviews were all conducted on very hot days, the participants referred directly to the temperatures:

> *«But you see, it‘s not July anymore [author’s note: interview in September 2024], we have these temperatures all the time, it‘s super-hot.» (I10_walking)*

Another interview talked about children coming back to school after the summer vacation at the end of August and it still being very hot:

> *«What‘s it like today? 32°? something like that. In a week, it might be 27, but it‘s still very hot.» (I7_walking)*

The actual idea of children having time off school during the summer months and starting the new school year refreshed again towards the end of the summer no longer works in view of longer periods of heat into September. Heat at night was described as “unpleasant” and “there are times when it’s very dense and difficult” (I9). Another interview referred to elderly people saying during heat waves:

> *«Ah well, that’s when I live with the shutters closed, almost 24 hours a day. I’m a bit fed up.» (I5)*

5.2.3 Challenges of heat-vulnerable people

The interviews covered a variety of challenges related to heat vulnerability, which are summarised under the following key findings:

Dehydration

Dehydration was reported as an issue that affects many different groups: on one hand, it was reported that people tend to sweat a lot on hot days and often forget to drink enough, regardless of their age or physical condition (I4_walking, I5). On the other hand, certain groups, such as those who consume alcohol or drugs, were mentioned as being more vulnerable to dehydration (I6, I8). Additionally, the accessibility and affordability of water can pose a barrier to staying hydrated on hot days (10_walking). The topic of availability of public drinking fountains, for instance, was discussed in this context. [See chapter 4]

Fig 39: Public drinking water in Lausanne

Affordability of cooling options

The affordability of cooling options was assessed as a significant issue for vulnerable groups, who are confronted with different barriers to staying hydrated and cool during hot periods.

For instance, simple summer pleasures like eating ice cream, often associated with childhood memories and a source of relief from the heat, were reported as out of reach for socio-economically weaker persons (I10_walking). Accessibility to hydration is similarly limited, with even basic amenities such as public drinking water not always being readily available (I10_walking). Moreover, public transport was seen as unaffordable for certain groups. This lack of access to affordable public transport means that while cooling resources like the Lake of Geneva may be nearby, they are effectively out of reach if a person cannot afford the ticket for the public transport and must walk long distances on steep roads in the heat (I6, I10_walking).

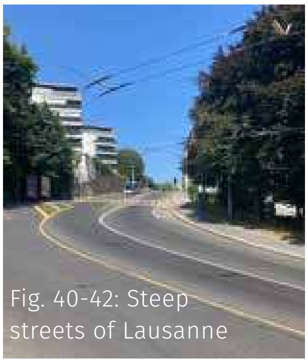


Fig. 40-42: Steep streets of Lausanne

Fig. 43: Metroline of Lausanne

Although there are some places where people can access water without needing to buy anything, the lack of public cooling options was nevertheless stated during the interviews (I6, I10_walking). For example, it was reported that only certain age groups, such as the young and the elderly, receive free access to amenities like swimming pools or air-conditioned cinemas, where they can cool off (I5, I6, I10_walking). Other vulnerable groups, however, are still excluded from such benefits, despite the fact that being able to take a shower, refresh oneself, or go swimming can be crucial during heat waves (I6).

This highlights a broader issue which was discussed during the interviews: offering reduced prices (e.g. in facilities like swimming pools or cinemas) is often not enough, as even discounted rates can be too costly for those in precarious financial situations (I6). Free access to cooling options was stated as necessary to ensure that everyone, regardless of their financial status, can find a way to stay cool during hot periods (I5, I6, I10_walking).

Further, it was discussed that people who are living in precarious conditions may also not have the resources to think about the heat itself and to elaborate strategies against the heat – “you cannot think when your stomach is empty” (I9).

The economic dimension of precariousness was also connected to the social dimension of precarious living conditions during the interviews: there are people who attend social organisations not only for food distributions but also for social contacts (I10_walking). (See also ‘Not moving and social isolation’)

Difficulties in maintaining hygiene

Maintaining hygiene was estimated as a significant challenge for people living in precarious living conditions: Sweating during hot temperatures is not only a problem for staying hydrated, it brings with it the challenge of body odour, which can lead to even more social stigma (I6, I10_walking).

The lack of accessible shower facilities means that some people have no possibility to refresh their entire body, which was considered essential not only for basic cleanliness but also for self-care and personal dignity (I6, I10_walking). Maintaining hygiene and access to clean clothes remain barriers in the everyday lives of people living in precarious conditions (I10_walking). As even social organisations don't always have shower facilities, a shortage of spaces where people can attend to their personal hygiene during heat waves was identified (I6, I10_walking):

> *«Yes, I mean access to... or opportunities to cool off, not just to be in the shade but to really cool off.» (I6)*

Even though there are public showers next to the Lake of Geneva, showering in a public space can also be stigmatising (I6, I10_walking). Choosing not to bathe in public places, like in the lake or to use the showers installed next to the lake, was put into context of social stigma and maintaining dignity (I6, I10_walking).

Overall, maintaining personal dignity in precarious living conditions was described as a complex issue. Therefore, providing more accessible shower facilities with private cabins in the social infrastructure of the city could be one measure for vulnerable groups affected by urban heat.

> *«Yes, the swimming pool would also be an opportunity for these people to take a shower. If they don't have access to emergency accommodation, they don't have the means to take a shower. That's a big problem. And to have access to a water point. And I think you have to pay a franc for a shower. So, it's not that trivial. I mean, this kind of offer would be really welcome for our population.» (I6)*

Fig. 44: Public shower next to Lake of Geneva

Not moving and social isolation

The phenomenon of not moving during hot weather reflects both the impact of heat on daily activities and a certain kind of personal cooling strategy (see also ‘Adaptation of activities and mobility’). High temperatures can make physical activity exhausting, especially on the steep streets of Lausanne (I5, I6). Consequently, trying not to move too much can be seen as a way to stay cool.

At the same time, this inactivity can be particularly harmful for older adults, as it poses risks to both their physical and mental health. Staying active despite the heat was therefore considered as both essential and a major challenge (I6).

The heat can also discourage people from leaving their house (I4_walking, I5, I9):

> *«During the day, I try to stay indoors more […] I barricade myself in.» (I4_walking)*

Maintaining social connections in hot weather can be therefore challenging.

It was also mentioned in the interviews that precarious living conditions are not only marked by economic challenges but also by social isolation: Filling the hours from morning until emergency shelters open in the evening can be a challenge. There are people who attend soup kitchens, not necessarily because they are homeless, but to have social interactions (I10_walking).

> *«[…] because if we talk about precariousness, what are we talking about? Clearly, economic precariousness, social precariousness, because it‘s all interconnected, all that. But there‘s also the question of loneliness. Simply loneliness.» (I10_walking)*

Therefore, it is crucial to think of cooling services that are intertwined with social interactions (I5, I10_walking).

«Tu peux faire le parc le plus beau avec plein des fontaines. En étant tout seul, tu vais pas là.» (I10_walking)

«You can make the most beautiful park with lots of fountains. If you're all alone, you won't go there.»

For those living without stable housing and carrying everything with them, they face the additional burden of managing their possessions in extreme weather, often sweating under the weight of their bags in the heat (I10_walking). Not moving much on hot days therefore seems easier to manage. Storage solutions for people in precarious situations are rare. Previously, public lockers were available at Place du Vallon, but this service is no longer provided (I8).

Heat at school

Children and young people were identified as one of the groups vulnerable to heat. Heat in the context of kindergartens and school buildings and playgrounds was therefore an important point of discussion in the interviews. It was reported that most of the buildings were not adapted to the heat in terms of their construction and building materials and that courtyards and recreation areas were often too hot for the children (I4_walking, I7_walking):

> *«Everything is super-hot in the context of schools.» (I7_walking)*

It is difficult for children to concentrate in the school buildings, which are already so hot in the morning that it is not possible to cool them down during the day (I4_walking). There is also little shade in the school playgrounds for the children to play in or wait for their parents after school (I4_walking, I7_walking). School sports areas located in the blazing sun and sealed car parks are other elements that can turn school grounds into small heat islands in the neighbourhood (I7_walking).

Heat as one aspect of precarious living conditions

But there is also another side, people who don‘t complain about the heat because their daily survival is more challenging than the heat (I6, I8). Based on the literature research, one of the aims of the interviews was to shed light on the situation of people in precarious circumstances: how do people with few resources and therefore few options deal with the urban heat? What does their everyday life look like during heatwaves?

Interviewees who work with people in precarious situations and who live under the radar of society emphasised that, while it is challenging for them to fully understand these individuals‘ experiences, they are committed to sharing these realities through conversations to help broaden perspectives (I6, I10_walking).

Precarious living takes many forms, and while heat poses its own challenges, different interviews mentioned the fact that winter and rainy seasons are even more difficult to manage (I6, I9, I10_walking). Without a secure place to relax, shower, or simply exist, people are forced into a lifestyle that requires high resilience (I6). Those in precarious situations must contend with weather-related issues year-round and the heat is one part of it. To really understand the situation of people in precarious situations during heatwaves, it would be crucial to talk directly to those affected. Further investigations are therefore necessary but could not be carried out within the scope of this work.

5.3 Cooling strategies: heat-vulnerable people

A central goal of this work was to highlight various cooling strategies, with a particular focus on vulnerable groups. It can be stated that in light of climate change and rising temperatures, everyone will need to develop their own cooling strategies.

However, vulnerable groups are already forced to confront this issue and often have fewer resources at their disposal to do so. A key finding of this work is that these cooling strategies should no longer remain niche knowledge but must be widely accessible. Climate change has become an everyday reality, making cooling strategies relevant for everyone. Therefore, they must be further developed to support the adaptive capacity of vulnerable groups.

In the interviews, the following cooling strategies of different vulnerable groups in Lausanne were discussed:

5.3.1 Adapting activities and mobility

To make use of the cooler hours of the day during heatwaves and avoid the hottest periods, activities and daily routines are adapted as much as possible (I4_walking, I5). For example, events at senior centres are held more often in the mornings, while afternoons are ideally spent at home — provided the homes do not overheat (I5).

This adjustment in daily routines is closely linked to changes in transportation choices: instead of walking, people more frequently opt for public transportation or take their own cars (I4_walking, I5).

This example clearly illustrates how increasing heat affects transportation choices: as temperatures rise, people may find it more appealing to use their own air-conditioned cars than to walk under the blazing sun. However, cars emit significant heat, which further contributes to the urban heat problem. Not moving at all can also be a cooling strategy (as already discussed under the aspect 'Not moving and social isolation' in 5.1.3).

5.3.2 Attending cooled public spaces

People in precarious living conditions depend on non-commercial spaces to cool down. One interview described the situation as „a bit of a scramble. Especially for people in precarious situations" (I10_walking). As also communicated on the 'Fresh places map' of the city (see also 5.5.3 Cooling planning measures), public libraries are recognised and visited as 'cooling zones', as well as lesser-known places like cafeterias within public facilities (I10_walking).

Overall, however, the interviews only touched lightly on cooled public spaces and did not talk in detail about specific cooled places and services (see also 5.6.2 Refreshing places).

5.3.3 Unsealing as a collective cooling strategy

In the course of this work, two examples of unsealing initiatives on the neighbourhood-level were examined as cooling strategies: the transformation of 'Place du Vallon' and the square adjacent to the neighbourhood centre 'Espace 44' in the Beaulieu neighbourhood. The analysis of these two places in the context of this study was of particular interest because in both cases vulnerable groups benefit from the de-paving and transformation.

Fig. 45: Square adjacent to the neighbourhood centre ‚Espace 44'

Both spaces were transformed from concrete into green areas through neighbourhood initiatives, driven by local motivation and ideas. In both cases, the main objective was to cool and to reappropriate the spaces by creating new meeting places for residents and organisations and the whole neighbourhood (I7_walking, I8).

Special attention was given to the individual design of seating areas by the initiators: at Place du Vallon, seating was created from local wood and reused granite from the renovation of a bridge in Lausanne, inviting people to sit and enjoy the space (I8). In the Beaulieu neighbourhood, the layout of the wooden block benches was carefully considered to encourage interaction, with varying heights and lengths that make them accessible for both young and old (I7_walking).

Both spaces were redesigned through a participatory process and financially supported by the city's participatory budget ('budget participatif'). In addition, these spaces particularly serve vulnerable groups as cool spots: the space in the Beaulieu neighbourhood is located right next to a kindergarten and a school, providing a small green oasis in an otherwise concrete-dominated area.


