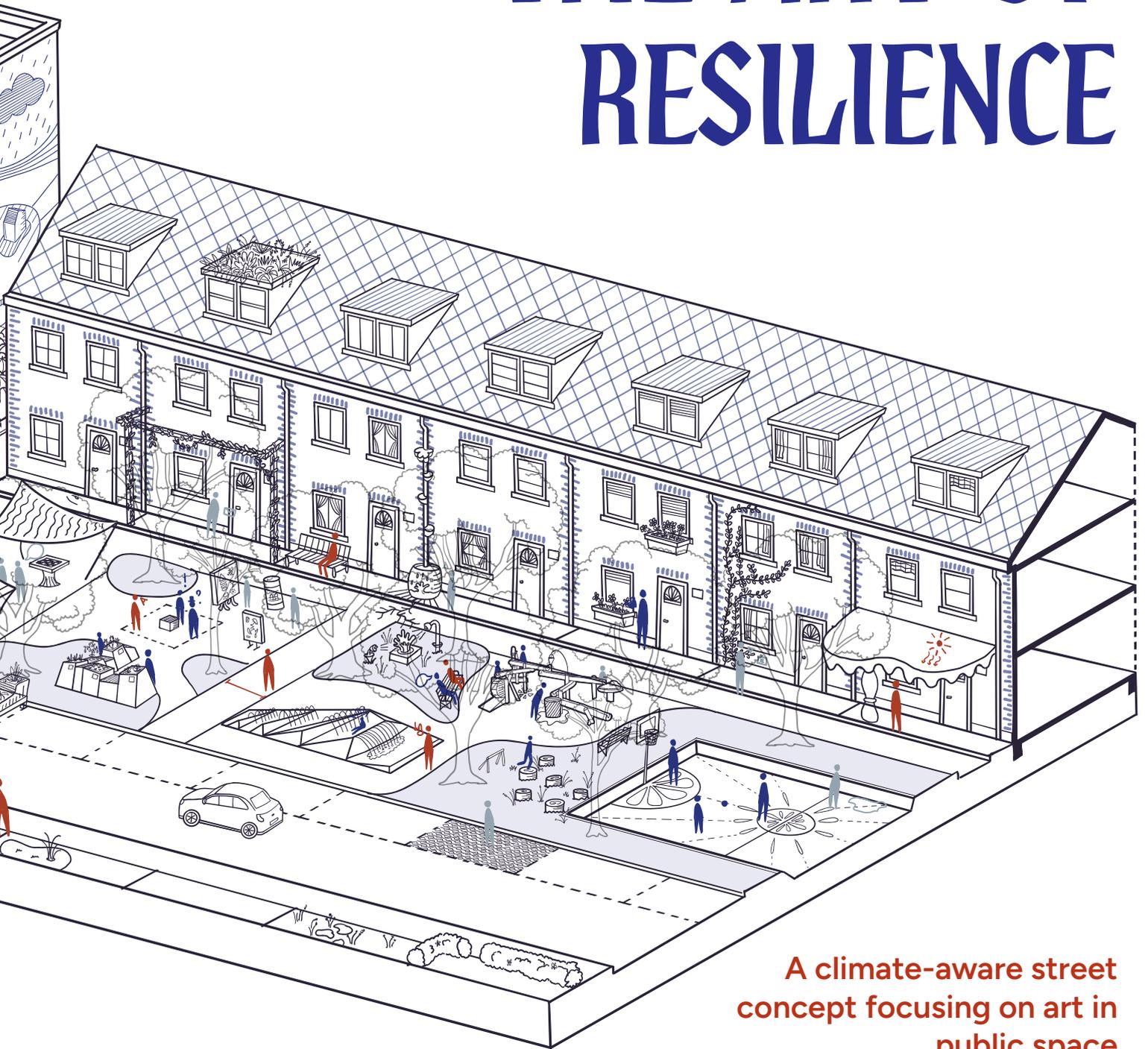


THE ART OF RESILIENCE



**A climate-aware street
concept focusing on art in
public space**

Manou Driessen

Colofon

THE ART OF RESILIENCE

A climate-aware street concept focusing on art in public space

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Preface

Grasp your paint brushes, because it is time to recolour your own street. After this thesis there is no possibility that you don't feel the urge to act against climate change (in a positive way). The solution is already on the street; climate awareness is the only thing we still need. This thesis explores the relationship between climate resilience, climate awareness and art in public space. The interest of the topic began as two separate subjects: climate resilience in cities and art in public space. During my studies abroad in Stockholm, these two topics were quite noticeable for me, resulting in the interest to exploring this further. Only at the start of the thesis, I was addressed on the possibility of merging these and there it was. The sketching paper ready and time to create climate art. Or at least exploring the topic of art and climate resilience. Is this going to be the way to making cities climate resilient by 2050?

I would like to thank my first mentor Ir. Kristel Aalbers, for supporting and contributing to the ideas and challenges that this topic has brought me. You inspired me, through your extensive knowledge about literally everything and steering the thesis to a great result. I would like to thank my second mentor Dr. Luisa Calabrese for showing me the possibilities of art in the field of Urbanism. You showed me that Urbanism can be more than a structure of streets, squares and infrastructure.

I hope you enjoy reading this report and may it inspire you of the opportunities that climate-aware streets have on public space!

Manou Driessen



Image 0.1: Water nuisance after short extreme precipitation: Stockholm, Sweden (author, 2024)



Image 0.2: Art in public space, Stockholm, Sweden (author, 2024)



Image 0.3: Community art wall in public space, Stockholm, Sweden (author, 2024)

Reading guide

The thesis is structured across 7 chapters. Each chapter is associated with objects commonly found on a drawing table to symbolize the topic of art. This metaphor provides both a specific meaning and a coherent narrative structure for the thesis. The chapters are represented by the following art tools:



Chapter 1: Introduction – the pencil

The pencil symbolizes the foundation of the thesis. The start of art by sketching the problem statement and the research questions.



Chapter 2: The approach – the sketch

The sketch visualises the conceptual and theoretical framework. They show the contours of the project.



Chapter 3: Climate resilience – drawing box

The drawing box represents the toolbox with all the tools. They can be seen as the different paint tubes, which the artist can choose from to create climate resilience.



Chapter 4: Climate awareness – the colour palette

The colour palette symbolizes the colours applied on the thesis. This reflects to the type of climate awareness that could be created.



Chapter 5: Art – the brushes

The brushes serve as the approach to implement the drawing, namely the art in public space. It shows the different brush techniques in which art can contribute to climate resilience and climate awareness.



Chapter 6: The concept – the canvas

The canvas brings all the concept together in one. It represents the finished design concept.



Chapter 7: The conclusion and discussion – the frame

The frame frames the drawing as it concludes the finished product and could reflect on the process of the project.

Abstract

Cities are pressured by the impacts of climate change (Nijs et al., 2019). Rising temperatures, wetter winters, drier summers and more extreme weather events demand a fundamental transformation of public space (KNMI, 2023). In the Netherlands, both national and municipal governments aim to achieve climate resilient cities by 2050, however, this ambition cannot be realised without the active involvement of citizens (Ministerie van Infrastructuur en Waterstaat, 2023). Unfortunately, there is a lack of climate awareness and visibility of climate resilient solutions (Lenzholzer et al., 2020).

This thesis addresses this gap by connecting the concepts of climate resilience, climate awareness and art and redesigning public space to create climate-aware streets. The research develops a toolbox of visible climate resilient interventions, analysed according to spatial scale, street typologies, microclimatic processes and climate extremes. To assess how awareness can be created, the study adopts and operationalises the three awareness mechanisms, experience, engagement and knowledge, derived from Iturriza et al. (2020). These mechanisms are applied to both the climate interventions and a curated set of fifteen art installations that engage with climate related themes.

The findings are combined in a climate-aware street concept, which integrates climate resilient interventions, awareness creating strategies, and art in public space. Illustrated through an archetypical street layout, the concept demonstrates how public space can be redesigned to make climate processes visible, tangible, and collectively understood. The street design concept can be implemented on various spatial contexts by a range of stakeholders, including the municipality, artists, designers and citizens, to collaboratively advance climate-resilient urban environments.

Keywords: Climate resilience, climate awareness, art in public space, street design concept, climate change