Fig. 46: Seating area, Beaulieu


Fig. 47: Community gardening, Beaulieu

Fig. 48: Unsealed and greened Place du Vallon

The Place du Vallon, on the other hand, is situated in a former industrial and working-class neighbourhood and is surrounded by several social facilities (a homeless shelter, a centre for people with mental illnesses, a neighbourhood association, and a centre for people affected by problematic use of psychotropic substances) that use the space partly "really a bite like as their own backyard or garden" (I8).

Since unsealing an area requires significant resources (in terms of budget, knowledge, networking, etc.), these examples are certainly not everyday strategies for coping with heat. However, it was important for this study to highlight that, at a collective level, there are cooling strategies in the city of Lausanne that not only combat heat on a small scale but also represent acts of neighbourhood empowerment.

«Je trouve ça extraordinaire qu'on puisse [...] avoir un impact. [...] il y avait quand même tout le monde qui était là, avec la barre à mine, à sentir les trucs, puis ça fait quelque chose aussi en terme de rassemblement de personnes. Tout le monde était hyper content d'enlever ça.» (I8)

«I find it extraordinary that you can [...] have an impact [...] everyone was there with their crowbars, taking things out, and it also creates a sense of togetherness. Everyone was so thrilled to remove these things.»

5.4 Cooling services: social organisations

Since a variety of social organisations were consulted for this work to examine the situation of vulnerable groups during heatwaves, a key takeaway from the analysis is also the role of these organisations themselves, along with their capacities and limitations in addressing urban heat challenges.

5.4.1 Offering refreshments

All the organisations I spoke with were well aware that water is essential on hot days. Therefore, they all offer free water to help keep those who visit stay hydrated and to provide a consumption-free place to rest for a moment (I5, I6, I10_walking). In addition to water, they mentioned other small refreshments that are sometimes available, such as fruit or ice cream. Ice cream was particularly highlighted because, on hot days, it brings a small joy that people in precarious situations often can't afford, yet it can make the heat more bearable, even if just for a moment (I10_walking). (See also 'Affordability of cooling services')

5.4.2 Informing and collaborating with the city

Providing information about coping with heat is another aspect social organisations mentioned in relation to supporting vulnerable groups during hot days. For example, they not only give reminders to stay hydrated but also share tips through newsletters or conversations on how to stay cool (such as running cold water over wrists, placing a damp towel on the neck, or visiting air-conditioned stores) (I5, I6, I8).

In addition, there were two main areas where collaboration with the city on the issue of heat was highlighted in the interviews. One is the city's 'Fresh Places Map' ('Carte des espaces frais'), and the other is the respective heatwave plan ('Plan Canicule') of the canton.

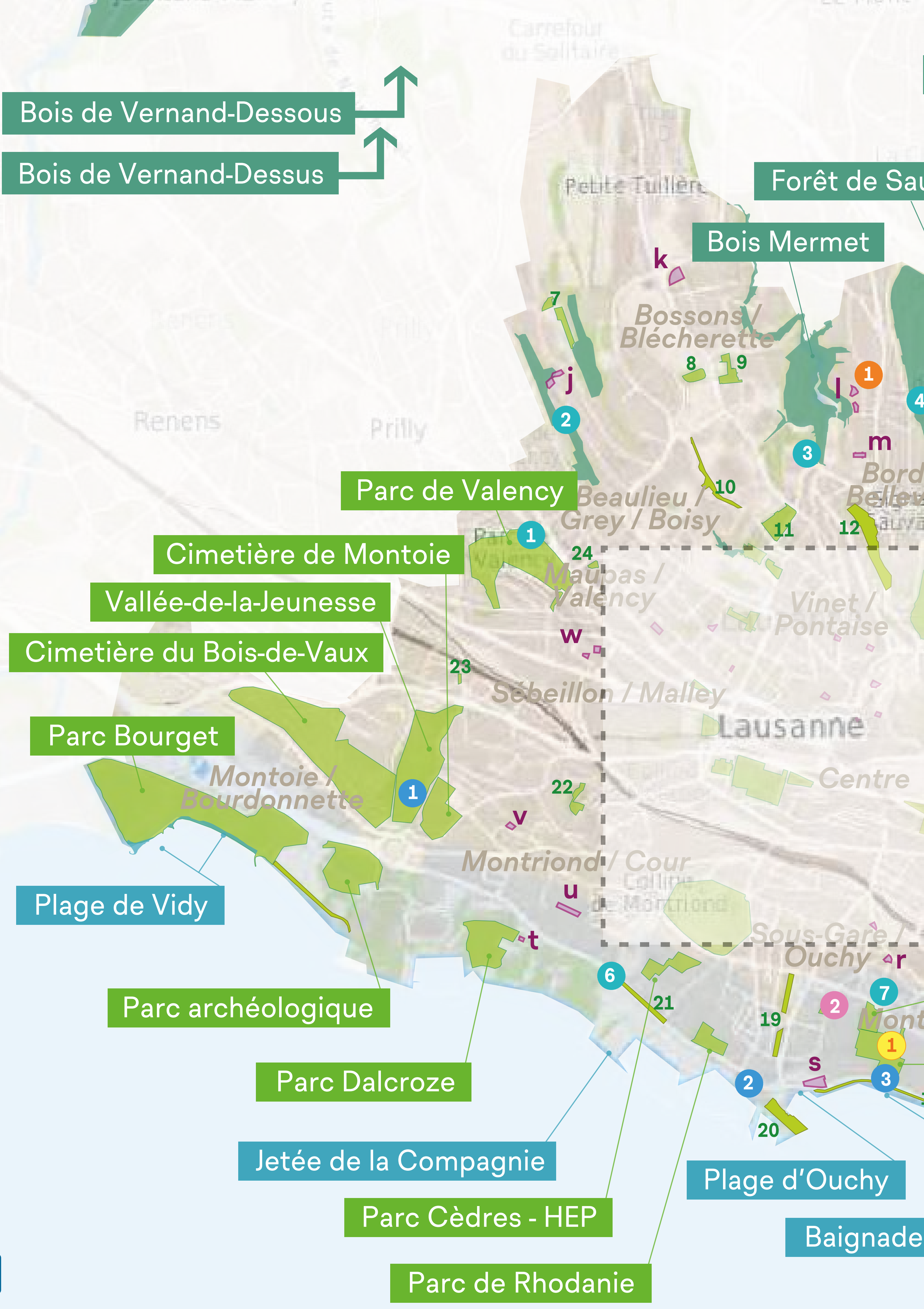


Fig. 49: Fresh places map, City of Lausanne

Carte des espaces frais à disposition de la population, pour trouver un refuge contre les fortes chaleurs pendant les canicules.

1 km

Fig. 50: Fresh places map, inner city, City of Lausanne

It was mentioned that they received the fresh places map and either put it up or distributed it to the people in their facilities (I5, I6). However, it's unclear to what extent people make use of the map, but still a few positive responses have been mentioned so far.

The heatwave plan was also known to the organisations. In this context, it was criticised that this measure primarily reaches those already involved in certain support structures, as they are more likely to sign up for the list (I5, I9).

One interviewee also reported on other collaborations between social organisations and the city under the keyword 'Plan Canicule': during heat waves, water bottles, hats, and raincoats (for summer storms) are distributed to people in precarious situations (I6). This indicates that the city recognises populations living in precarious situations also as vulnerable to heat.

However, detailed information regarding this specific part of the city's heatwave plan was not accessible online during my research. This information could therefore not be sufficiently verified.

5.4.3 Limitations for social organisations

Overall, the issue of urban heat was connected to everyday experiences of vulnerable groups and local knowledge in all interviews. However, when it came to specific measures that social organisations can take to support vulnerable populations during heat events, one aspect became particularly evident: the organisations themselves are faced with the overheating of their buildings and facilities and cannot provide cool spaces:

> *«Because here we offer a welcome. But we are in a place that's not fresh at all. […] So even we, whose mission it is to welcome this population, don't offer the ideal conditions for people to regain a little energy with the freshness.»* (I6)

> *«It's true that it's difficult to adjust the temperature of the place. Because all throughout the morning, the sun shines directly into our building. So, it heats everything up. […] It's terrible sometimes.»* (I5)

> *«Last week, it was very hot, so we have a small room, and it heats up very quickly. Sometimes I have 30 people in the room. So, the question of heat is very important.»* (I10_walking)

For social organisations to truly support vulnerable populations during heat events, the issue of urban heat needs to be integrated into caring infrastructures more holistically. This starts with providing cooler spaces inside and outside of buildings and extends to offering public showers, as well as creating more areas where people can drink for free, cool off, rest, and spend time with others (I5, I6, I10_walking).

5.5 Cooling planning measures: City of Lausanne

Urban heat is a complex climate issue, with many interconnected contributing factors, many ways to address and various actors involved. The city of Lausanne has not yet formulated a specific heat strategy with overarching goals and guidelines. Nevertheless, the City's tree planting plan ('Objectif canopée') presents a partial strategy within the topic of heat. In addition, several heat mitigation and adaptation measures are integrated into other strategic documents, such as the municipal master plan ('Plan directeur communal', 2022) or the City's climate plan ('Plan Climat', 2021).

It is beyond the scope of this paper to discuss general heat mitigation planning measures such as greening of facades and roofs or reducing emissions in Lausanne. Instead, the analysis focussed on planning measures for heat equity and the question of how different vulnerable groups are taken into account in strategic planning documents in Lausanne.

5.5.1 Identifying vulnerable groups and analysing urban heat areas

Both in its climate plan and in its strategic municipal master plan, the city of Lausanne has set itself the goal of identifying heat-vulnerable population groups (Plan Climat, 2021, p. 44; Plan directeur communal, 2022, p. 138). The documents list infants, elderly people, socially isolated people and people in poor health as examples (Plan directeur communal, 2022, p. 138; Plan directeur communal, Axes actions, 2022, p. 288).

Furthermore, an analysis of most heat-vulnerable areas and streets should be carried out to provide a basis for adaptation measures (Plan Climat, 2021, p. 45, 55; Plan directeur communal, 2022, p. 137).

The interviews with the city's planning experts revealed that such an analysis similar to a heat vulnerability index has already been carried out: Several quantitative indicators for vulnerable population groups were defined on the basis of a literature analysis and presented in a map, spatially differentiated using available statistical data on the population of Lausanne (I1). This map is now used to prioritise measures but is treated confidentially and is only intended as an internal planning tool (I1).

5.5.2 Providing information, warning and care systems for elderly people

Another measure, especially for vulnerable groups, is the provision of information and specific warning and care systems. The documents state that "shared knowledge of climate risks and how to behave during heatwaves [...] helps to limit health risks" (Plan communal directeur, Axes actions, 2022, p. 288). Therefore, advice and recommendations how to behave on hot days should be further disseminated (Plan communal directeur, Axes actions, 2022, p. 289).

During heatwaves, the cantonal heat plan ('Plan canicule') is activated by the city (Plan Climat, 2021, p. 44). The plan envisages that people over the age of 70 who live alone or suffer from a chronic illness will be visited by specialists on heat days. The affected group is specifically informed by letter that they can call an emergency number or voluntarily put themselves on an emergency list. General tips are also given, such as keeping the heat outside during the day and ventilating at night or staying hydrated.

However, the heat plan is only intended as an intervention for older people and has not yet been extended to other vulnerable population groups (I1).

5.5.3 Expanding cooling infrastructure

An important adaptation strategy in Lausanne's urban planning is the creation of green and recreational areas through the integration of "fresh zones/islands" (Plan directeur communal, 2022, p. 123, 138). Therefore, passive cooling methods such as shade, awnings, and covered walkways should be connected to designated public "cool zones", e.g. shaded plazas, parks with water features, or air-conditioned buildings (Plan directeur communal, 2022, p. 138).

The city's climate office has collected already existing fresh places on a map ('Carte des espaces frais', see fig. 49), which is distributed to the population both via the Internet and by placing it in social facilities (I1). In addition to parks, forests and natural water areas, the map also includes publicly accessible libraries and churches. In addition to these free facilities, the map also lists places that charge a fee, such as museums and swimming pools (see fig. 50).

In summer 2024, the city also called on people to contribute to the map and add their own cool places via Instagram as part of the official participatory initiatives ('Lausanne participe'). Instagram posts not only advertised the map, but also explained how to get to the cool places by public transport.

Fig. 51: Participatory process for fresh places map, screenshot of instagram posts by the City of Lausanne, summer 2024

Even if this measure is not specifically listed by the city for vulnerable groups, it can still be a means for those groups to better deal with the heat. As already described under point 5.3.2, two social organisations mentioned in the interviews that they had received the fresh places map from the city and had communicated it to their target groups. The extent to which the map is actually used by vulnerable groups could not be ascertained.