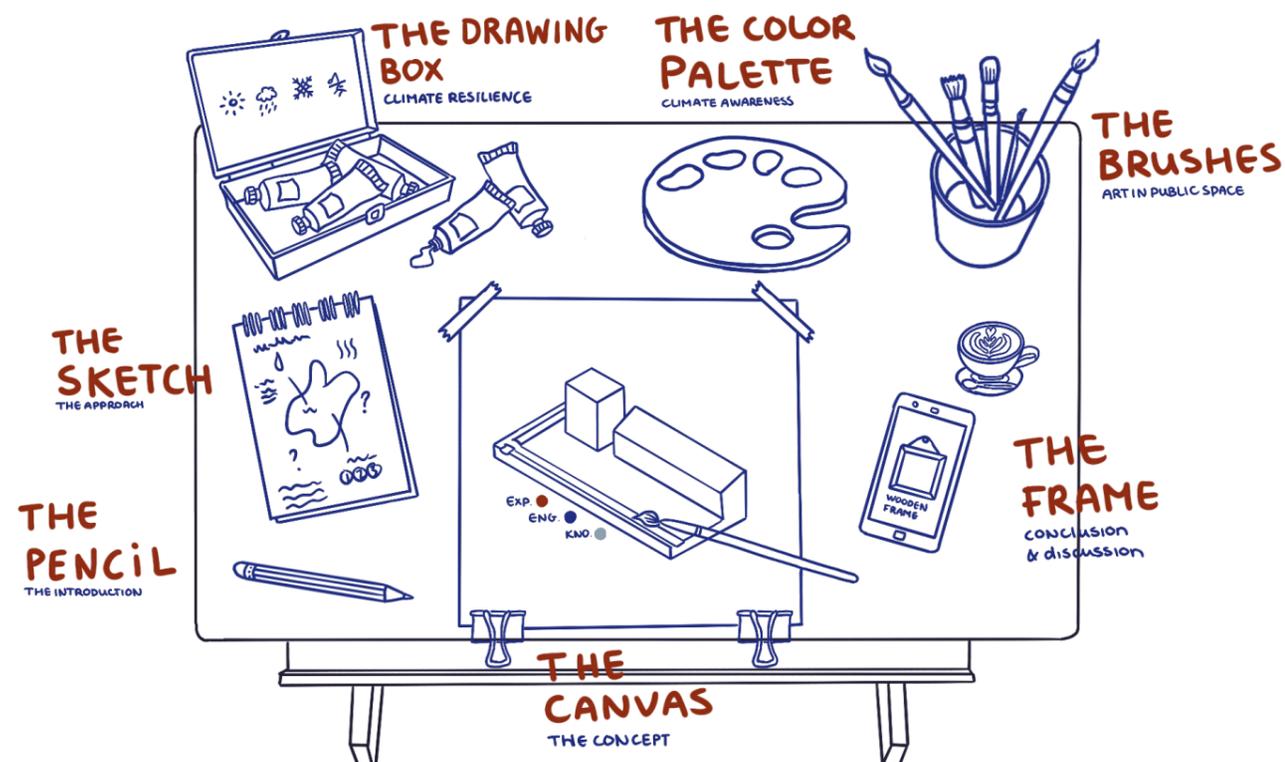


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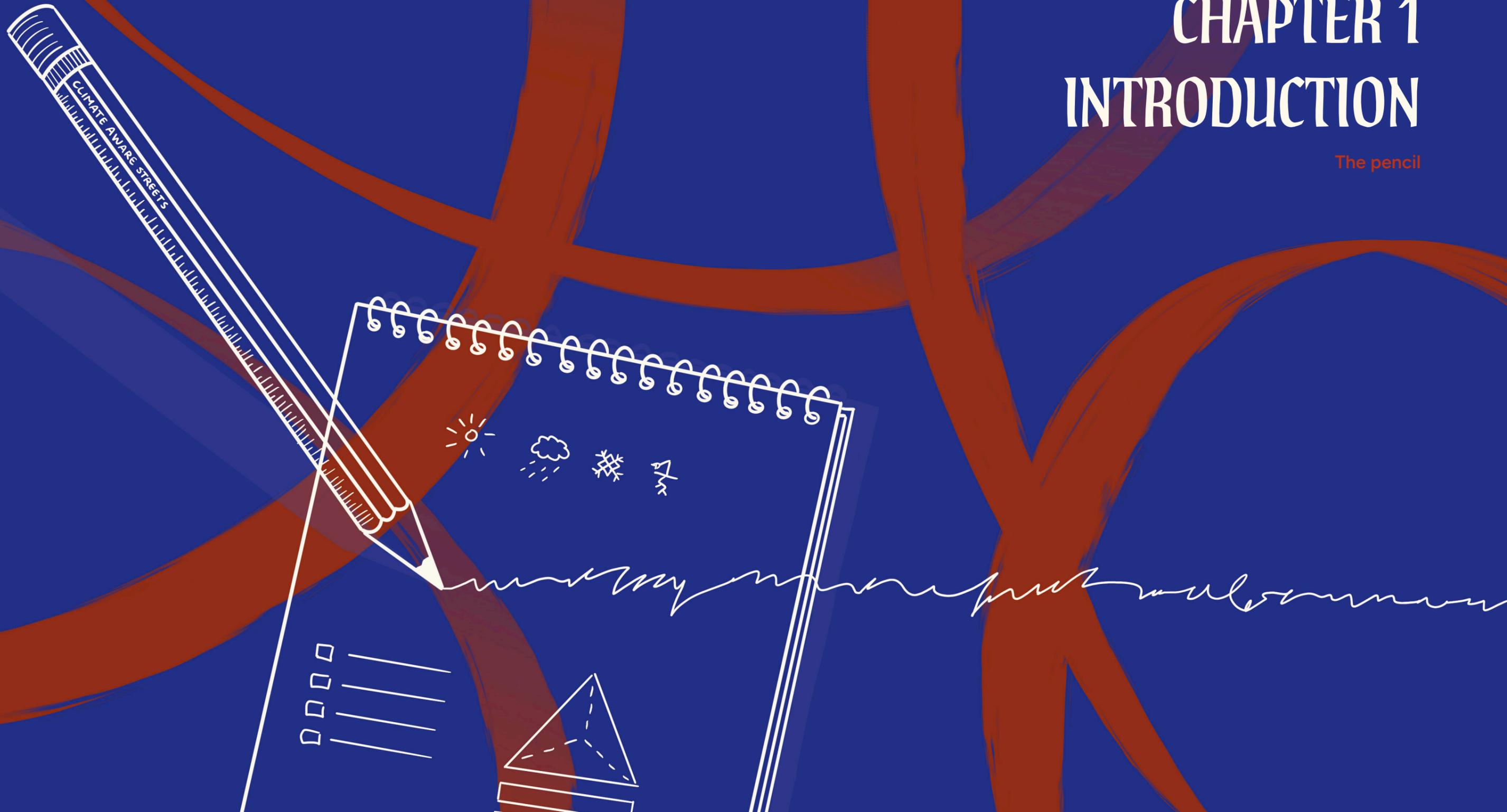
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CHAPTER 1

INTRODUCTION

The pencil



PROBLEM FIELD

Climate change

Climate change poses one of the most pressing challenges for cities worldwide. Since the industrial revolution, the extensive burning of fossil fuels has led to a rapid increase in greenhouse gases concentration, causing global warming and intensifying climate extremes (Riebeek, 2010; Kaddo, 2016; Nijs et al., 2019). In recent decades, the world has witnessed rising average temperatures, melting ice caps, sea level rise, and an increasing frequency of extreme weather events such as droughts, heatwaves, and heavy rainfall (IPCC, 2018). Despite international agreements such as the

Paris Agreement, aiming to limit warming to well below 2°C, global average temperatures already exceeded the 1.5°C threshold in 2024 (Aan de Brugh, 2025).

Urban areas are particularly vulnerable to these developments. Due to high concentrations of impervious surfaces and dense built structures, cities increase the effects of climate change through the urban heat island effect, reduced infiltration capacity, and limited resilience to extreme weather (Yang et al., 2016). The Netherlands illustrates this trend.



Figure 1.1: Newspaper with climate topics (author, 2025)

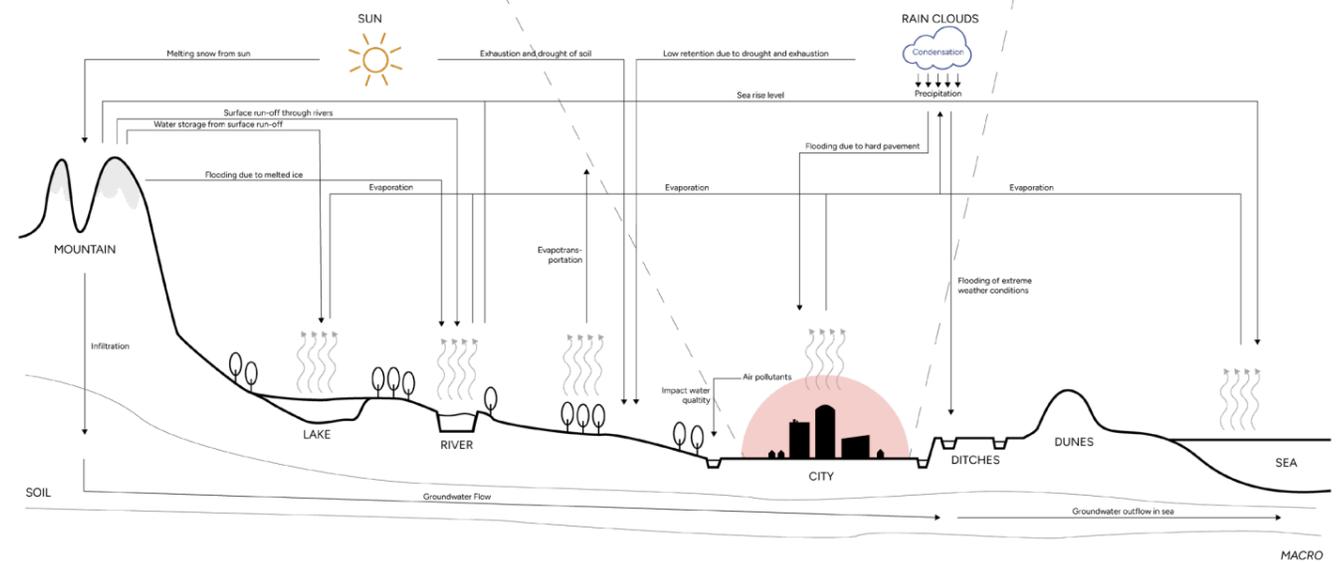
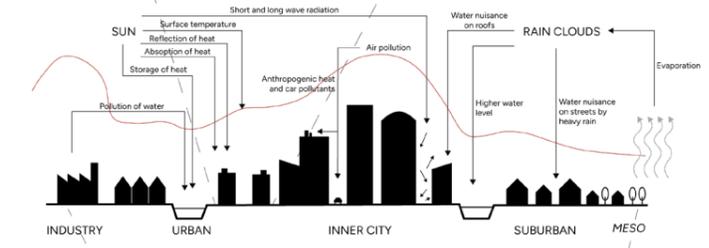
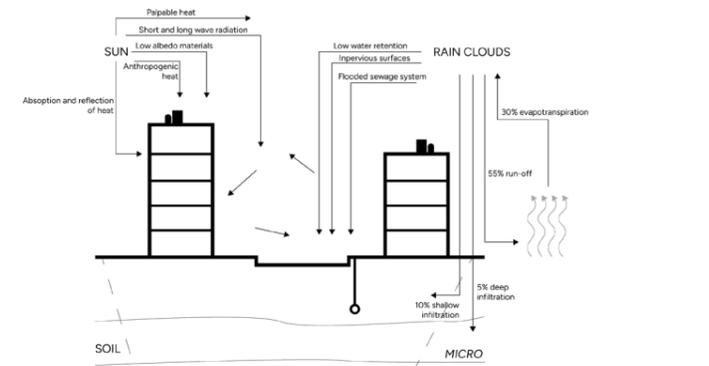


Figure 1.2: Flow chart of the impact of sun and precipitation due to climate change (Author, 2025)

National meteorological projections by Royal Netherlands Meteorological Institute (KNMI) (2023) indicate that summers will become hotter and drier, while rainfall events will occur with greater intensity over shorter time spans. Although the total annual precipitation may not increase, its distribution is shifting towards extreme downpours, overwhelming drainage systems and leaving water on streets (Luijtelaar et al., 2008).