5.5.4 Combatting heat in schools

The problem of heat at schools has already been touched on under aspect 5.1.3 as a finding of the qualitative interviews. In the strategic documents, the topic of heat in and around school buildings is not framed as part of the discussion on particularly vulnerable population groups.

Nevertheless, the measures to renovate school buildings and green schoolyards can be read as a central finding in relation to vulnerable groups: "The municipality also wishes to launch a wide-ranging initiative to refurbish the school playgrounds, turning what are currently very mineral areas into oases of freshness. [...] Additionally, the courtyards will be redeveloped in collaboration with users (schools and residents) and will become new living spaces within the neighbourhoods." [translated by the author] (Plan Climat, 2021, p. 56).

In addition, this measure is concretised through quantitative and qualitative objectives: by 2040, 50% of the schoolyard area should be shaded by canopy roofs and at least 60% of the schoolyard area should be permeable (Plan Climat, 2021, p. 57). To increase biodiversity, different tree species are to be planted and natural ground coverings with a high albedo effect are to be used (Plan Climat, 2021, p. 57).

This measure is also the only one to set a financial framework: more than CHF 300 million has been earmarked for the renovation of school buildings by 2030 (Plan Climat, 2021, p. 6). It is not clear from the documents to what extent the renovation of the school buildings also includes facilities such as air conditioning or other design options for cooling the classrooms.

«Le présent Plan climat définit [...] une politique climatique volontariste pour faire de Lausanne une ville zéro carbone, vivante, apaisée, verte, saine, juste et durable.» (Plan Climat, 2021, p. 2)

«This Climate Plan defines [...] a proactive climate policy to make Lausanne a zero-carbon city that is lively, peaceful, green, healthy, just and sustainable.»

5.5.5 Implementing affordable and solidarity measures

The brochure for the city's climate plan states the goal on the cover: '0% carbon. 100% solidarity'. What exactly is meant by solidarity in the climate change context or how this slogan was developed is not explicitly included in the documents. What is directly addressed, however, is that the energy transition should not lead to the impoverishment of vulnerable social classes (Plan Climat, 2021, p. 18).

Further, the climate plan states that "the impact of climate change on particularly vulnerable groups (the elderly, children, etc.) must be addressed through specific measures, and the framework conditions at all political levels must develop in this direction" ([translated by the author] (Plan Climat, 2021, p. 18).

Two initial measures in relation to the affordability of the energy transition are the reduction of public transport tariffs and the analysis of the impact of energy-efficient renovations on rents and suitable accompanying measures (Plan Climat, 2021, p. 18). Due to the division of competences between the Confederation, cantons and communes with regard to public transport fares, the city of Lausanne has adopted the strategy of issuing transport vouchers for certain groups (Plan Climat, 2021, p. 26-27).

However, there is no comprehensive embedding of the measures in terms of solidarity or justice in the climate plan.

5.6 Heat-related places

A central concern of the work was to identify places in the city of Lausanne that are particularly relevant for vulnerable populations. The locations identified with the help of interview participants can be divided into two main groups: those perceived as particularly hot and uncomfortable, and those described as cooling and refreshing.

It should be noted that people in precarious living situations often develop their own strategies and find places to survive the heat. Given that these individuals frequently face discrimination and live under the radar of society and the police, they often need to keep their personal locations secret (I6). Therefore, asking these individuals about their cooling strategies and cool spaces for a master's thesis can also pose challenges for them. This limitation should be considered when analysing the results.

5.6.1 Particularly hot places

The places identified as particularly hot were mainly urban squares and corridors with significant traffic hubs (I2, I4_walking, I5, I6, I8, I10_walking). These locations are especially important because they are used by people in precarious living conditions and often represent their central spaces in daily life. These places include Flon and Place de l'Europe (I6, I8), the Chauderon – Bel-Air – Saint-Francois axis (I4_walking, I8, I10_walking), the city centre (I4_walking) and large roads like Avenue Bergières, Avenue du Grey or Rue da la Borde (I2, I4_walking).


Fig. 52: Flon and Place de l'Europe

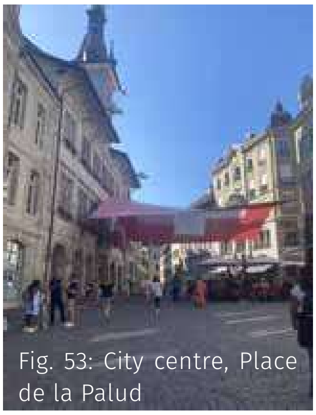


Fig. 53: City centre, Place de la Palud

Fig. 54: Square infront of the train station, temporarily equipped with green

Another particularly hot location is the train station and its square, which is temporarily equipped with shaded seating (I6, I10_walking). According to the heat map (fig. 38), the station is a notably hot spot and is frequently used by vulnerable populations. However, major construction projects by the Swiss Federal Railways (SBB) are planned for Lausanne's train station, making the future design of this heat island uncertain.

Another widely discussed area is the Place de la Riponne, which serves a prominent example of urban heat in combination with a large presence of vulnerable groups (I5, I6, I8, I10_walking). This urban, centrally located square stands out due to its high level of asphalt, lack of trees and shade, and a quite visible, large number of drug users concentrated on a quite restricted perimeter in the public space.

Fig. 55: Place de la Riponne

Even though there is a fountain, the entire square is still very hot as it is largely exposed to the blazing sun. The fact that there is an underground parking garage beneath the square and that it is used for weekly markets and events makes the redesign of this square particularly difficult (I2). Nevertheless, the city already announced plans to green the square and equip it with new water features (I1, I2).

5.6.2 Refreshing places

The findings regarding refreshing places can be divided into two categories: first, natural areas such as parks, forests, or places with water were mentioned, and second, cooled indoor spaces that people visit during hot weather.

Specifically mentioned in the first category were: Forêt de Pierrefleur and Forêt de Desert (I4_walking), parks that are easily accessible by bus like Parc Valency, Parc de Milan or Mon Repos (I5, I10_walking), as well as Place du Vallon (I8). The second category includes daytime facilities that offer water and food, (e.g., 'La Soupe Populaire, Fondation Mère Sofia', 'L'Espace', Ville de Lausanne, 'Point d'Appui', 'L'Ancre' etc.) air-conditioned cinemas and public libraries, and semi-public spaces such as cooled cafeterias within medical infrastructure (I5, I6, I10_walking).

An interesting aspect of the findings on refreshing places is the notable absence of certain locations that might have been expected: in the interviews, the lake played a minimal role when discussing cooling spots.

Although Lausanne is a lakeside city, it simultaneously feels distant from the lake. The historic urban centre from the Middle Ages sits on a hill and, while well-connected to the lake by buses and a metro line, the elevation difference seems to create a critical sense of distance. Despite the potential of the lake to mitigate the heat, it was strikingly undermentioned in the interviews. What might be the reasons for this?

For one, some mentioned that the lake is not part of their daily routes and is too far from their homes (I4_walking, I5). Additionally, people in precarious living situations often stay within a restricted area in the urban space (I6, I10_walking). For them, the lake is quite literally out of reach - whether mentally or financially, when steep streets and bus fares present a barrier (I6, I10_walking).

Fig. 56: View of Lake of Geneva from Parc de Milan in Lausanne

Another aspect that sparked controversy in the interviews, aside from the lake, was the presence of other water sources and fountains throughout the city of Lausanne. The city of Lausanne has around 300 fountains (drinking water fountains and decorative fountains) (Ville de Lausanne, n.d.-b), yet the interviews revealed that knowledge about these fountains and their locations appeared limited (I4_walking, I6, I10_walking).

However, as places offering free and publicly accessible refreshment, they could play a central role. Not only do fountains provide drinking water, but they also offer a way to cool the face and arms, and children can even bathe their entire bodies in them (I9, I10_walking). Swimming pools (Bellerive, Montchoisi), which in the past have occasionally been accessible free of charge during heatwaves, were also mentioned as refreshing places (I5, I6, I9).

5.7 Solidarity in the context of urban heat

The slogan of the climate plan reads: '0% Carbon. 100% Solidarity.' I shared this slogan with my interview participants, and I often received feedback that the city's message was unclear; they felt that the city needed to explain more specifically what it means by solidarity (I5, I6, I9, I10_walking). What does solidarity really mean in the context of climate change?

In the interviews, it was suggested that the fresh places map could represent a form of solidarity: people share their knowledge about public cooling spots and thus give others the opportunity to cool down too (I5).

Beyond this, a broader sense of care for one another was discussed, particularly at the neighbourhood level. It was proposed that the community centres of Lausanne ('centres socio-culturelles') could take on a new role in raising awareness about urban heat (I9): They could promote discussions on ways to support each other during heatwaves, from sharing resources and knowledge to looking out for each other's well-being during heatwaves (I5, I9).

Caring for one another could involve assisting elderly neighbours with tasks such as grocery shopping, walking their dog, or accompanying them on walks during hot temperatures (I9). These aspects of mutual support during heat waves were described as possibilities to make the climate slogan a lived reality within the neighbourhoods of Lausanne (I5).

Fig. 57: Social change. Innovation sharing. FASL: Fondation for socio-cultural animation in all 17 districts of Lausanne

6

CONCLUSION

6.1 Discussion of results

In view of rising temperatures in cities and the uneven distributed effects of heat, this Master's thesis contributed to a more differentiated picture of heat-related challenges for vulnerable groups and their cooling strategies. The specific example of the city of Lausanne empirically illustrated that proactive and local solutions are needed to support adaptive capacities of vulnerable groups and to develop an understanding of planning for heat equity. The results of the work are outlined below. Finally, the limitations of the research are discussed.

The first crucial part of the empirical research was to understand how heat-related vulnerability is understood in Lausanne. Therefore, local concerns in relation to heat were discussed with different social organisations. The identified heat-related vulnerable groups were largely congruent with the literature: elderly people, children, people in precarious living situations (e.g., people who live from one day to another, people who live in the streets, who don't have a cooler place to stay in/at, or people who cannot act autonomously for economic reasons or due to a precarious residential status), people with physical or mental illnesses, and people who live in building blocks without green spaces or trees or who live in hot apartments. An important insight that surfaced was that people can also be confronted with multiple vulnerabilities (e.g., an elderly person living on the street). Heat-related vulnerability is not a rigid categorisation system and can evolve over time.

From this I deduce that the tackling of urban heat should not focus on labelling different groups but on recognising the different sensitivities in relation to heat. Urban planners contribute to the different effects of heat through land use planning and urban design.

By providing shade and improving thermal comfort particularly in low-income and minority neighbourhoods, urban greening plays a key role in heat equity. At the same time, green gentrification must be avoided through targeted measures.

With its tree-planting strategy, the city of Lausanne intends to prioritise particularly affected areas and plant them first. I consider it fundamental to monitor displacement and processes in this upgrading of disadvantaged areas and to take measures to counteract green gentrification.

Furthermore, it was essential to assess the awareness of certain living conditions and subsequently gain a more comprehensive picture of challenges in relation to heat. The main challenges for vulnerable groups identified in the interviews were 1) dehydration, 2) affordability of cooling options, 3) difficulties in maintaining hygiene, 4) not moving and social isolation, and 5) heat at school. Furthermore, individual cooling strategies were discussed to get insights into the adaptive capacity of vulnerable groups.

To make use of the cooler hours of the day during heatwaves and to avoid the hottest periods, activities and daily routines are adapted as much as possible. This adjustment in daily routines is closely linked to changes in transportation choices: instead of walking, people more frequently opt for public transportation or take their own cars. This example illustrates how increasing heat affects transportation choices: as temperatures rise, it seems more attractive to use the own air-conditioned car which emits significant heat, further contributing to the urban heat problem.

Attending cooled public places was also referred to as a cooling strategy. The findings regarding refreshing places can be divided into two categories: first, natural areas such as parks, forests, or places with water, and second, cooled indoor spaces that people visit during hot weather. People in precarious living conditions depend on non-commercial spaces to cool down. Public libraries, for example, are recognised and visited as ‘cooling zones’. Furthermore, it was noticeable that the lake of Geneva played a subordinate role as a cooling infrastructure. Two examples of unsealing initiatives on the neighbourhood-level were examined as collective cooling strategies which not only combat heat on a small scale but also represent acts of neighbourhood empowerment.

From these insights I conclude that researching local knowledge in relation to challenges and strategies is an important step in the development of measures for heat equity in Lausanne. The possibilities and limitations of adaptation strategies at the level of the individual and social organisations have clearly shown me that the effects of climate change are already having an impact on everyday realities. As these effects can no longer be reversed, I consider it crucial to recognise the impact on those most affected and to take their challenges seriously.

The city of Lausanne has set itself the goal of identifying heat-vulnerable population groups and analysing most heat-vulnerable areas and streets to provide a basis for adaptation measures. For urban planning, I see it as essential to increasingly focus on adaptation strategies in addition to mitigation strategies. The results of this master‘s thesis show that urban planning can take various measures to increase the adaptive capacities of vulnerable groups.

→ Accessibility and affordability of cooling options

The accessibility and affordability of drinking water can be seen as a central element for planning for heat equity. Located in high-traffic areas and equipped with shaded benches, fountains can offer a refreshing break in every part of Lausanne. Public water features, such as the installation of fixed drinking water dispensers or other hydration stations in public spaces could therefore be expanded.

Furthermore, cooling options must be considered more in terms of affordability. Relief from the heat can take different forms: Whether it‘s eating an ice cream, resting in a refreshing place or cooling your whole body with water. Offering reduced prices (e.g., in facilities like swimming pools or cinemas) is often not enough, as even discounted rates can be too costly for those in precarious financial situations. To ensure that everyone, regardless of their financial status, can find a way to stay cool during hot periods access to cooling infrastructure should be at no cost. Free admission could also be extended to swimming pools and cinemas, which are currently available at reduced prices, especially for children or senior citizens.

The issue of mobility on hot days is also closely linked to this. Free public transport could ensure that cooling resources like the lake of Geneva or other facilities such as air-conditioned places are used more frequently and easily.

The City of Lausanne has set itself the goal of ensuring that climate change adaptation goes hand in hand with social cohesion. Due to the division of competences between the Confederation, cantons and communes regarding public transport fares, the city of Lausanne has adopted the strategy of issuing transport vouchers for certain groups: according to the climate plan, public transport should be free for recipients of social benefits (AVS-AI) and price reductions should be available for young and older people.

However, the results of the study show that free public transport should be considered and expanded for many other groups, especially for those affected by heat. Lausanne's topography and steep streets make it all the more important to be able to use public transport without restrictions.

In addition to the free use of public transport, the greening and cooling of waiting areas is also a key factor in ensuring mobility for vulnerable groups on hot days. Thus, I consider it a suitable measure to design bus and train stations with elements that provide shade, vegetation and water feature to enhance thermal comfort while walking and waiting in public spaces.

Additionally, the lack of accessible shower facilities means that some people have no possibility to refresh their entire body, which was considered essential not only for basic cleanliness but also for self-care and personal dignity. Providing more accessible shower facilities with private cabins in the social infrastructure of the city could be one measure for vulnerable groups affected by urban heat. Existing infrastructures such as swimming pools or day-care centres could be expanded with cooling facilities and used free of charge by vulnerable groups in hot weather.

In sum, I see the expansion of the cooling infrastructure as supporting adaptive capacities of vulnerable groups and therefore highly relevant for planning for heat equity.

→ The role of social organisations and socio-cultural centres

It is crucial that heat-vulnerable groups are better acknowledged, so that they can be better considered in accessibility issues. Social organisations that are in contact with vulnerable groups can also play a central role here. As it can be difficult for municipalities to reach out to vulnerable groups, the network and already existing infrastructure of social organisations can be used and expanded to meet the needs of vulnerable groups during hot days. At neighbourhood level, these social organisations and socio-cultural centres could be further developed as cooling zones.

Moreover, it is crucial to think of cooling services that are intertwined with social interactions: as maintaining social connections in hot weather can be challenging, cooling centres could be a place of refreshment and exchange at the same time.

However, social organisations themselves are faced with the overheating of their buildings and facilities and are currently unable to provide cool spaces. I therefore see it as a central task of city planning to invest more resources redesigning existing facilities as cooled spaces where people can refresh. In this way, existing infrastructures could be utilised and further developed instead of planning completely new cooling locations. Rather than offering exclusively financial or technical support, suitable planning measures can be reached by collaborating with local organisations and actors to expand internal capacity.

→ Information, warning and care systems for vulnerable people

The provision of information and specific warning and care systems is another key factor in reducing health risks due to urban heat. Therefore, advice and recommendations how to behave on hot days should be further disseminated.

A key finding of this work is that cooling strategies should no longer remain niche knowledge but must be widely accessible. Apart from general tips, the practices of vulnerable groups can also be incorporated into information campaigns.

The city of Lausanne already has a warning and care system for elderly people as part of the cantonal heatwave plan. The results of this work show that it would be crucial to extend this offer to other heat-vulnerable groups. Additionally, information on cooling centres and refreshing places should be widely disseminated and available in different languages. The fresh places map ('carte des espaces frais') of the city's climate office can be seen as a good example of disseminating information about local cooling options.

→ Combatting heat in the context of education infrastructure

Kindergartens, school buildings and playgrounds were assessed as an important area of action for heat adapted planning in the context of this work. As many school buildings are not adapted to the heat in terms of their construction and building materials and that courtyards and recreation areas are often too hot for the children, education infrastructure represents a large proportion of heat islands in Lausanne. The city's climate plan aims for 50% of the schoolyard area to be shaded by canopies and at least 60% of the schoolyard area to be permeable by 2040. Apart from shade and unsealing, further measures can be considered in the context of schools: by involving children, teachers and caretakers in remodelling processes of school environments, local needs can be better identified and implemented. This also raises awareness of the topic and allows cooling strategies to be discussed with the children in class.

→ Solidarity in the context of rising temperatures

In the course of this work, I repeatedly came across the topic of solidarity in the context of rising temperatures. The city of Lausanne is prominently publicising solidarity with its climate plan slogan, '0% Carbon. 100% Solidarity.'. The city's vision is that climate change adaptation should not be carried out at the expense of weaker social groups. The measures proposed so far relate to the affordability of public transport and rents. The interviews made it clear that solidarity can mean much more in the context of heat. The fresh places map, for example, can represent a form of solidarity: people share their knowledge about public cooling spots and thus give others the opportunity to cool down too.

Beyond this, a broader sense of care for one another, particularly at the neighbourhood level can contribute to solidary communities: Caring for one another could involve assisting elderly neighbours with tasks such as grocery shopping, walking their dog, or accompanying them on walks during hot temperatures. The community centres of Lausanne (centres socio-culturelles) could take on a new role in raising awareness about urban heat. They could promote discussions on ways to support each other during heatwaves, from sharing resources and knowledge to looking out for each other's well-being during heatwaves.

All in all, I have observed that the idea of solidarity in the context of heat is an important component of planning for heat equity. Nevertheless, it was not clear how the city's slogan was created. Accordingly, it is questionable to what extent the inhabitants of Lausanne identify with it and contribute to making the slogan a lived practice..

6.2 Limitations and future directions

In the course of this work, many insights were gained in the area of heat-related vulnerability and urban planning. However, some aspects were beyond the scope of this thesis and should be investigated in further studies.

One limitation of this thesis is the challenge of reaching people in precarious living conditions. To really understand the situation of people in precarious situations during heatwaves, it would be crucial to talk directly to those affected. In further studies, more resources (in terms of time, social capital and language capacities) must therefore be made available to establish trust in relevant networks and to directly represent the perspective of vulnerable groups.

Additionally, it would be interesting to examine further how residential locations in the city affect heat vulnerability. One hypothesis put forward in the interviews was that the level of precariousness increases coincidingly with the distance from the lake. This intersection of built environment and heat-related socio-economic factors could be further explored in Lausanne.

When planning for heat equity, it is essential that heat-vulnerable groups are protected from green gentrification. Since nature-based solutions in the fight against urban heat can go hand in hand with displacement as a result of the upgrading processes, further research is also needed here.

Finally, it would be interesting to delve further into the topic of solidarity in order to find out what processes are needed to implement solidarity-based measures to adapt to the heat. Theoretical links can be made, for example, to concepts like care and the city and environmental justice.

Fig. 58

LITERATURE & ANNEX

Literature

A

Abrams, L.S. (2010). Sampling 'Hard to Reach' Populations in Qualitative Research: The Case of Incarcerated Youth. *Qualitative Social Work, 9*(4), 536-550. https://doi.org/10.1177/1473325010367821

Adger, W.N. (2006). Vulnerability. *Global Environmental Change, 16,* 268-281. https://doi.org/10.1016/j.gloenvcha.2006.02.006

Allex, B., Mayrhuber, E., Wiesböck, L., Arnberger, A., Eder, R., Kutalek, R., Wanka, A., Hutter, H., Wallner, P., & Kolland, F. (2018): *Ergebnisse aus dem Projekt „EthniCityHeat: Vulnerability of and adaptation strategies for migrant groups in urban heat environments".* Publizierbarer Endbericht, Klima- und Energiefonds. Wien.

Andjelkovic, V. (Ed.) (2018). *Plant, Abiotic Stress and Responses to Climate Change.* IntechOpen.

Angel, S., & Vatne, S. (2017). Vulnerability in patients and nurses and the mutual vulnerability in the patient–nurse relationship. *Journal of Clinical Nursing, 26*(9–10), 1428–1437. https://doi.org/10.1111/jocn.13583

B

Benoit, C., Jansson, M., Millar, A., & Phillips, R. (2005). Community-academic research on hard-to-reach populations: benefits and challenges. *Qual Health Res, 15*(2), 263-282. https://doi.org/10.1177/1049732304267752

Bosch Padros, M. (2021). *Spatiotemporal patterns of urbanization during the last four decades in Switzerland and their impacts on urban heat islands.* (EPFL_TH8141). [Doctoral dissertation, École Polytechnique Fédérale de Lausanne]. Retrieved from https://infoscience.epfl.ch/entities/publication/b1d8e18d-df49-4aa6-9ac4-14edd659b570

Bovay, C. (2020). *Ilots de chaleur urbains & végétation : Diagnostic et potentiels de réversibilité. Le cas de Lausanne.* [Master's thesis, Université de Lausanne]. Retrieved from https://igd.unil.ch/memoires/memoires/1781

Brooks, N. (2003). Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre for Climate Change Research,* Working paper 38. Norwich, UK: University of East Anglia.

Retrieved from https://www.researchgate.net/publication/200032746_Vulnerability_Risk_and_Adaptation_A_Conceptual_Framework

Brown, K., Ecclestone, K., & Emmel, N. (2017). The many faces of vulnerability. *Social Policy & Society, 16*(3), 497-510. https://doi.org/10.1017/S1474746416000610

Bryman, A. (2012). *Social Research Methods*. Oxford University Press.

Bundesamt für Umwelt (BAFU). (2012). A*npassung an den Klimawandel in der Schweiz. Ziele, Herausforderungen und Handlungsfelder. Erster Teil der Strategie des Bundesrates vom 2. März 2012.* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/anpassung-klimawandel-schweiz-2012.html

BAFU. (2018). *Hitze in Städten. Grundlage für eine klimaangepasste Siedlungsentwicklung. Umwelt-Wissen Nr. 1812*. Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/hitze-in-staedten.html

BAFU. (2019). *Hitze und Trockenheit im Sommer 2018. Auswirkungen auf Mensch und Umwelt. Umwelt-Zustand Nr. 1909.* Retrieved from www.bafu.admin.ch/uz-1909-d

BAFU, & Bundesamt für Meteorologie und Klimatologie (MeteoSchweiz). (2020). *Klimawandel in der Schweiz. Indikatoren zu Ursachen, Auswirkungen, Massnahmen. Umwelt-Zustand Nr. 2013.* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/klimaaenderung-schweiz.html

Bao, J., Cao, Z., Huang, C., Lei, L., Yang, Y., Peng, J., & Shi, X. (2021). Modification effect of urban landscape characteristics on the association between heat and stroke morbidity: A small-scale intra-urban study in Shenzhen, China. *Science of the Total Environment, 786*. https://doi.org/10.1016/j.scitotenv.2021.147223

Birkmann, J., Garschagen, M., Kraas, F., & Quang, N. (2010). Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change. *Sustainability science, 5*(2), 185-206. https://doi.org/10.1007/s11625-010-0111-3

Buyantuyev, A., & Wu, J. (2010). Urban heat islands and landscape heterogeneity: linking spatiotemporal variations in surface temperatures to land-cover and socioeconomic patterns. *Landscape Ecol, 25,* 17–33. https://doi.org/10.1007/s10980-009-9402-4

C

Canton, J., & Dipankar, A. (2024). Climatological analysis of urban heat island effects in Swiss cities. *International Journal of Climatology, 44*, 1549-1565. https://doi.org/10.1002/joc.8398