Figure 1.1, a self-designed newspaper front page, captures the urgency of climate challenges as they are increasingly reported in Dutch media.

To further illustrate how climate drivers manifest across spatial scales, figure 1.2 accompanying a sun-and-precipitation flow diagram. At the regional level, changing oceanic influences raise the likelihood of extreme rainfall; at the city level, pavement and density amplify heat stress and flooding; and at the street level, microclimatic conditions directly impact citizens' health, comfort, and safety. Cities, however, are not yet adequately equipped to withstand these challenges. While resilience strategies exist, their effectiveness is often limited without strong citizen engagement and awareness (Kleerekoper et al., 2024; Lenzholzer et al., 2020).

PROBLEM FIELD

Future predictions

To understand the implications ongoing climate change, the KNMI has published four scenarios that project probable future developments in weather conditions towards 2050 and 2100 (KNMI, 2023). These scenarios are constructed along two axes: the level of greenhouse gas emissions (low or high) and changes in precipitation patterns (wetter winters or drier summers). This results in four distinct scenarios: Ln (low emissions, wetter), Ld (low emissions, drier), Hn (high emissions, wetter), and Hd (high emissions, drier). Together, these provide a bandwidth within which future climate change in the Netherlands is likely to unfold (figure 1.3). Across all scenarios, certain developments are consistent: rising temperatures, wetter winters, drier summers, and more extreme weather events.



Precipitation

Precipitation patterns are projected to become more contrasting across the seasons. Winters are expected to become significantly wetter, with an increase of up to 24% in the Hn-scenario by 2100. Summers, conversely, become drier, with reductions of up to 29% in the Hd-scenario (Figure 1.5) (KNMI,2023). At the same time, precipitation extremes intensify. Light rainfall events will occur less often, while heavy downpours with large volumes of water in a brief period will become more common. The amount of precipitation falling within an hour or a day may increase considerably (figure 1.6), heightening the risk of pluvial flooding in urban areas. Moreover, severe summer storms with hail, strong gusts, and thunderstorms are projected to occur more frequently.



Temperature

Temperature in the Netherlands has already increased by more than 2°C since 1901, with summers warming faster than winters (figure 1.4). This is partly the result of soil desiccation and a higher frequency of easterly winds, which bring warm and dry air. Heatwaves are becoming more frequent, longer lasting, and more intense. The record-breaking heatwave of July 2019, when 40.7°C was measured, would in a future climate be even more extreme, with maxima up to 45°C in a world 2°C warmer, and potentially reaching 50°C under a 4°C warming pathway. Tropical nights (minimum temperature ≥ 20°C) also increase substantially: from almost none at present to dozens per summer under high-emission scenarios. This intensifies the problem of heat stress, particularly in urban areas that are already affected by the urban heat island effect.

Temperature in the Netherlands has already increased by more than 2°C since 1901 (KNMI, 2023)



Drought

Drought represents another growing concern. Drought arises when reduced rainfall coincides with increased evaporation. This is particularly severe in the dry scenarios. In the Hd-scenario, for example, an average summer around 2100 would be as dry as the extremely dry summer of 2018. The maximum precipitation deficit (the difference between evaporation and rainfall during April–September) is projected to almost double, from 160 mm at present to more than 280 mm by 2100. Such increases in water deficit would pose serious risks for agriculture, ecosystems, freshwater quality, and the availability of drinking water.

Overall, the projections underscore that without transformation of public space, future cities will lack the resilience required to cope with future predictions.



Figure 1.3: four scenario's for climate change in the Netherlands (KNMI, 2023)

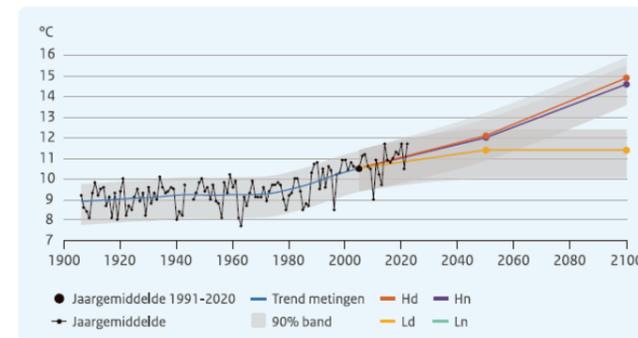


Figure 1.4: Average year temperature, average nationwide; Observations (black) and the four KNMI'23-climatescenario's (2050 and 2100, in three colours (Ln and Ld fall together)) (KNMI, 2023)

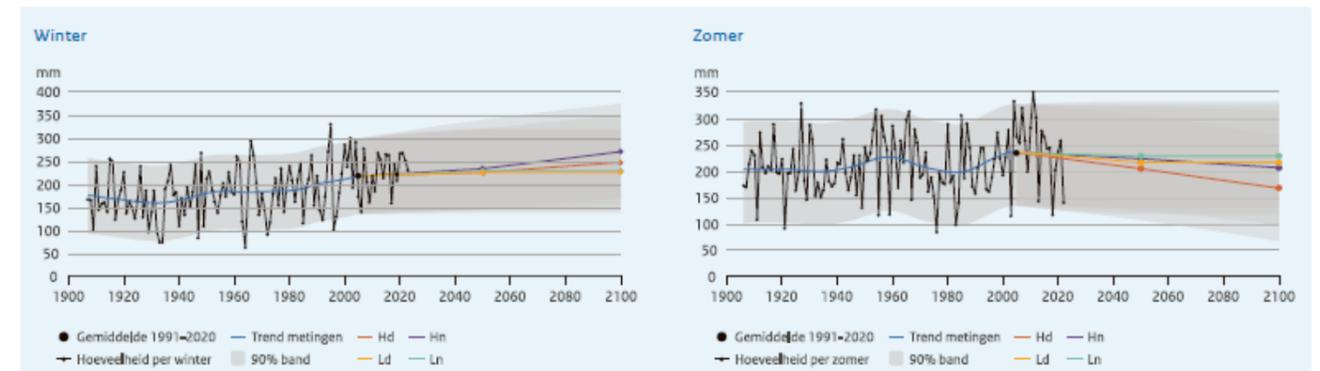


Figure 1.5: precipitation amount in the Netherlands in winter (left) and in summer (right), nationwide average: observations (black) and the four KNMI'23-climatescenario's (2050 and 2100, in four colours) (KNMI, 2023)

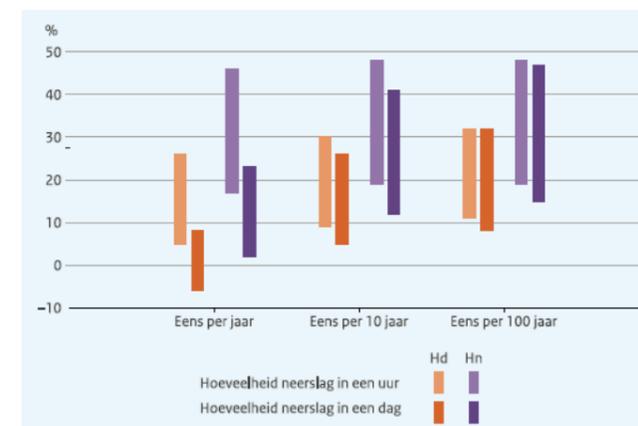


Figure 1.6: Bandwidth of percentage changes or extreme daily and hourly precipitation in summer, according to the high KNMI'23-Climatescenario's around 2100 (KNMI, 2023)

PROBLEM FIELD

Change of public space

With over 74% of its population living in urban areas, Dutch cities face growing risks of heat stress, water nuisance, and reduced liveability (PBL, 2015; Yang et al., 2016). A comparison of street design from 1960 to the present (figure 1.7) reveals both spatial and societal change. In the 1960s, early signs of climate issues appeared, yet urban streets became increasingly dominated by cars (BoschSlabbers & Buro Bergh, 2024). Public space was designed primarily for traffic efficiency, while communal greenery declined. Although streets then encouraged strong social contact among neighbours, the dominance of vehicles reduced environmental quality and contributed to rising heat and pollution.

In contrast, today's urban design increasingly incorporates climate resilience. Cities experiment with green-blue infrastructure, permeable surfaces, and hidden water storage systems to reduce heat and flooding. However, many of these interventions remain invisible to citizens: underground infiltration crates or climate-smart materials do not create awareness, even though

74% of the Dutch population is living in urban areas (PBL, 2015)

they perform crucial functions. While expert knowledge on climate adaptation is expanding, it does not always translate into broad citizen

understanding. At the same time, processes of individualization and the dominance of online platforms have shifted social interactions indoors, limiting opportunities for shared awareness in the street (Willems, 2017).

This tension highlights a central argument that cities must not only invest in technical adaptation measures but also design public spaces that communicate climate challenges to citizens.