CDC. U.S. Centers for disease control and prevention. (2024, June 18). *Heat and Medications – Guidance for Clinicians.* Retrieved January 15, 2025, from https://www.cdc.gov/heat-health/hcp/clinical-guidance/heat-and-medications-guidance-for-clinicians.html

Chamberlain, K., & Hodgetts, D. (2018). Collecting Qualitative Data with Hard-to-Reach Groups. In. U. Flick (Ed.), *The SAGE Handbook of Qualitative Data Collection* (pp. 668-685). SAGE Publications Ltd. https://doi.org/10.4135/9781526416070

Checker, M. (2011). Wiped out by the "greenwave": environmental gentrification and the paradoxical politics of urban sustainability. *City & Society, 23*(2), 210–229. https://doi.org/10.1111/j.1548-744X.2011.01063.x

Christogianni, A., O'Garro, J., Bibb, R., Filtness, A., & Filingeri, D. (2022). Heat and cold sensitivity in multiple sclerosis: A patient-centred perspective on triggers, symptoms, and thermal resilience practices. *Multiple Sclerosis and Related Disorders, 67.* https://doi.org/10.1016/j.msard.2022.104075

Couch, J., Durant, B., & Hill, J. (2014). Uncovering marginalised knowledges: Undertaking research with hard-to-reach young people. *International Journal of Multiple Research Approaches, 8(*1), 15–23. https://doi.org/10.5172/mra.2014.8.1.15

D

Deilami, K., Kamruzzaman, MD, & Liu, Y. (2018). Urban heat island effect: A systematic review of spatio-temporal factors, data, methods, and mitigation measures. I*nternational Journal of Applied Earth Observation and Geoinformation, 67,* 30-42. https://doi.org/10.1016/j.

jag.2017.12.009

E

ElGamal, M., & Altrock, U. (2024). Beteiligungsanspruch und Wirklichkeit. Das Beispiel Hamburg Osdorfer Born und die Rolle von schwer erreichbaren Zielgruppen. In N. Berding, K. Frieling, & M. Maikämper (Eds.), *pnd rethinking planning, 1/2024 (Un)Möglichkeit der Teilhabe*, 113-127. https://doi.org/10.18154/RWTH-2024-03959

Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonal, R. I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C., & Wilkinson, C. (Eds.). (2013). *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. A Global Assessment.* Springer. https://doi.org/10.1007/978-94-007-7088-1

Erell, E., Pearlmutter, D., & Williamson, T. (2011). *Urban Microclimate: Designing the Spaces Between Buildings.* Routledge.

European Court of Human Rights. (2024, April 9). *Violations of the European Convention for failing to implement sufficient measures to combat climate change. ECHR 087 (2024).* [Press Release]. Retrieved from https://www.echr.coe.int/w/grand-chamber-rulings-in-the-climate-change-cases

European Environment Agency (EEA). (2023, March 13). *Heat and cold – extreme heat.* European Environment Agency. Retrieved March 13, 2024, from https://www.eea.europa.eu/publications/europes-changing-climate-hazards-1/heat-and-cold/heat-and-cold-extreme-heat

EEA. (2024). *European climate risk assessment. Executive summary. EEA Report 01/2024.* Retrieved from https://www.eea.europa.eu/publications/european-climate-risk-assessment

F

Fineman, M. (2008). The Vulnerable Subject: Anchoring Equality in the Human Condition. *Yale Journal of Law & Feminism, 20*(1).

Fineman, M., & Spitz, L.M. (Eds.). (2024). *Law, Vulnerability, and the Responsive State: Beyond Equality and Liberty.* Routledge.

Forman, R.T.T. (2014). *Urban Ecology. Science of Cities.* Cambridge University Press. https://doi.org/10.1017/CBO9781139030472

Fritzsche, B., & Weitkämper, F. (2018). *Qualitativ-rekonstruktive Sozialforschung.* QUASUS. Qualitatives Methodenprotal zur Qualitativen Sozial-, Unterrichts- und Schulforschung. Retrieved October, 29, from https://www.ph-freiburg.de/quasus/was-muss-ich-wissen/was-ist-qualitative-sozialforschung/qualitativ-rekonstruktive-sozialforschung.html

G

Gabbe, C.J., Chang, J.S., Kamson, M., & Seo, E. (2023). Reducing heat risk for people experiencing unsheltered homelessness. *International Journal of Disaster Risk Reduction, 96*. https://doi.org/10.1016/j.ijdrr.2023.103904

Gehrig, R., König, N., & Scherrer, S. (2018). *Städtische Wärmeinsel in der Schweiz – Klimatologische Studie mit Messdaten in fünf Städten. Fachbericht MeteoSchweiz 273.* Bundesamt für Meteorologie und Klimatologie, MeteoSchweiz (Ed.). Retrieved from https://www.meteoschweiz.admin.ch/service-und-publikationen/publikationen/berichte-und-bulletins/2018/staedtische-waermeinseln-in-der-schweiz-klimatologische-studie-mit-messdaten-in-fuenf-staedten.html

German Red Cross. (2024). Installation and Management of Community Cooling Centres. Manual. Retrieved from https://preparecenter.org/wp-content/uploads/2024/04/Community_Cooling_Centre_Manual.pdf

Global Heat Health Information Network (GHHIN). (n.d.-a). *Heat & Health.* Retrieved January 15, 2025, from https://ghhin.org/heat-and-health/

GHHIN. (n.d.-b). *Manage and adapt to heat at work*. Retrieved January 19, 2025, from https://ghhin.org/at-work/

Gombert, K., Douglas, F., McArdle, K., & Carlisle, S. (2015). Reflections on ethical dilemmas in working with so-called 'vulnerable' and 'hard-to-reach' groups: experiences from the Foodways and Futures project. *Educational Action Research, 24*(4), 583–597. https://doi.org/10.1080/09650792.2015.1106958

Greiving, S. (2018). Resilienz/Robustheit. In ARL – Akademie für Raumforschung und Landesplanung (Ed.), *Handwörterbuch der Stadt- und Raumentwicklung* (pp. 2063–2072). Verlag der ARL.

Grimmond, S., Roth, M., Oke, T., Au, Y.C., Best, M., Betts, R., Carmichael, G., Cleugh, H., Dabberdt, W., Emmanuel, R., & Freitas, E. (2010). Climate and More Sustainable Cities: Climate Information for Improved Planning and Management of Cities (Producers/Capabilities Perspective). *Procedia Environmental Sciences, 1,* 247-274. https://doi.org/10.1016/j.proenv.2010.09.016

Guardero, M., Hondula, D.M., Oritz, J., & Redman, C.L. (2022). Adaptive capacity to extreme urban heat: The dynamics of differing narratives. *Climate Risk Management, 35*. https://doi.org/10.1016/j.crm.2022.100415

H

Hansen, A., Bi, P., Nitschke, M., Ryan, P., Pisaniello, D., & Tucker, G. (2008). The effect of heat waves on mental health in a temperate Australian City. E*nvironmental Health Perspectives, 116*(10), 1369–1375. https://doi.org/10.1289/ehp.11339

Helfferich, C. (2004). *Die Qualität qualitativer Daten. Manual für die Durchführung qualitativer Interviews.* VS Verlag für Sozialwissenschaften.

Helfferich, C. (2014). Leitfaden- und Experteninterviews. In N. Baur & J. Blasius (Eds.), *Handbuch Methoden der empirischen Sozialforschung* (pp. 559-573). Springer VS.

Hertel, D., Pößneck, J., Kabisch, S., & Schlink, U. (2024). Hitzestress in Stadtquartieren – Methodik und empirische Belege unter Nutzung des Planetary-Health-Ansatzes. In S. Kabisch, D. Rink, & E. Banzhaf (Eds.), *Die Resiliente Stadt. Konzepte, Konflikte, Lösungen* (pp. 247-266). Springer. https://doi.org/10.1007/978-3-662-66916-7

Hirschfeld, J., Hansen, G., Messner, D., Opielka, M., & Peter, S. (2023). Die klimaresiliente Gesellschaft – Transformation und Systemänderungen. In G.P. Brasseur, D. Jacob, & S. Schuck-Zöller (Eds.), *Klimawandel in Deutschland. Entwicklung, Folgen, Risiken und Perspektiven. 2., überarbeitete und erweiterte Auflage* (pp. 461-474). Springer. https://doi.org/10.1007/978-3-662-66696-8

Holstein, J.A., & Gubrium, J.F. (1995). *The active Interview.* SAGE publications, Inc. https://doi.org/10.4135/9781412986120

I

Intergovernmental Panel on Climate Change (IPCC). (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. (McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., & White, K.S., Eds.). Cambridge University Press.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama, Eds.). Cambridge University Press. https://doi.org/10.1017/9781009325844

IPCC. (2023). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Core Writing Team, H. Lee, & J. Romero, Eds.). https://doi.org/10.59327/IPCC/AR6-9789291691647

International Federation of Red Cross and Red Crescent Societies (IFRC). (2020). *Heatwave guide for cities.* Retrieved from https://www.ifrc.org/document/heat-wave-guide-cities

J

Jamei, E., Ossen, D.R., Seyedmahmoudian, M., Sandanayake, M., Stojcevski, A., & Horan, B. (2020). Urban design parameters for heat mitigation in tropics. *Renewable and Sustainable Energy Reviews, 134*. https://doi.org/10.1016/j.rser.2020.110362

Johnson, D.P., Stanforth, A., Lulla, V., & Luber, G. (2012). Developing an applied extreme heat vulnerability index utilizing socioeconomic and environmental data. *Applied Geography, 35*(1–2), 23–31. https://doi.org/10.1016/j.apgeog.2012.04.006

K

Kahlenborn, W., Reusswig, F., & Schauser, I. (2023). Analyse von Anpassungskapazitäten. In G.P. Brasseur, D. Jacob, & S. Schuck-Zöller (Eds.), *Klimawandel in Deutschland.* Springer Spektrum. https://doi.org/10.1007/978-3-662-66696-8_26

Kanton Aargau Department Bau Verkehr und Umwelt (BVU). (2021). *Hitzeangepasste Siedlungsentwicklung. Leitfaden für Gemeinden.* Retrieved from https://www.ag.ch/media/kanton_aargau/bvu/klima/siedlung/Leitfaden_Hitzeangepasste_Siedlungsentwicklung_Aargau_RZ.pdf

Keith, L., & Meerow, S. (2022). *Planning for urban heat resilience: PAS Report 600. American Planning Association.* Retrieved from https://www.planning.org/publications/report/9245695/

Kofman, E., & Lebas, E. (Eds.) (1996). *Writings on Cities. Henri Lefebvre.* Selected, translated and introduced by Eleonore Kofman and Elizabeth Lebas. Blackwell Publishers.

Kusenbach, M. (2003). Street Phenomenology. *Ethnography,* 4, 455-485.

L

Labedens, S., Scartezzini, J.-L., & Mauree, D. (2018). Effect of future urban planning on the Urban Heat Island intensity. Urban Climate. Advance Online Publication. https://doi.org/10.31223/osf.io/c8mzb

Lefèbvre, H. (1968). Le Droit à la ville [The right to the city] (2nd ed.). Anthropos.

Luna, Florencia. (2009). Elucidating the concept of vulnerability: layers not labels. *IJFAB: International Journal of Feminist Approaches to Bioethics, 2*(1), 121-139. https://doi.org/10.3138/ijfab.2.1.121

Lung, T., Lavalle, C., Hiederer, R., Dosio, A., & Bouwer, L. M. (2013). A multi-hazard regional level impact assessment for Europe combining indicators of climatic and non-climatic change. *Global Environmental Change, 23*, 522-536. https://doi.org/10.1016/j.gloenvcha.2012.11.009

Matthews, P., Netto, G., & Besemer, K. (2012). *'Hard-to-Reach' or 'Easy-to-Ignore'? A rapid review of place-based policies and equality.* University of Stirling. Retrieved from http://hdl.handle.net/1893/25969

Mayring, P. (1997). *Qualitative Inhaltsanalyse. Grundlagen und Techniken. 6., durchgesehene Auflage 1997.* Deutscher Studien Verlag.