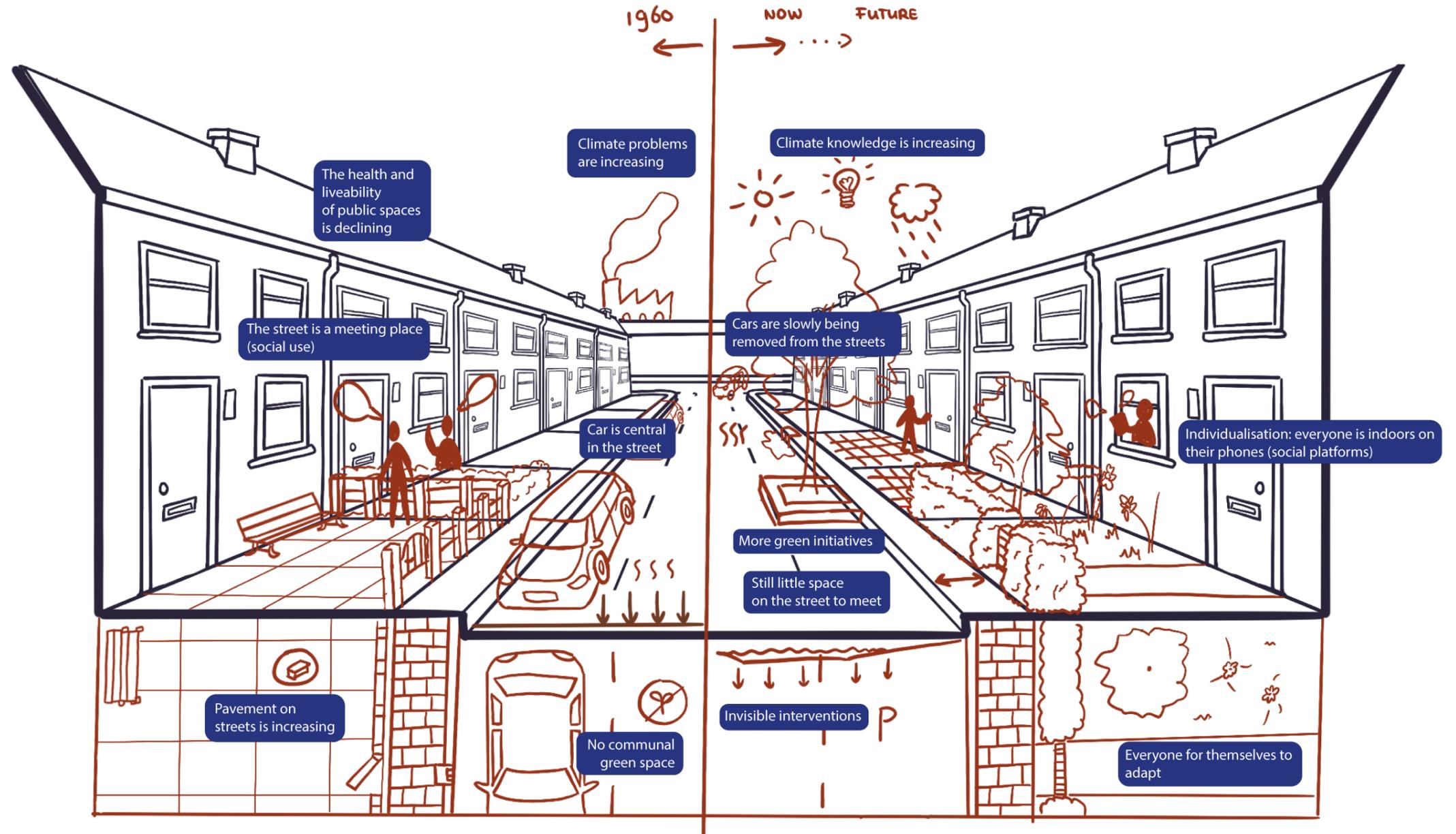


Figure 1.7: The changing street: 1960 to the present (Author, 2025)

PROBLEM FIELD

Climate resilient Netherlands

National policy recognises these challenges. The Dutch implementation plan states that by 2050 all cities must be water-resistant and climate resilience (Ministerie van Infrastructuur en Waterstaat, 2023). The plan emphasises three principles: climate resilience has to be smarter, more intensive and more inclusive. Smarter through integrated and flexible design, more intensive by prioritizing climate resilience initiatives in policies and more inclusive by collaborating with other stakeholders to realise climate resilience.

The Delta plan for Spatial Adaptation (Nationaal Deltaprogramma, 2025) outlines seven steps to achieve this goal (Figure 1.8). These steps include assessing the risks, integrating climate resilience into policy, and acting proactively. Identifying climate impacts remains challenging, future predictions leave no doubt that cities must prepare for a wide range of climate extremes (Opitz-Stapleton, 2011; Wardekker et al., 2010).



Figure 1.8: Steps of the Deltaplan for Spatial Adaptation (2025) (Author, 2025)

PROBLEM FIELD

The city of Amersfoort

Amersfoort, a Dutch city located centrally in the country, plays a role in these national objectives by incorporating climate resilience into local policy (figure 1.9). The environmental vision (omgevingsvisie) and the environmental rapport (omgevingsrapport) indicates that Amersfoort scores low on climate adaptation, particularly in heat resistant public space, water storage and drought resilience (Gemeente Amersfoort, 2023; Lindeboom et al., 2022). To tackle these challenges, its 2028 implementation plan shift the attention showing how climate resilience can be implemented (Provincie Utrecht, 2024). By implementing guidelines on building climate resilient and entering policies about heat stress and flooding the municipality is open to integrating measures for climate resilience. For this reason, Amersfoort was selected as the case study for this thesis. Not for a redesign of the city, but to make decisive choices for the project.



Figure 1.9: Situation Amersfoort in the Netherlands and its current climate scores (Author, 2025)

CLIMATE AWARENESS

Climate awareness is a frequently occurring phenomenon when talking about climate resilience (Lenzholzer et al., 2020). It refers to the capacity of urban systems, communities, and ecosystems to anticipate, absorb, adapt to, and recover from the impacts of climate change (figure 1.10) (Tyler & Moench, 2012). Six out of ten Dutch citizens believe they should live in a more climate aware manner (CBS, 2023).

The solutions already lie on the street. Numerous technical and spatial interventions have been developed, ranging from green infrastructure (figure 1.12 & 1.14) to permeable pavements and water storage facilities (figure 1.13), however, the primary issue is that many interventions remain out of sight, meaning that citizens neither see nor understand the role these measures play in addressing climate risks (Lenzholzer et al., 2020). Municipalities alone are insufficient to match the pace of implementation and the scale of the challenge (Kleerekoper et al., 2024). Something needs to be done about this.

Government and municipal implementation plan consistently emphasise the importance of involving citizens in climate resilience (Provincie Utrecht, 2024; Ministerie van Infrastructuur en Waterstaat, 2023). Strategies include campaigns, sharing knowledge and participatory involvement. However, these strategies do not reach all citizens, as climate change remains unfamiliar, perceived distant or unseen (Lenzholzer et al. 2020).

This lack of awareness presents a fundamental barrier to climate resilience (figure 1.11). Research has highlighted the existence of an “awareness gap” between experts and citizens: while technical solutions are well understood within professional domains, residents often underestimate climate risks and are uncertain about their own role in adaptation (Willems, 2017; Lenzholzer et al., 2020). This results in

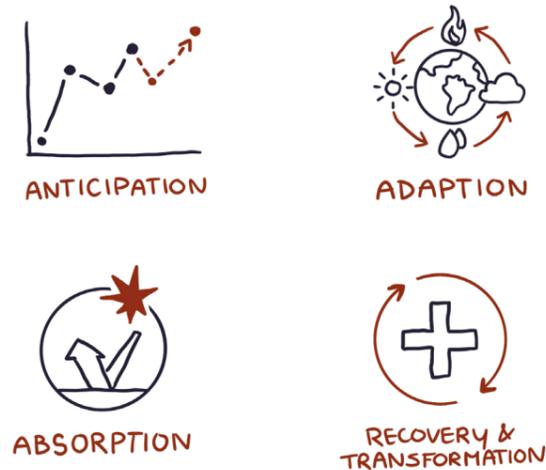


Figure 1.10: Processes of climate resilience (author, 2025)

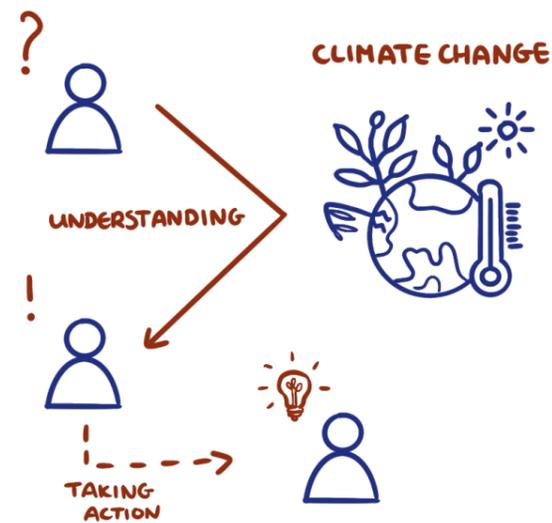


Figure 1.11: Creating climate awareness (author, 2025)

citizens acknowledging climate change without taking meaningful action. Without citizen engagement, resilience remains limited to physical measures, missing the opportunity to encourage behavioural change and collective responsibility (Calculli et al., 2021).



Figure 1.12: Impression of a watering and aeration system from treenovations (Treebuilders, z.d.)



Figure 1.13: Underground water storage around the Nassauquare, Zundert (via Kennisportaal Klimaatadaptatie)

Figure 1.14: Green roof (via milieucentraal.nl)

PROBLEM STATEMENT

Cities worldwide are increasingly exposed to the impacts of climate change. Rising temperatures, intensifying heatwaves, heavier rainfall events, prolonged drought, and shifting seasonal patterns place significant pressure on urban environments (KNMI, 2023; Riebeek, 2010; Kaddo, 2016; Nijs et al., 2019). Urban areas are particularly vulnerable due to dense built structures, imperious surfaces, and limited vegetation, all of which increase heat stress, reduce infiltration capacity, and heighten the risk of flooding (Kleerekoper et al., 2024). In response, the Dutch national implementation plan states that all cities must be water-resistant and climate resilience by 2050 (Ministerie van Infrastructuur en Waterstaat, 2023). To achieve this, national and municipal policies increasingly emphasise the need for inclusive and participatory climate resilience.