Meishar, N. (2018). The social aftermaths of landscape architecture: Urban parks and green gentrification. *Landscape Metropolis 5*(2), 63-76. https://doi.org/10.7480/spool.2018.2.3303

Messerschmidt, M., Guardaro, M., White, J., Berisha, V., Hondula, D., Feagan, M., Grimm, N., & Beute, S. (2019). *Heat Action Planning Guide for Neighborhoods of Greater Phoenix*. Retrieved from https://hdl.handle.net/2286/R.A.220853

MeteoSchweiz. (n.d.-a). *Hitze in Städten.* Retrieved December 06, 2024, from https://www.meteoschweiz.admin.ch/klima/klima-der-schweiz/hitze-in-staedten.html

MeteoSchweiz. (n.d.-b). *Hitze, Trockenheit, Kälte und Schnee*. Retrieved November 05, 2024, from https://www.meteoschweiz.admin.ch/klima/klimawandel/hitze-trockenheit-kaelte-und-schnee.html

MeteoSchweiz. (n.d.-c). *Hitzewarnungen*. Retrieved November 09, 2024, from https://www.meteoschweiz.admin.ch/wetter/wetter-und-klima-von-a-bis-z/hitzewarnungen.html

MeteoSchweiz. (n.d.-d). *Klima CH2025.* Retrieved November 05, 2024, from https://www.meteoschweiz.admin.ch/ueber-uns/forschung-und-zusammenarbeit/projekte/2023/klima-ch2025.html

MeteoSchweiz. (n.d.-e). *Klima-Indikatoren*. Retrieved November 07, 2024, from https://www.meteoschweiz.admin.ch/klima/klimawandel/hitze-trockenheit-kaelte-und-schnee/klima-indikatoren.html

MeteoSchweiz. (n.d.-f). *Klimawandel*. Retrieved November 07, 2024, from https://www.meteoschweiz.admin.ch/klima/klimawandel.html

MeteoSchweiz. (n.d.-g). *Normwert-Karten*. Retrieved February 13, 2025, from https://www.meteoschweiz.admin.ch/klima/klima-der-schweiz/klima-normwerte/normwert-karten.html

Middel, A., AlKhaled, S., Schneider, F.A., Hagen, B., & Coseo, P. (2021). 50 Grades of Shade. *Bulletin of the American Meteorological Society, 102*(9), 1805-1820. https://doi.org/10.1175/BAMS-D-20-0193.1

Muhr, M., Gartner, F., & Scherhaufer, P. (2025). Walking interviews. Exploring urban heat on the go. In R. Kogler & A. Hamedinger (Eds.), *Interdisziplinäre Stadtforschung II. Zugänge und Methoden* (pp. 53-66). Transcript.

National Centre for Climate Services (NCCS). (2018). *CH2018 - Climate Scenarios for Switzerland. Technical Report.* Retrieved from https://www.nccs.admin.ch/nccs/en/home/climate-change-and-impacts/swiss-climate-change-scenarios/technical-report.html

O'Brien, K., Eriksen, S., Schjolden, A., & Nygaard, L. P. (2004). What's in a word? Conflicting interpretations of vulnerability in climate change research. *CICERO Working Paper, 4.* Retrieved from http://hdl.handle.net/11250/192322

Oke, T. R. (1973). City size and the urban heat island. *Atmospheric Environment (1967), 7*(8), 769–779. https://doi.org/10.1016/0004-6981(73)90140-6

Oke, T. R. (1982). The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society, 108*(455),1–24. https://doi.org/10.1002/qj.49710845502

P

Palme, M., & Salvati, A. (Eds.) (2021). *Urban microclimate modelling for comfort and energy studies.* Springer. https://doi.org/10.1007/978-3-030-65421-4

Pham, T.-T.-H., Apparicio, P., Séguin, A.-M., Landry, S., & Gagnon, M. (2012). Spatial distribution of vegetation in Montreal: An uneven distribution or environmental inequity? *Landscape and Urban Planning, 107*(3), 214-224. https://doi.org/10.1016/j.landurbplan.2012.06.002

Pohl, J. (1998). Qualitative Verfahren. In E.-H. Ritter, & K. Wolf (Eds.), *Methoden und Instrumente räumlicher Planung. Handbuch* (pp. 95-112). Akademie für Raumforschung und Landesplanung.

Priemus, H., & Rietveld, P. (2009). Climate Change, Flood Risk and Spatial Planning. *Built Environment, 28*(4), 425-431. https://doi.org/10.2148/benv.35.4.425

Przyborski, A., & Wohlrab-Sahr, M. (2021). *Qualitative Sozialforschung. Ein Arbeitsbuch*. De Gruyter. https://doi.org/10.1515/9783110710663

R

Ragettli, M.S., & Röösli, M. (2021). *Hitze-Massnahmen-Toolbox 2021. Ein Massnahmenkatalog für den Schutz der menschlichen Gesundheit vor Hitze*. SwissTPH. Retrieved from https://www.nccs.admin.ch/dam/nccs/de/dokumente/website/sektoren/gesundheit/hitze-massnahmen-toolbox-2021.pdf.download.pdf/Hitze-Massnahmen-Toolbox%202021.pdf

Rajagopal, P., Priya, R.S., & Senthil, R. (2023). A review of recent developments in the impact of environmental measures on urban heat island. *Sustainable Cities and Society, 88*. https://doi.org/10.1016/j.scs.2022.104279

Ramsay, E.E., Hamel, P., Chown, S.L., & Duffy, G.A. (2024). Humid heat stress overlooked for one billion people in urban informal settlements. *One Earth, 7*(1), 2-5. https://doi.org/10.1016/j.oneear.2023.12.005

Ren, C., Yang, R., Cheng, C., Xing, P., Fang, X., Zhang, S., Wang, H., Shi, Y., Zhang, X., Kwok, Y., & Ng, E. (2018). Creating breathing cities by adopting urban ventilation assessment and wind corridor plan – The implementation in Chinese cities. *Journal of Wind Engineering and Industrial Aerodynamics, 182*, 170-188. https://doi.org/10.1016/j.jweia.2018.09.023

Richardson, L. (2003). Writing: A method of inquiry. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Collecting and interpreting qualitative materials* (pp. 499-541). Sage.

Romanello, M., Walawender, M., Hsu, S.-C., Moskeland, A., Palmeiro-Silva, Y., Scamman, D., Ali, Z., Ameli, N., Angelova, D., Ayeb-Karlsson, S., Basart, S., Beagley, J., Beggs, P. J., Blanco-Villafuerte, L., Cai, W., Callaghan, M., Campbell-Lendrum, D., Chambers, J. D., Chicmana-Zapata, V., … Costello, A. (2024). The 2024 Report of the Lancet Countdown on Health and Climate Change: Facing Record-Breaking Threats from Delayed Action. *The Lancet (British Edition), 404*, 1847–1896. https://doi.org/10.1016/S0140-6736(24)01822-1

S

Saleem, M.S., Ahmad, S.R., Shafiq-Ur-Rehman, & Javed, M.A. (2020). Impact assessment of urban development patterns on land surface temperature by using remote sensing techniques: a case study of Lahore, Faisalabad and Multan district. *Environmental Science and Pollution Research, 27*, 39865–39878. https://doi.org/10.1007/s11356-020-10050-5

Sanchez, L., & Reames, T.G. (2019). Cooling Detroit: A socio-spatial analysis of equity in green roofs as an urban heat island mitigation strategy. *Urban Forestry & Urban Greening, 44*. https://doi.org/10.1016/j.ufug.2019.04.014

Schifano, P., Cappai, G., De Sario, M., Michelozzi, P., Marino, C., Bargagli, A., & Perucci, C. (2009). Susceptibility to heat wave-related mortality: a follow-up study of a cohort of elderly in Rome. *Environmental Health, 8*. https://doi.org/10.1186/1476-069X-8-50

Schweizerische Eidgenossenschaft. (2020). *Anpassung an den Klimawandel in der Schweiz. Aktionsplan 2020–2025. Strategie des Bundesrates, herausgegeben vom Bundesamt für Umwelt (BAFU).* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/publikationen-studien/publikationen/anpassung-klimawandel-schweiz-aktions-plan-2020-2025.html

Setiawati, M. D., Jarzebski, M. P., & Fukushi, K. (2022). Extreme heat vulnerability assessment in Indonesia at the provincial level. *IOP Conference Series: Earth and Environmental Science, 1095*(1). https://doi.org/10.1088/1755-1315/1095/1/012021

Siders, A.R. (2018). Adaptive capacity to climate change: A synthesis of concepts, methods, and findings in a fragmented field. *WIREs Climate Change, 10*(3). https://doi.org/10.1002/wcc.573

Spielman, S.E., Tuccillo, J., Folch, D.C., Schweikert, A., Davies, R., Wood, N., & Tate, E. (2020). Evaluating social vulnerability indicators: criteria and their application to the Social Vulnerability Index. *Natural Hazards, 100*, 417-436. https://doi.org/10.1007/s11069-019-03820-z

Spini, D., & Widmer, E. (Eds.) (2023). *Withstanding Vulnerability throughout Adult Life: Dynamics of Stressors, Resources, and Reserves*. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-4567-0

Stalhandske, Z., Nesa, V., Zumwald, M., Ragettli, M. S., Galimshina, A., Holthausen, N., Röösli, M., & Bresch, D. N. (2022). Projected impact of heat on mortality and labour productivity under climate change in Switzerland. *Nat. Hazards Earth Syst. Sci., 22*, 2531–2541. https://doi.org/10.5194/nhess-22-2531-2022

Stewart, I.D. (2011). A systematic review and scientific critique of methodology in modern urban heat island literature. *International Journal of Climatology, 31*(2), 200-217. https://doi.org/10.1002/joc.2141

Stone, B., Hess, J. J., & Frumkin, H. (2010). Urban Form and Extreme Heat Events: Are Sprawling Cities More Vulnerable to Climate Change Than Compact Cities? *Environmental Health Perspectives, 118*(10), 1425-1428. https://doi.org/10.1289/ehp.0901879

Strauss, A., & Corbin, J. (1996). *Grounded Theory: Grundlagen Qualitativer Sozialforschung*. Psychologie Verlags Union.

T

Tupinier Martin, F., Boudreault, J., Campagna, C., Lavigne, E., Gamache, P., Tandonnet, M., Généreux, M., Trottier, S., & Goupil-Sormany, I. (2024). The relationship between hot temperatures and hospital admissions for psychosis in adults diagnosed with schizophrenia: A case-crossover study in Quebec, Canada. *Environmental Research, 246*. https://doi.org/10.1016/j.envres.2024.118225

U

Umamaheswar, J. (2018). Studying Homeless and Incarcerated Persons: A Comparative Account of Doing Field Research With Hard-to-Reach Populations. *Forum Qualitative Social Research, 19*(3). https://doi.org/10.17169/fqs-19.3.3053

UN-Habitat. (n.d.). *Urban Energy*. UN-Habitat. Retrieved March 13, 2024, from https://un-habitat.org/topic/urban-energy

United Nations. (2019). *World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420)*. Department of Economic and Social Affairs, Population Division. Retrieved from https://population.un.org/wup/assets/WUP2018-Report.pdf

United Nations Environment Programme (UNEP). (2021). *Beating the Heat: A Sustainable Cooling Handbook for Cities*. Retrieved from https://www.unep.org/resources/report/beating-heat-sustainable-cooling-handbook-cities

V

VCÖ. (2024). *Wie Verkehr die Hitzebelastung in Städten verschärft. VCÖ factsheet, 2024-07.* Retrieved from https://vcoe.at/publikationen/vcoe-factsheets/detail/wie-verkehr-die-hitzebelastung-in-staedten-verschaerft#anker_quellen_1

Ville de Lausanne. (n.d.-a). *Histoire*. Ville de Lausanne. Retrieved October 29, 2024, from https://www.lausanne.ch/portrait/carte-identite/histoire.html

Ville de Lausanne. (n.d.-b). *L'eau des fontaines*. Retrieved February 14, 2024, from https://www.lausanne.ch/vie-pratique/energies-et-eau/eau/territoires/fontaines/eau-des-fontaines.html

Ville de Lausanne. (2022). *Plan directeur communal. Vision stratégique & Programme d'actions*. Retrieved from https://www.lausanne.ch/officiel/grands-projets/lausanne-2030/plan-directeur-pdcom.html

Ville de Lausanne. Direction du logement, de l'environnement et de l'architecture. Bureau climat et durabilité. (2024). *Modélisation de scénarios de mesures pour la ville de Lausanne. Rapport final. Elaboré par GEO-NET Umweltconsulting GmbH.* Retrieved from https://www.lausanne.ch/dam/jcr:ec7e710a-c2db-4b7b-bb12-a7ba4eb7d994/Lausanne_scenarios_de_mesures.pdf

Ville de Lausanne Municipalité. (2021). *Plan Climat. Rapport-préavis N° 2020/54 & Catalogue des Axes d'action du Plan climat.* Retrieved from https://www.lausanne.ch/portrait/climat/publications/plan-climat

Ville de Lausanne Municipalité. (2022). *Communiqué. La Ville de Lausanne déclenche à nouveau son plan canicule.* Retrieved from https://www.lausanne.ch/apps/actualites/index.php?actu_id=76530

Voelkel, J., Hellman, D., Sakuma, R., & Shandas, V. (2018). Assessing Vulnerability to Urban Heat: A Study of Disproportionate Heat Exposure and Access to Refuge by Socio-Demographic Status in Portland, Oregon. *International Journal of Environmental Research and Public Health, 15*(4). https://doi.org/10.3390/ijerph15040640

Vogt, R., & Parlow, E. (2011). Die städtische Wärmeinsel von Basel – tages- und jahreszeitliche Charakterisierung. *Basler Zeitschrift für Geographie – Regio Basiliensis, 52*(19), 7-15.