However, there is a general lack of climate knowledge amongst citizens which might which could be concluded from the intangible and invisible nature of urban climate processes.

The solutions already lie on the street, but the climate awareness is too low to notice this. As a result, individuals do not recognise their presence or understand their function, limiting opportunities for public engagement and reducing climate awareness (Lenzholzer et al., 2020). Yet, this transfer of knowledge is essential for achieving inclusive climate resilience, as citizen engagement forms the foundation to encourage behavioural change and create collective responsibility (Calulli et al., 2021).

Therefore, a gap exists between the visible technical implementations for climate resilience interventions and creation of climate awareness among individuals, regarding the impact and functioning of these climate resilient interventions (Willems, 2017; Lenzholzer et al., 2020). This thesis proposes that art in public space can serve as mediator to bridge this gap of climate resilience and climate awareness (figure 1.15).

MOTIVATION FOR ART

Art serves as medium capable of supporting a wide range of societal objectives. It can express political or emotional perspectives (Sălcudean, 2012), inspire individuals (Schuermans et al., 2012), stimulate economic development (Currid, 2010), attract tourism and revitalise neighbourhoods (Grodach, 2009), contribute to local identity (Arandelovic, 2018), facilitate knowledge exchange (Schuermans et al., 2012), and enhance social interaction and engagement (Grodach, 2009). Through these diverse functions, art plays a versatile role in shaping awareness and perception of public space.

This thesis approaches art as an interception of technology, design and science (Emergence Delft, 2023). Rather than merely facilitating technical information, art should inspire dialogue and reflection on the opportunities of climate resilience. In this sense, art has the potential to translate climate resilience technologies and knowledge into tangible experiences, making climate information more accessible and relatable for individuals. Unlike hidden infrastructures, artistic interventions can make the invisible visible: visualizing the mechanisms of water retention, shading, or cooling. Furthermore, art can serve as an engaging medium that draws attention to both the challenges posed by climate change and the solutions within public space.

The central challenge, therefore, is how to conceptualize and design a climate-aware street through the integration of art. This thesis seeks to address this knowledge gap by providing a novel perspective on street design that links climate resilience with climate awareness.

Art ...



translates technical knowledge into tangible experiences



serves as a medium to engage people

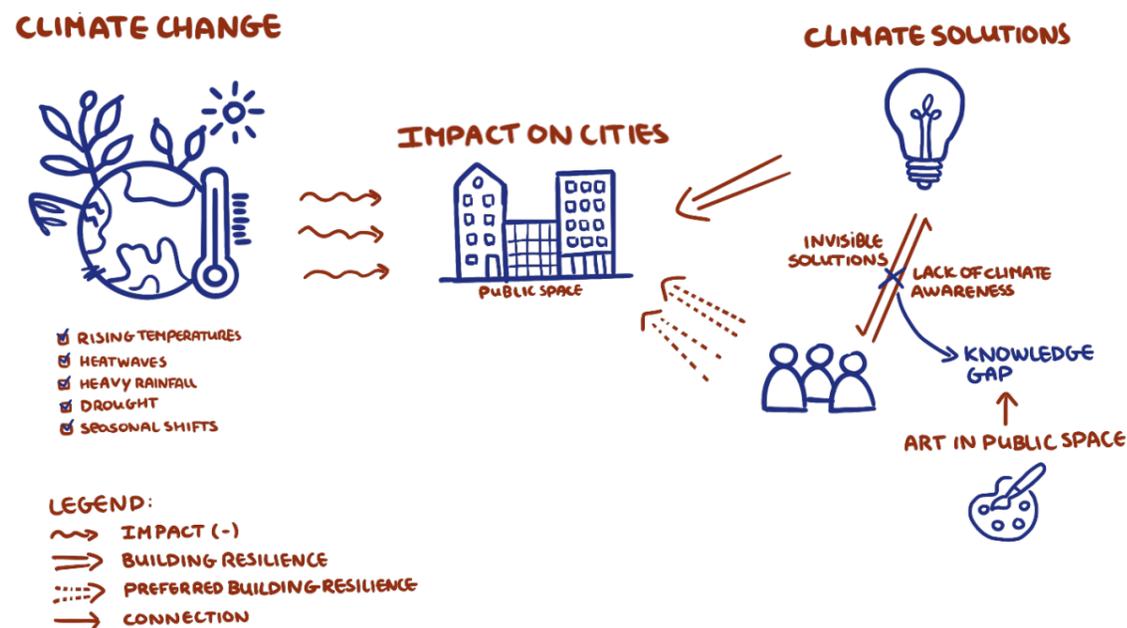


Figure 1.15: Problem statement field (author, 2025)

RESEARCH OBJECTIVE

The objective of this thesis is to enhance climate resilience and create climate awareness on the street. This is done by identifying the relationship between climate resilience, climate awareness and art in public. The project develops an archetypal street concept for redesigning public space that can be applied across various urban contexts. The three components, visible climate resilient interventions, climate awareness mechanisms and art examples, should operate simultaneously to establish the connection and presents how climate resilience can become both functional and communicative (figure 1.16). The project shows an innovative approach in how individuals, designers, and municipalities can contribute to achieving the national ambition of a climate resilient Netherlands by 2050.

Scope

The scope of this project is restricted to above-ground climate interventions, ensuring that all measures remain visible and therefore

contribute to climate awareness in public space. Additionally, art considered in this thesis must be located outdoors in public space, where they can contribute to climate resilience. And lastly, the financial aspects of implementing art, such as production, installation, and maintenance costs, fall outside the scope of this research and is therefore not included.

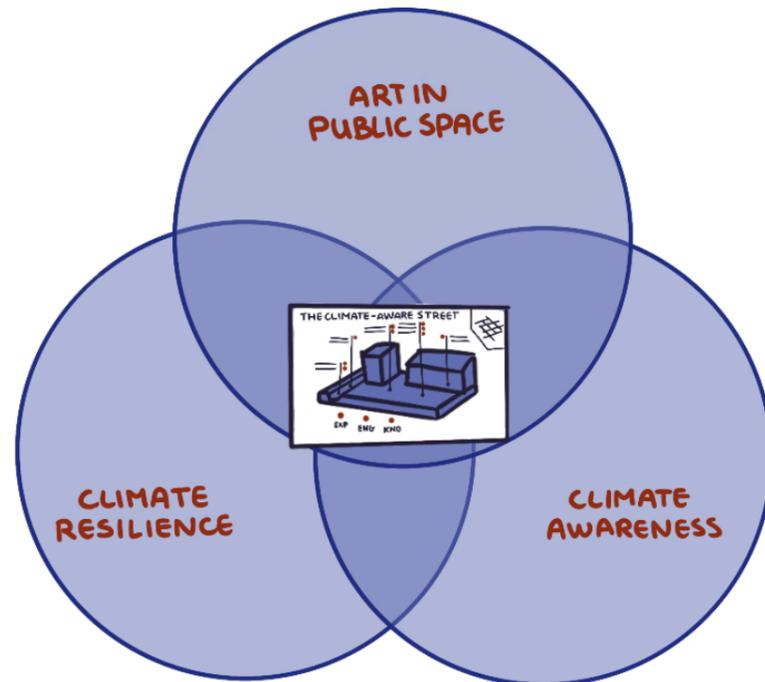


Figure 1.16: Objective of the research (author, 2025)

RESEARCH QUESTIONS

The main research question guiding this thesis is:

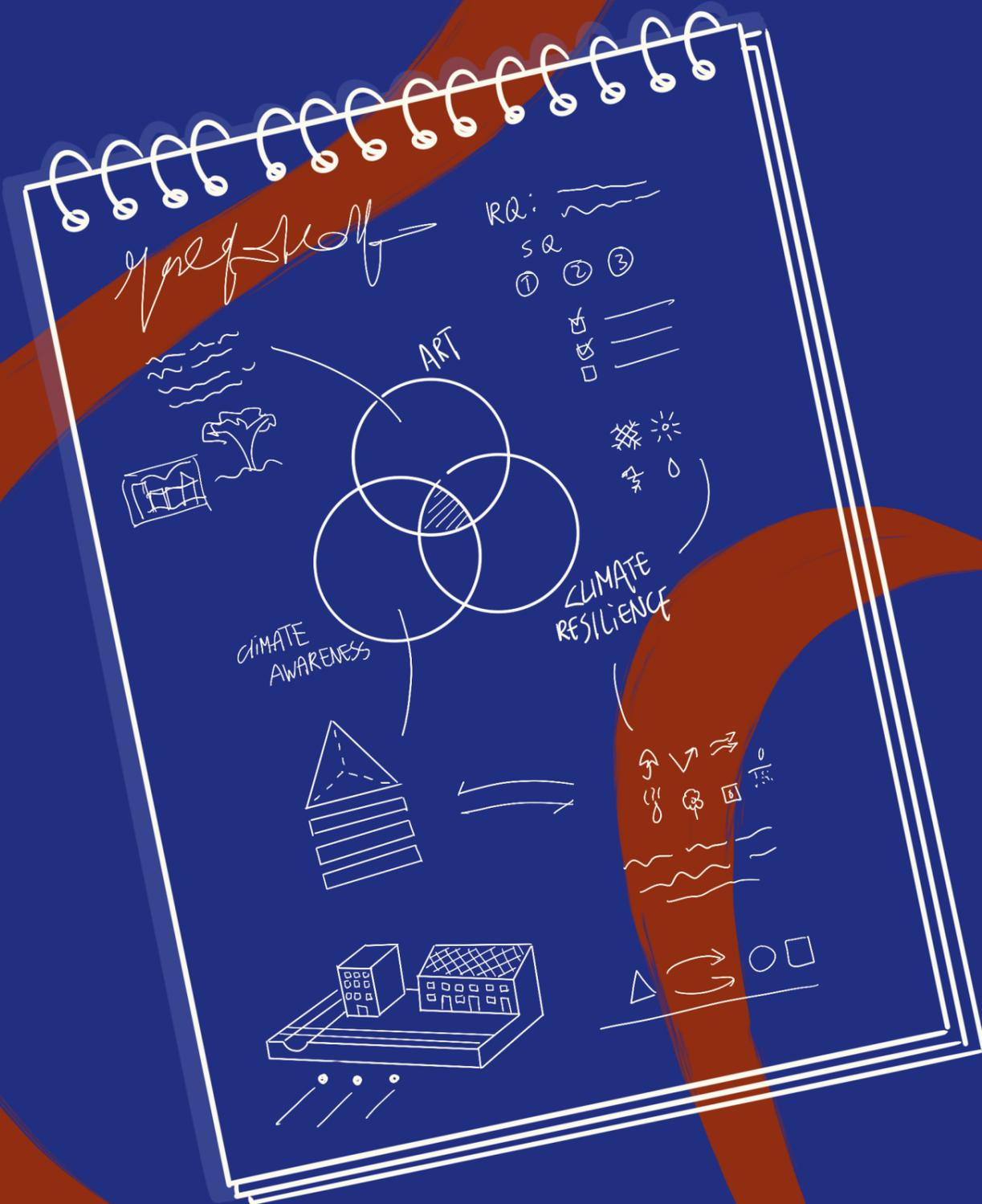
How can a street design concept integrating **art in public space**, enhance **climate resilience** and create **climate awareness**?

Several sub questions emerge from this main research question:

- SQ1** Which visible **climate resilient** interventions can be implemented in public space?
- SQ2** How can climate interventions create **climate awareness** in public space?
- SQ3** How can **art in public space** enhance **climate resilience** and create **climate awareness**?

CHAPTER 2 THE APPROACH

The Sketch



CONCEPTUAL FRAMEWORK

While climate change poses urgent challenges, such as heat stress, flooding, and drought, to the quality and functioning of public space, this thesis explores the development of climate-aware streets as the objective to address the challenges. By means of the creation of a public space design concept situated at the intersection of climate resilience, climate awareness, and art in public space, this thesis aims to illustrate an integrated approach to achieve the objective (diagram 2.1). The awareness mechanisms, experience, engagement and knowledge, serve as a framework to visualise generated awareness through both climate resilient interventions and art examples. These mechanisms structure the street design concept in a layered approach that collectively support a more resilient, understandable, and communicative public space.

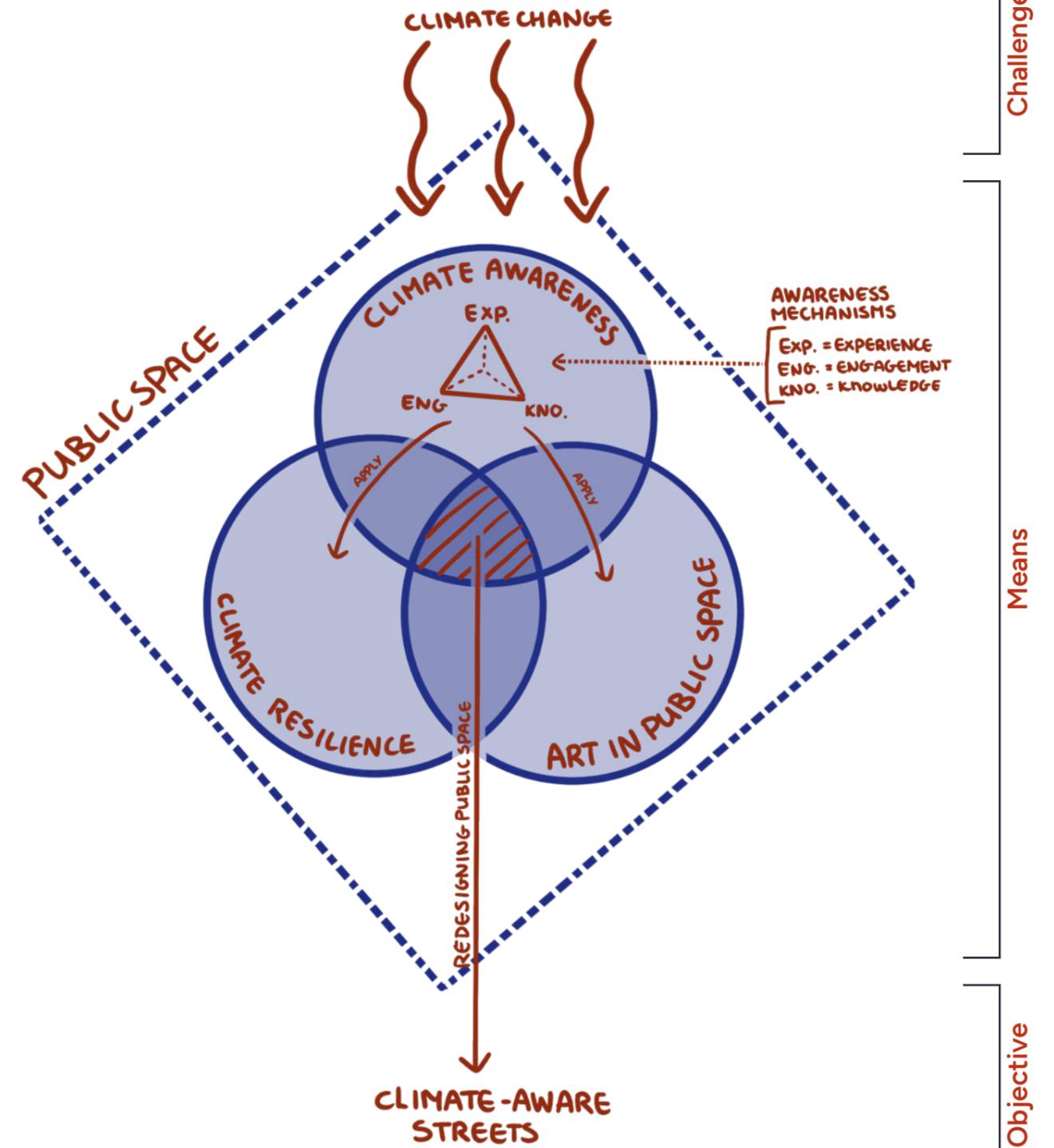


Diagram 2.1: The conceptual framework of the climate-aware street (Author, 2025)

METHODOLOGICAL FRAMEWORK

The methodological framework (diagram 2.2) illustrates the relationship between the concepts identified in the conceptual framework, the sub-questions guiding the research, the methods employed, and the outcomes created by those methods. The interconnections between the outcomes are visualised through arrows, indicating how the outcomes of one method inform or reinforce other.

Sub Questions:

1. Which visible climate resilient interventions can be implemented in public space?

2. How can climate interventions create climate awareness in public space?

3. How can art in public space enhance climate resilience and create climate resilience?

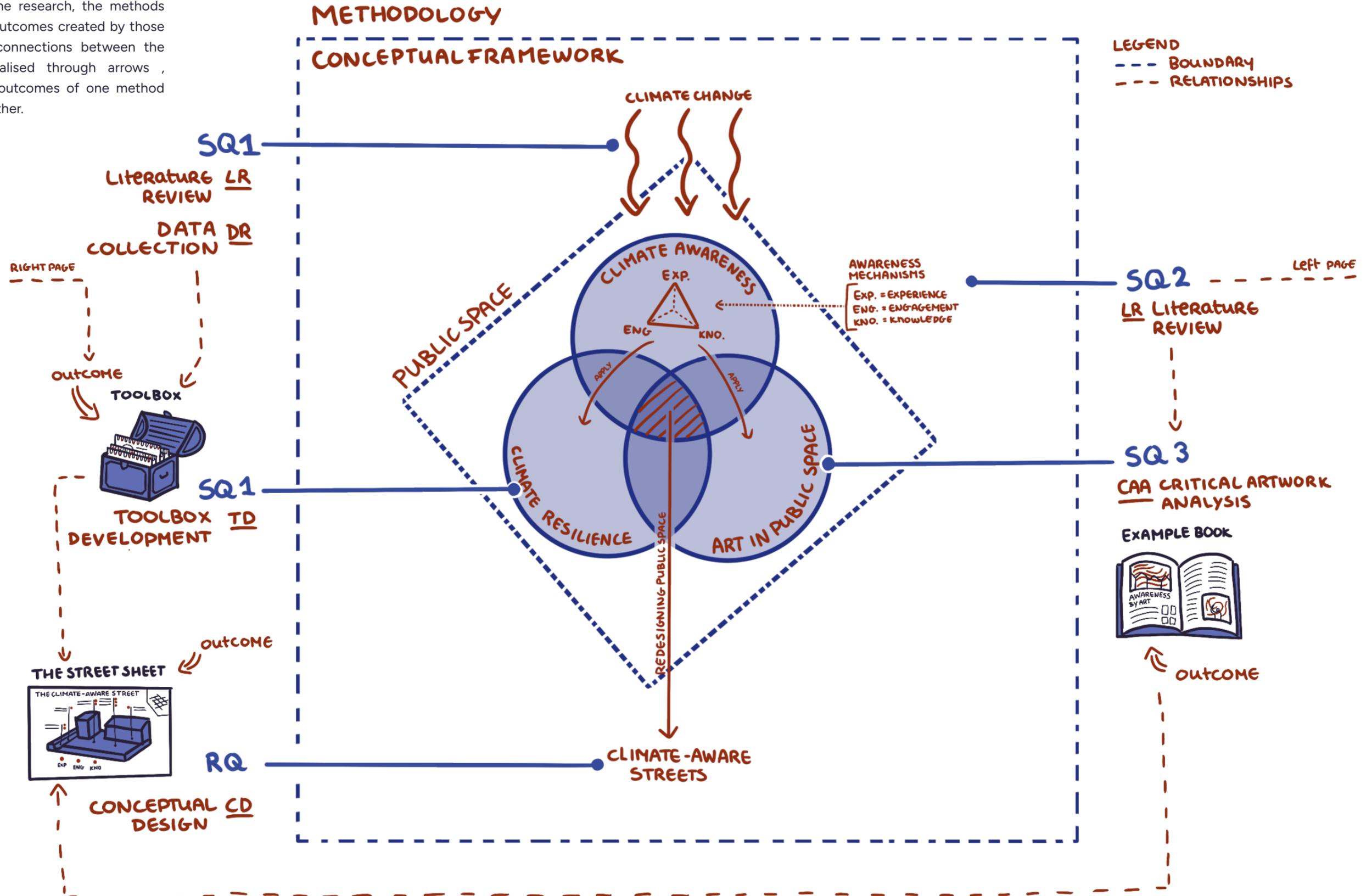


Diagram 2.2: The methodological framework of the climate-aware street (Author, 2025)

METHODOLOGY

To address the main research question and its sub-questions, a combination of methods was applied. This chapter outlines these methods and clarifies how each contributes to answering the respective sub-questions

SQ1:

Which visible **climate resilient interventions** can be implemented in public space?