W

Walker, G. (2011). *Environmental Justice. Concepts, Evidence and Politics*. Routledge. https://doi.org/10.4324/9780203610671

Wang, Z.-H. (2022). Reconceptualizing urban heat island: Beyond the urban-rural dichotomy. *Sustainable Cities and Society, 77.* https://doi.org/10.1016/j.scs.2021.103581

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd ed.).* Routledge.

Williams, B. (2023). *Policing Mental Health, Vulnerability and Risk*. Critical Publishing Ltd.

Williams, M. (2017). Care-full Justice in the City. Antipode, 49(3), 821-839. https://doi.org/10.1111/anti.12279

Wilson, B., & Chakraborty, A. (2019). Mapping vulnerability to extreme heat events: lessons from metropolitan Chicago. *Journal of Environmental Planning and Management, 62*(6), 1065-1088. https://doi.org/10.1080/09640568.2018.1462475

Winter, R. (2011). Ein Plädoyer für kritische Perspektiven in der qualitativen Forschung. *Forum: Qualitative Sozialforschung, 12*(1). https://doi.org/10.17169/fqs-12.1.1583

Wolf, T., & McGregor, G. (2013). The development of a heatwave vulnerability index for London, United Kingdom. *Weather and Climate Extremes, 1,* 59–68. https://doi.org/10.1016/j.wace.2013.07.004

Wood, M. (2023). Enhancing Vulnerable Groups' Participation in Medicines Risk Regulation: The Case of the European Medicines Agency's Public Hearing on Quinolone Antibiotics. *European Journal of Risk Regulation, 14*(2), 332–350. https://doi.org/10.1017/err.2023.10

Y

Yoon, L., Belotti, G., Stern, R., White, K., Mohajeri, A., Zhou, A., Miranda, E., Siao, E., Le, T., Masuda, J., Lee, E., & Buse, C. (2025). To cool or not to cool: understanding and improving cooling centre use in metro Vancouver through community-based participatory action research. *Environmental Research: Health, 3.* https://doi.org/10.1088/2752-5309/ada6f4

Z

Zhou, D., Xiao, J., Bonafoni, S., Berger, C., Deilami, K., Zhou, Y., Frolking, S., Yao, R., Qiao, Z., & Sobrino, J. A. (2019). Satellite Remote Sensing of Surface Urban Heat Islands: Progress, Challenges, and Perspectives. *Remote Sensing, 11*(1). https://doi.org/10.3390/rs11010048

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Interview guidelines

Guideline based interview

Research questions:

- How do organisations observe everyday practices of vulnerable groups dealing with heat? = **SUBJECTIVE CONCERN + COOLING STRATEGIES**
- Which heat related areas in the neighbourhood are relevant for vulnerable groups? = **PLACES**

Introduction

Cadre du projet:

Je m'appelle Fidelia Gartner et je suis une étudiante d'échange de la TU Wien. J'écris ma thèse de Master à l'EPFL sous la direction du Prof. Luca Pattaroni (EPFL) et Alexander Hamedinger (TU Wien).

Mon projet de master porte sur le thème de la chaleur urbaine à Lausanne. Je m'intéresse à la manière dont différentes personnes perçoivent les vagues de chaleur à Lausanne et comment elles font face à la chaleur dans leur vie quotidienne. De plus, j'aimerais explorer les zones du quartier qui sont pertinentes pour les personnes vivant à Lausanne lorsqu'il fait chaud. Pour ce faire, je mène des entretiens avec différentes organisations. Les résultats de ces entretiens seront intégrés à ma thèse de master et publiés dans le cadre de celui-ci.

Cadre d'entretien:

Si vous êtes d'accord, j'aimerais enregistrer la conversation. Les informations seront traitées de manière confidentielle. Je ne les transmettrai pas à des tiers et ne les utiliserai que dans le cadre de mon travail de master. Pour l'évaluation, je pseudonymiserai les déclarations. L'entretien dure environ une heure. J'ai préparé une déclaration de consentement. Veuillez lire ceci et si vous êtes d'accord, veuillez signer le formulaire.

--- **activer le micro** ---

Merci beaucoup d'avoir pris le temps de m'accorder une interview. Je vais commencer à poser mes questions, si vous n'avez plus de questions. Il est bien sûr possible de ne pas répondre à certaines questions.

A Introduction

- Quelles sont vos tâches principales au sein de XX ?
- Quelle est l'importance du thème de la chaleur urbaine pour vous dans votre vie professionnelle ?
    - Dans quelle mesure avez-vous déjà été confronté au thème de l'adaptation à la chaleur dans votre travail ?
- Dans quelle mesure la chaleur est-elle un sujet de préoccupation dans les activités que l'équipe développe ?
- Dans quelle mesure la chaleur est-elle un sujet de préoccupation pour les seniors à l’association ?

B Les personnes vulnérables

Je m'intéresse à la manière dont surtout les personnes vulnérables perçoivent les vagues de chaleur à Lausanne et comment elles font face à la chaleur dans leur vie quotidienne.

- Selon vous, quels sont les groupes les plus touchés par la chaleur à Lausanne ?

Comme vous êtes particulièrement en contact avec des personnes XX, j'aimerais me focaliser avec vous sur le groupe des XX.

- Quels sont les principaux défis auxquels sont confrontés les XX dans le contexte de la chaleur urbaine à Lausanne ? Qu'observez-vous ?
  [p.ex. problèmes de santé, isolement social, les rues escarpées de Lausanne comme défi à la mobilité…]
    - Dans quelle mesure les XX vivent-ils les canicules comme une contrainte à Lausanne ?

C Stratégies lorsqu’il fait chaud

La vulnérabilité à la chaleur se définit entre autres par la capacité à s'adapter. C'est pourquoi je voudrais parler un peu des stratégies que les XX ont pour se débrouiller lorsqu'il fait chaud.

- Que racontent les seniors, comment vivent-ils les vagues de chaleur avec plusieurs jours de plus de 30 degrés et des nuits de plus de 20 degrés d'affilée ?
    - Dans quelle mesure rapportent-ils qu'ils adaptent leur quotidien ?
    - Quelles sont les stratégies des XX pour se rafraîchir ? Qu’observez-vous ?
- Qu'est-ce qui aiderait les XX, surtout à la maison, lorsqu'il fait chaud ?
- Prenez-vous des mesures ici dans l'association pour aider les XX pendant les journées chaudes ? Lesquelles ?

- La ville propose-t-elle des offres pour les XX pendant les journées chaudes ? Lesquelles ?
    - Que pensez-vous de ces mesures ?
    - Que pourrait faire de plus la ville ?

D Endroits chauds et lieux pertinents :

Je m'intéresse aussi au rôle de la planification au contexte de la chaleur et comment l'espace public est aménagé.

- Quels sont les endroits de Lausanne où il fait particulièrement chaud en été ? Pourquoi ?
    - Quels sont les endroits de Lausanne qui représentent un défi particulièrement pour les XX en cas de chaleur ?

- Si vous en avez un aperçu : Pouvez-vous me dire comment les déplacements quotidiens des XX dans la ville changent lorsqu'il fait chaud ? (pour aller faire des courses/rencontrer des amis etc.) *[les rues escarpées de Lausanne comme défi à la mobilité]*
    - Lorsque l'amplitude de mouvement se réduit : Comment évaluez-vous le risque d'isolement social des XX lorsqu'il fait chaud ?

- Quels sont les endroits les plus agréables pour les XX à Lausanne lorsqu'il fait chaud ?

- Existent-ils des endroits spécialement destinés aux XX pour se rafraîchir à Lausanne ?
    - Comment les lieux doivent-ils être conçus pour que les XX puissent se rafraîchir ?

E Perspective

- Connaissez-vous le plan climat de la ville de Lausanne ?
    - Le slogan dit : « 0% carbone. 100% solidarité ». Comment interprétez-vous la solidarité dans le contexte du changement climatique ?
- Si vous aviez un souhait à formuler concernant la chaleur et l'adaptation au changement climatique à Lausanne, quel serait votre souhait le plus cher ?
- Avons-nous oublié quelque chose ? Souhaites-tu ajouter quelque chose au sujet ?

Walking interview

Research questions:

- How do vulnerable groups perceive heat in Lausanne? = **PERCEPTION**
- What everyday practices do vulnerable groups have to deal with heat? = **SUBJECTIVE CONCERN + COOLING STRATEGIES**
- Which heat related areas in the neighbourhood are relevant for vulnerable groups? = **PLACES**

<u>Introduction</u>

Cadre du projet:

Je m'appelle Fidelia Gartner et je suis une étudiante d'échange de la TU Wien. J'écris ma thèse de Master à l'EPFL sous la direction du Prof. Luca Pattaroni (EPFL) et Alexander Hamedinger (TU Wien).

Mon projet de master porte sur le thème de la chaleur urbaine à Lausanne. Je m'intéresse à la manière dont différentes personnes perçoivent les vagues de chaleur à Lausanne et comment elles font face à la chaleur dans leur vie quotidienne. De plus, j'aimerais explorer les zones du quartier qui sont pertinentes pour les personnes vivant à Lausanne lorsqu'il fait chaud. Pour ce faire, je mène des entretiens en marchant avec les gens dans leur quartier. Les résultats de ces entretiens seront intégrés à mon mémoire de master et publiés dans le cadre de celui-ci.

Cadre d'entretien:

Si vous êtes d'accord, j'aimerais enregistrer la conversation. Les informations seront traitées de manière confidentielle. Je ne les transmettrai pas à des tiers et ne les utiliserai que dans le cadre de mon travail de master. Pour l'évaluation, je pseudonymiserai les déclarations. L'entretien dure environ une heure. J'ai préparé une déclaration de consentement. Veuillez lire ceci et si vous êtes d'accord, veuillez signer le formulaire.

--- **activer le micro** ---

Merci beaucoup d'avoir pris le temps de m'accorder une interview. Je vais commencer à poser mes questions, si vous n'avez plus de questions. Il est bien sûr possible de ne pas répondre à certaines questions.

A Introduction

- Nous commençons ici à X. Qu'est-ce qui vous relie à ce lieu/ce quartier ?
- Pourquoi commençons-nous ici et où allons-nous ?
- [Question permanente : Quels sont les éléments qui sont importantes pour toi en cours de route lorsqu'il fait chaud ?]
- [Question permanente : Nous passons actuellement devant XX, est-ce important pour toi ? Par exemple, les fontaines, les éléments aquatiques, les sièges, etc.]

B Percevoir une journée chaude à Lausanne

- Peux-tu me raconter comment se déroule une journée typique de canicule pour toi à Lausanne ?
- Comment vis-tu les vagues de chaleur avec plusieurs jours de plus de 30 degrés et des nuits de plus de 20 degrés d'affilée ?
- Notre santé est également un sujet important lorsqu'il fait chaud. Comment se port ta santé lorsqu'il fait chaud ?
- Qu'est-ce qui est insupportable pour toi lorsqu'il fait chaud ?
  Peux-tu me parler d'un événement concret que tu as vécu lors d'une journée chaude à Lausanne ?

C Stratégies quand il fait chaud

- Tu as dit que les jours de canicule, par exemple, tu fais X, pour t protéger de la chaleur. Quelles sont les autres mesures que tu prends pour faire face à la chaleur ?
- Qu'est-ce qui t'aide ou t'aiderait particulièrement à la maison ?
- Comment ta routine quotidienne change-t-elle lorsqu'il fait très chaud ?
  Comment cela se passe-t-il en semaine et pendant les jours de congé ?
- Qui peut t'aider à faire face à la chaleur et comment ?
- Comment est-ce que tu aides ta famille, tes amis et d'autres personnes à faire face à la chaleur ?

D Endroits chauds et espaces pertinentes

- Quels sont les endroits de ton quartier que tu trouves personnellement très chauds en été ? Pourquoi ?
- Quels sont les endroits de la ville où tu trouves personnellement qu'il fait très chaud en été ? Pourquoi ?
- Dans quelle mesure tes déplacements quotidiens dans la ville (pour aller faire des courses/travailler etc.) changent-ils lorsqu'il fait chaud ?
- Quel rôle les espaces verts et les parcs jouent-ils pour toi lorsqu'il fait chaud ?
- Quel rôle l'eau joue-t-elle pour toi dans la ville ?

E Perspective

- Quels sont les défis que tu envisage de relever pour faire face à la chaleur à l'avenir ?
- Qu'est-ce qui t'aiderait le plus pendant les journées chaudes ?
- Avons-nous oublié quelque chose ? Souhaites-tu ajouter quelque chose au sujet ?

Expert interview

Research questions:

- How are different vulnerable groups taken into account in strategic planning measures for mitigating and adapting to heat in Lausanne? = **CONSIDERATION OF VULNERABLE GROUPS**

<u>Introduction</u>

Project framing:

My name is Fidelia Gartner and I'm an exchange student from TU Wien. I'm working on my Master Thesis at EPFL and I'm supervised by Prof. Luca Pattaroni (EPFL) and Prof. Alexander Hamedinger (TU Wien).

My Master's thesis focuses on the role of planning in the face of increasingly frequent heatwaves. I am therefore interested in questions concerning the existing strategies and measures at urban planning level in Lausanne, and the vision of how heat should be managed in the future – in view of the fact that not everyone is affected in the same way. To do this, I'm conducting interviews with people working on heat mitigation and adaptation planning. The results of these interviews will be incorporated into my Master's thesis and published as part of it.

Interview frame:

If you agree, I would like to record the conversation. The information will be treated confidentially. I will not pass it on to third parties and will only use it for my master's thesis. For evaluation purposes, I will pseudonymize the statements. The interview lasts about an hour. I have prepared a declaration of consent. Please read this and if you agree, please sign the form.

--- start recording ---

Thank you very much for taking the time for this interview. If you don't have no more questions, I'll start the interview. It is of course possible not to answer certain questions.

A Introduction

- What are your main tasks at the 'Bureau climat et durabilité'?
- To what extent have you already had to deal with heat adaptation in the course of your work?
- How important is the topic of urban heat in your work?

B Urban heat – mitigation and adaptation in Lausanne

Strategies and measures

- What do you see as the (greatest) challenges in dealing with heat in Lausanne?
- What plans and strategies exist at urban planning level to deal with heat in Lausanne?
    - Plan Climat, Objectif Canopée, Plan directeur communal → Have I missed any important documents on heat and heatwaves?
    - Are the basic studies for the Municipal Master Plan public? Are there any maps of urban heat islands in Lausanne that I can consult?
- What do you think are the most important measures to combat the heat? (Measures: axes d'actions et mesures proposes)
- What do you think is missing from the plans with regard to heat?
- What are the obstacles to implementation? (Plan Climat and Objectif Canopée; obstacles to implementation for each plan)

Plan Climat

- It says "0% carbon. 100% solidarity" in the Climate Plan. Can you elaborate a little on this slogan? How was is created?
- The plan aims to ensure that renovations do not displace tenants. Can you elaborate a little on this measure? How did you come to this and why are you taking this measure in Lausanne?
    - Are there other ideas towards the effects of climate change and measures against heat on social equality in Lausanne?
    - If there are negative effects: What are your ideas towards avoiding these negative effects?

Objectif Canopée:

- Is there a more detailed document regarding the tree planting plan? (I only have the 2-page strategy.)
- Besides trees, are there other planned plantations (green facades, parks, temporary green spaces, etc.)? Are there other Nature-Based Solutions?
- Are there also plans for water elements, shading systems, seating related to heat planning?
- The 2020 Climate Plan report states: "It is time for trees to guide the city's development." How would you interpret this statement?

Responsibilities/actors:

- Who are the actors involved in the planning for urban heat resilience in Lausanne / in the development and implementation of the Plan Climat? How is the "Bureau du climat et durabilité" networked with other actors on the subject of heat?
- What is the collaboration between the canton and the city on this issue?
- What is the scope of action at the neighbourhood level?

C Vulnerable Groups:

- Which groups are most affected by heat in Lausanne? And why?
- Which places/neighbourhoods are most affected by heat in Lausanne? And why?
- To what extent are the different affected groups considered in the plans?
- How are the different (vulnerable) groups involved in the planning process? How are the involved in the implementation?

D Conclusion and Outlook:

- Outlook:
    - What vision is there in the face of increasingly hot days?
    - If you had a wish regarding heat and climate change adaptation in Lausanne, what would you wish for most?
- Have we forgotten anything? Would you like to add anything to the subject?

Coding manuals

Interviews

Main category	Subcategory	Short definition	Example	Creation
Aspects de la vulnérabilité à la chaleur (aspects of heat-related vulnerability)		Facteurs locaux déterminant la vulnérabilité à la chaleur à Lausanne (local factors that determine heat vulnerability in Lausanne)		Inductive
	Qui est vulnérable à la chaleur à Lausanne ? (who is vulnerable to heat in Lausanne?)		« Sans doute des personnes âgées. Sans doute. Après, comment je t'ai dit : La difficulté des gens en précarité, c'est qu'ils n'ont pas des choix. » (I10_walking)	Inductive
	Caractérisation de la chaleur à Lausanne (characterisation of heat in Lausanne)		« Moi, maintenant je trouve qu'elle est envahissante. Elle est tuante, je la supporte mais elle est éprouvante. » (I9)	Inductive
Défis des personnes vulnérables à la chaleur (challenges for heat-vulnerable people)		Défis individuels liés à la chaleur au quotidien (individual challenges with the heat in everyday life)		Deductive
	Aspects de la précarité à Lausanne (aspects of precarious living conditions in Lausanne)		« Et ces gens sont quand même très concentrés sur dans un périmètre très restreint. » (I6)	Inductive
	Déshydratation (dehydration)		« Le plus difficile, c'est de boire. » (I10_walking)	Inductive
	Problèmes de concentration (chaleur à l'école) (problems with concentrating in school)		« On arrive à se concentrer rentrer, mais c'est dur avec la chaleur. » (I4_walking)	Inductive
	Accessibilité des options de fraîchissement (accessibility of cooling options)		« Mais je pense qu'elle devrait même être vraiment gratuite parce que moins cher, ça reste trop cher pour les gens qui n'ont pas les moyens. » (I6)	Inductive
	Difficultés à maintenir l'hygiène (difficulties in maintaining hygiene)		« Tout l'hygiène, c'est complexe en général, aux vêtements aussi, mais la question de la dignité, c'est complexe aussi. » (I10_walking)	Inductive
	Ne pas bouger et isolement social (not moving and social isolation)		« Je dirais de… malgré la chaleur de rester actif. » (I5)	Inductive
Stratégies de fraîchissement – personnes vulnérables (cooling stratgies – heat-vulnerable people)		Individual strategies of vulnerable people to cool down on hot days		Deductive
	Adaptation des activités (adaptation of activities)		« C'est l'activité générale le matin, hein. Pour l'après midi, il fallait rentrer chez eux et puis se mettre au frais. » (I5)	Inductive

	Refroidissement à la maison (cooling at home)		« Déjà le matin, je ne lève pas mes stores. Je les laisse fermés pour continuer à avoir le frais dans ma chambre et pas que le soleil tape. » (I4_walking)	Inductive
	Aller dans des espaces publics rafraîchis (attending cooled public spaces)		« Alors qu'est ce qu'elles font ces personnes dans la chaleur ? Je vais te dire : Ils vont à la bibliothèque municipale. » (I10_walking)	Inductive
	Adaptation de la mobilité (adaptation of mobility)		« Ouais, il y en a qui prennent plus la voiture alors qu'ils prennent pas d'habitude. » (I5)	Inductive
Services de rafraîchissement - organisations		Possibilités et limites des organisations sociales pour permettre aux groupes vulnérables de se refroidir (possibilities and limits of social organisations to enable vulnerable groups to cool down)		Inductive
	Offrir des rafraîchissements		« On met à disposition des boissons ce qui permet un petit peu aux gens de se s'hydrater. » (I5)	Inductive
	Informer		« En tout cas on dit il faut bien boire de l'eau et pas de l'alcool. » (I8)	Inductive
	Prendre soin des autres		« Donc c'est clair qu'il faut être attentif ou par exemple au niveau d'association. » (I5)	Inductive
	Utilisation de la carte des espaces frais de la ville		« Oui, mais nous on a reçu cette carte. Et puis et puis on l'a affichée. Maintenant, est-ce que les gens la regardent ? Ça c'est une autre question. » (I5)	Inductive
	Collaboration avec la ville : Plan Canicule		« Il y a le plan canicule qui est la quand même, qui est très bon, mais qui est très bon surtout pour les gens qui ont déjà des soutiens. » (I5)	Inductive
	Défis		« Parce que nous ici on offre un accueil. Mais on est dans un lieu qui n'est pas frais du tout. » (I6)	Inductive
Lieux liés à la chaleur		Lieux particulièrement pertinents pour les groupes vulnérables en cas de chaleur (places that are particularly relevant for vulnerable groups in hot weather)		Deductive
	Lieux particulièrement chauds		« Quartier, au quartier du Flon, là aussi c'est vraiment ce béton béton, béton, béton... » (I8)	Inductive
	Lieux rafraîchissants		« Les gens ils iraient plus dans les parcs et tout ca... » (I10_walking)	Inductive
Solidarité dans le contexte de la chaleur urbaine (solidarity in the context of urban heat)		Compréhension locale d'un comportement solidaire en cas de chaleur (local understanding of solidary behaviour in the heat)		Inductive
			« Après, moi, je pense que les mesures prises là-bas, justement avec cette carte, euh, sur les endroits frais, je pense que ça, c'est déjà un acte de solidarité. » (I5)	

Documents

Main category	Subcategory	Example	Creation
Identifier des groupes vulnérables et analyser des zones particulièrement concernés (identifying vulnerable groups and analysing heat areas)			Inductive
		« Identifier les populations particulièrement vulnérables aux canicules et événements climatiques extrêmes (par ex. personnes âgées, isolées, en mauvaise santé) et mettre sur pied des dispositifs d'information, d'alerte et de prise en charge spécifiques. » (PDCom, p. 138)	
Systèmes d'information, d'alerte et de soins pour les personnes âgées (providing information, warning and care systems for elderly people)			Inductive
		« Le plan canicule sera déployé en cas de vague de chaleur et adapté au besoin. » (Plan Climat, p. 44)	
Développement de l'infrastructure de refroidissement (expanding cooling infrastructure)			Inductive
	Création d'espaces verts et récréatifs (integration of of green and recreational areas as 'fresh zones')	« Mettre en œuvre un développement urbain prenant en compte les changements climatiques afin de lutter notamment contre l'effet « îlots de chaleur », en agissant sur la structure urbaine (orientation, exposition aux vents dominants, capacité d'écoulement des courants d'air, ...), la forme, le type et la couleur des matériaux et des bâtiments et de leurs superstructures (stores, auvents etc.) afin de maximiser la ventilation et le rafraichissement naturels. » (PDCom, p. 138)	Inductive
	Carte des espaces frais (fresh places map)	« Déjà le matin, je ne lève pas mes stores. Je les laisse fermés pour continuer à avoir le frais dans ma chambre et pas que le soleil tape. » (I4_walking)	Inductive
Lutter contre la chaleur à l'école (combatting heat in schools)			Inductive
		« La Municipalité souhaite également lancer une large démarche de réaménagement des préaux scolaires pour faire de ces espaces, aujourd'hui très minéraux, des oasis de fraîcheur. » (Plan Climat, p. 56)	
Accessibilité et solidarité (affordability and solidarity)			Inductive
	Cohésion sociale (social cohesion)	« La Municipalité ne peut donc envisager que la transition énergétique ait pour effet d'appauvrir les classes sociales les plus vulnérables. » (Plan Climat, p. 18)	Inductive
	Contrôler les loyers (controlling rents)	« En parallèle, la Municipalité entend lancer des études pour analyser les conséquences sur les loyers d'une politique intensive d'assainissement des bâtiments et les mesures à prendre pour protéger les locataires. » (Plan Climat, p. 18)	Inductive
	Tarifs réduits de transport public (reduced prices for public transport)	« Dans le domaine de la mobilité, la Municipalité entend s'engager par étapes vers une diminution significative du prix des transports publics pour compenser les entraves aux transports individuels motorisés et la fin des véhicules thermiques. » (Plan Climat, p. 18)	Inductive