DC Data collection

Purpose: gain and process data on climate challenges in Amersfoort

Approach: using websites as datasets from the 'omgevingseffectatlas' and 'atlas leefomgeving' to collect data on the climate challenges in Amersfoort

Output: A set of climate maps, such as heat stress, flood risk, drought, and distance to cool places to create a synthesis map of Amersfoort.

LR Literature Research

See SQ2

TD Toolbox development

Purpose: The toolbox will identify and systematize visible climate resilience solutions that address pressing challenges, particularly too hot and too wet climate extremes. It will serve as a practical resource for municipalities, artists, and citizens to understand, communicate and act upon climate challenges

Approach: A review of climate resilience measures will be undertaken, with a focus on too wet and too hot scenarios. Based on different elements, such as spatial scales, climatic processes, street typologies and climate awareness they are analysed and elaborated.

Output: A curated set of design tools that can be applied in street-level projects to enhance climate resilience and climate awareness. This tool is transferable on various contexts

SQ2:

How can climate interventions create **climate awareness** in public space?

LR Literature Research

Purpose: Literature research provides the theoretical foundation for the thesis by consolidating knowledge on climate change, climate resilience, climate awareness, art in public space, and national and municipal visions and policy documents. This framework ensures the feasibility and academic grounding of the project.

Approach: Relevant sources will be collected and analysed from academic publications, municipal documents, books, and newspapers.

Output: Theoretical background to the framework. And the foundation of the climate awareness mechanisms, experience, engagement and knowledge.

SQ3:

How can **art in public space** enhance climate resilience and create climate resilience?

CAA Critical artwork analysis

Purpose: Showing art in public space that contributes to climate resilience and create climate awareness that inspire individuals on the opportunities of art in public space.

Approach: Describing the art, analysing the climate resilience objectives, interpreting the awareness mechanisms and evaluating the value of the art in public space in terms of contributing to climate resilience and climate awareness.

Output: A book called awareness by art: examples, which displays 15 art installations that contributes to climate resilience and create climate awareness

RQ:

How can a street design concept integrating **art in public space**, enhance **climate resilience** and create **climate awareness**?

CD Conceptual design

Purpose: Developing a street design concept integrating art in public space to contribute to climate resilience and climate awareness

Approach: Merging climate resilient interventions in public space with climate awareness measures in an archetypal street design concept. By dividing the measures in the climate awareness mechanisms, the concept can be layered in different approaches.

Output: a street sheet of the climate aware street design concept that integrates climate resilient interventions, measures of climate awareness, and art in public space.

THEORETICAL FRAMEWORK

Climate Resilience

'The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organization, and the capacity to adapt to stress and change.' (IPCC, 2007)

This means that climate resilience refers to the capacity of urban systems, communities, and ecosystems to anticipate, absorb, adapt to, and recover from the impacts of climate change (Tyler & Moench, 2012).

Anticipation involves identifying and predicting risks such as heatwaves, floods, and droughts, though planners still struggle to address unexpected events (Opitz-Stapleton, 2011; Wardekker et al., 2010).

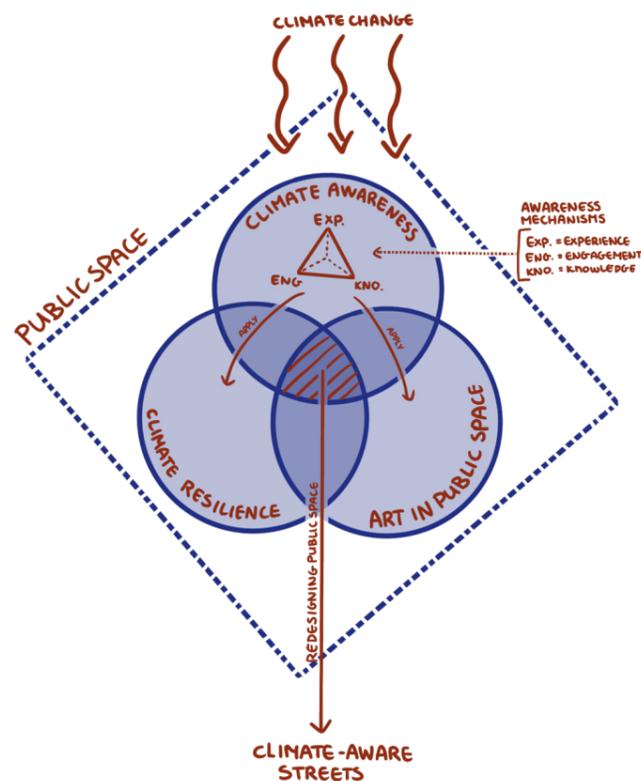
Adaptation requires behavioral, infrastructural, and policy adjustments, such as integrating urban greenery to mitigate heat and retain water (IPCC, 2018).

Absorption entails temporary buffering of shocks (Schleussner et al., 2021), while recovery and transformation emphasize rebuilding and learning for long-term resilience (IPCC, 2018).

Climate Awareness

'The concept refers to our understanding and consciousness about climate change. It is the foundation for actionable solutions, and it involves recognizing the causes, risks, and outcomes of climate change and global warming in addition with the solutions and implementations.' (Lenzholzer et al., 2020).

This provides a basic definition that clarifies the meaning of the term. In Iturriza (2020), a diagram is presented that illustrates the mechanisms underlying the creation of awareness (figure 2.1). This conceptualization forms the foundation for



how awareness is understood within the context of this thesis. For the purpose of enhancing resilience through art, the term attention is replaced with engagement, as it better aligns with the scope of the thesis.

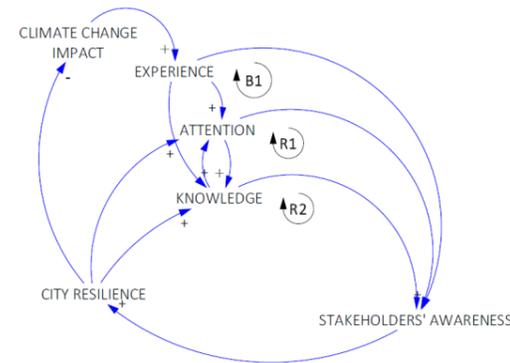


Figure 2.1: Awareness mechanisms in the development process (Iturriza et al., 2020)

'**Experience** refers to the lived real-life practices related to a specific problem' (Anguelovski et al., 2014).

'**Engagement**, formerly referred to as attention, reflects on the proactive behaviour someone acts upon climate challenges' (Sollberger et al., 2017).

'**Knowledge** refers to the quantity and quality of the information collected and analysed about a problem.'

Art

'There are no necessary and sufficient conditions for the definition of "art". The notion is an open concept, and their instances have "family resemblance".' (Weitz cited by Dickie, 1969)

The argument of the meaning of art is an ongoing phenomenon in the art world (Dickie, 1969). Elaborating that art has multiple meanings shows the possibilities of art. For example, art can function as a translator of emotion (Sălcudean, 2012), inspire individuals, invite reflection and raise awareness (Schuermans et al., 2012), act as

a catalyst for economic revitalization (Grodach, 2009), contribute to the creation of identity (Arandelovic, 2018), and foster social interaction and engagement (Grodach, 2009).

Several research emphasises the objective of art. Within this thesis art is seen as the relationship between technology, design and science (Emergence, 2023) which simultaneously work together for two specific purposes:

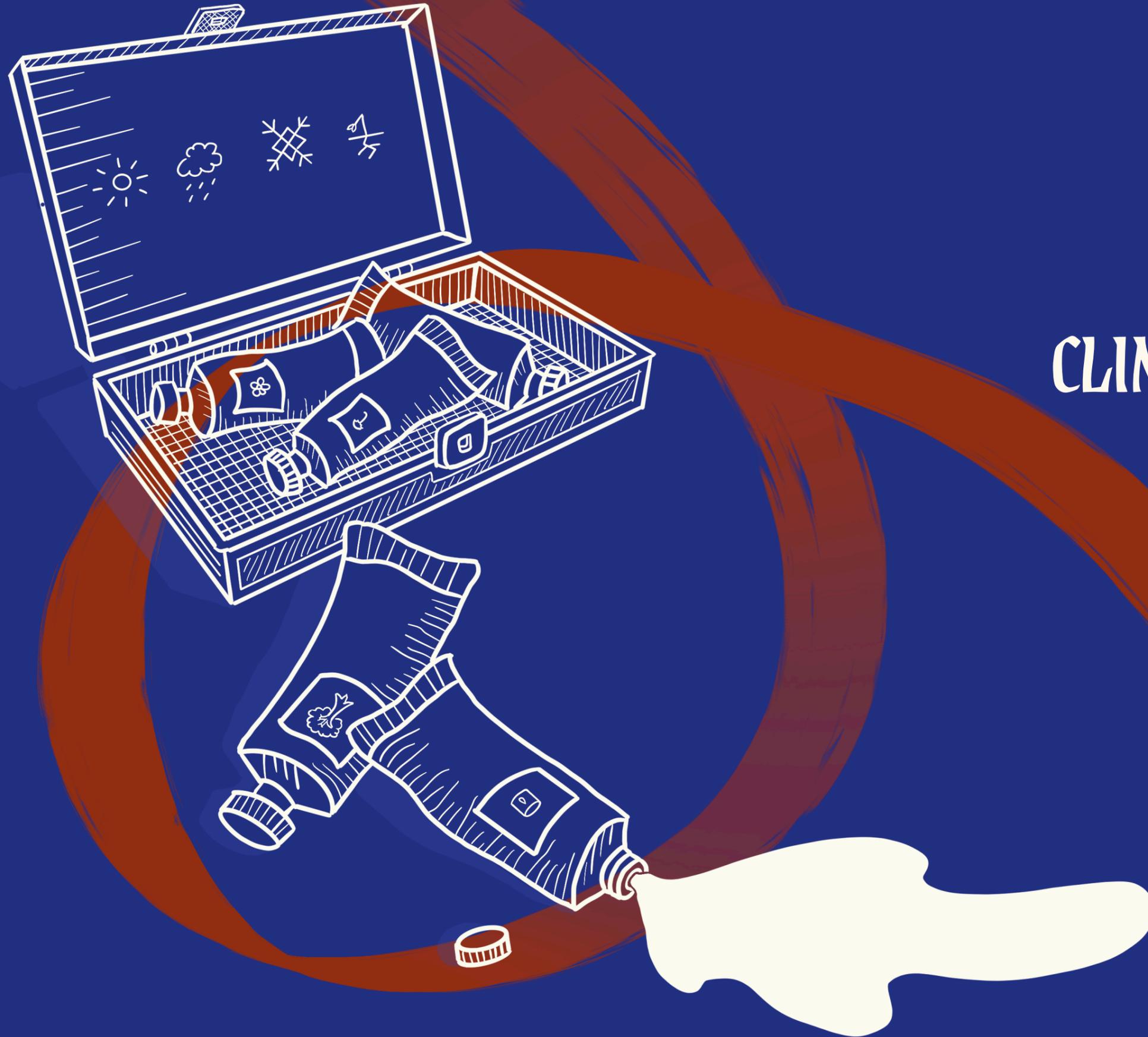
First, art is explored as a technology in itself, an intervention that can directly enhance climate resilience in public space. In this sense, art becomes not only a tool for communication, but also a medium for translating resilience into visible and experiential forms (Lee, 2021).

Second, art is used as a means to engage people with knowledge and experience, making the often abstract processes of climate change more tangible and showing citizens what role they can play in mitigating its future impacts (Gorseigner, 2016; Lee, 2021).

Public space

'Public space is an open, unobstructed space used for movement in the open air, with the public, semipublic, and private zones.' (Patil, 2015)

In other words, it is a space in between buildings in towns (Patil, 2015). Within the scope of this thesis public inside space is not included in the definition of public space.



CHAPTER 3

CLIMATE RESILIENCE

Paintbox with paint tubes

INFLUENCES ACROSS CLIMATE RESILIENCE

In the introduction, the problematization of climate change states that certain developments such as rising temperatures, wetter winters, drier summers, and more extreme weather events, will occur more frequently which makes daily life difficult (KNMI, 2023; van Gaalen et al., 2024). The three components temperature, precipitation and drought are reasons for these developments to happen. Pötz & Bleuzé (2012) made a manual called green-blue grids (groenblauwe netwerken) in which they give solutions to enhance climate resilience in cities. The climate solutions given in the book have been adopted and analysed in their potential to function as art in public space. From this a list of 38 interventions emerged that form the foundation of the toolbox. To analyse the interventions, influences that weaken or strengthen the developments in the public space, such as climate extremes, spatial scale, street typology and the climatic processes, are explained and elaborated to expand the field of opportunities and challenges for existing climate resilient interventions (figure 3.1).

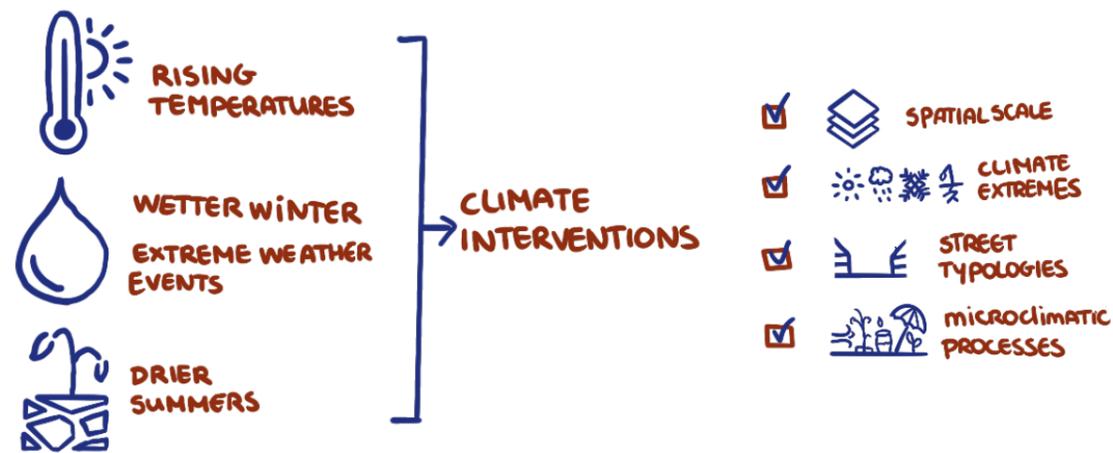


Figure 3.1: how the toolbox is formed (Author, 2025)

CLIMATE EXTREMES

Based on the KNMI scenarios, designing resilient cities requires addressing the extremes of wetter and drier weather conditions. These hydrological extremes can be considered alongside another set of climatic contrasts: warmer and colder temperatures (figure 3.2). While the KNMI scenarios emphasise the growing risks of heat, the potential weakening of the Atlantic Meridional Overturning Circulation (AMOC) raises concerns that colder conditions may also need to be taken into account (KNMI, 2023).

The AMOC, which includes the Gulf Stream, is a major ocean circulation system that transports warm surface water from the tropics northward into the North Atlantic, where it cools, becomes denser, and sinks into the deep ocean (KNMI, 2025). According to the 2021 IPCC report, there is straightforward evidence that the AMOC has weakened over the past century, most likely as a consequence of anthropogenic climate change. Increased freshwater input from ice melt and precipitation reduces the salinity and density of surface waters, weakening the

sinking mechanism and slowing the overturning circulation (KNMI, 2025). For the Netherlands, such a slowdown could lead to regional cooling due to the diminished transport of warm tropical waters towards northwestern Europe.

Design interventions must account for the full spectrum of microclimatic conditions, including wetter, drier, colder, and hotter environments. Given the scope of this thesis, the primary focus is placed on interventions addressing the too wet/too hot scenarios. Nevertheless, the other microclimatic conditions are also taken into consideration to evaluate how proposed interventions perform under varying circumstances.

In examining the challenges in urban areas, it is essential to first analyse the existing spatial configuration of the street. What elements in the street improve or deteriorate the scenarios. The key street profiles, related to Amersfoort are researched to analyse the potential in public space.

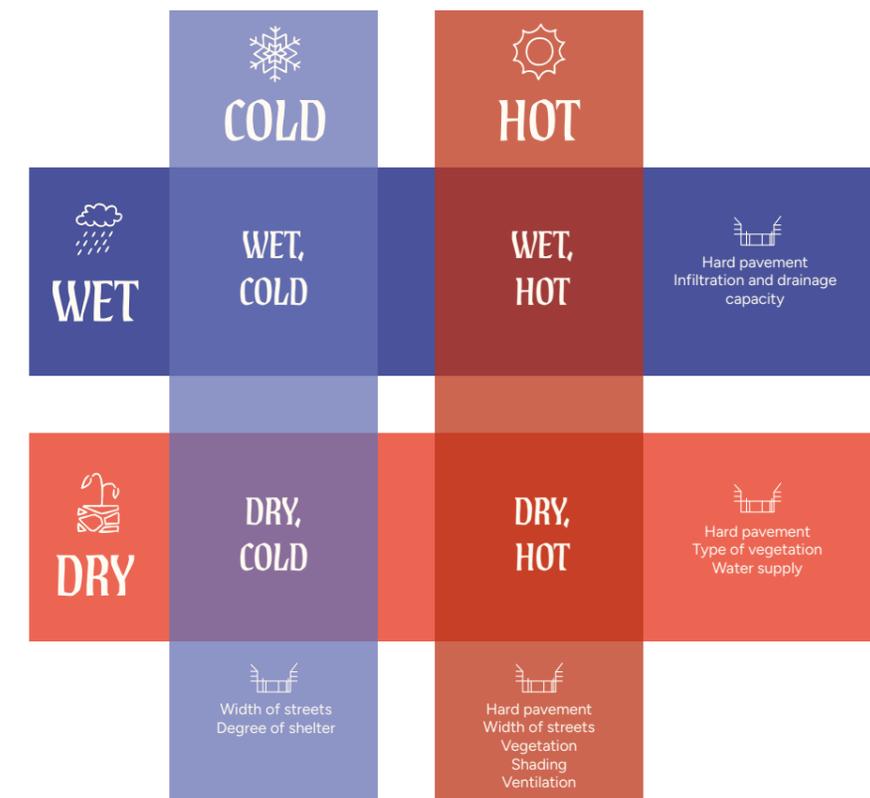


Figure 3.2: Climate scenarios from climate extremes: too hot, too wet, too cold, too dry (Author, 2025)

STREET TYPOLOGIES

Characteristics

Every urban typology has its own characteristics that influence how it responds to climate extremes such as heat and excessive rainfall. Research from the Amsterdam University of Applied Sciences has analysed different neighbourhood types (wijktypen) to understand their relationship with climate adaptation (Kluck et al., 2023).

The design of Dutch streets is closely tied to the historical period in which they were built. Each era in urban development introduced distinct spatial layouts and design principles, making streets from the same period recognisable across the country. These historical design patterns provide a framework for categorising neighbourhoods into different typologies.

Such typologies are highly relevant for climate resilience. By classifying neighbourhoods based on their characteristic features, it becomes possible to identify typical vulnerabilities to climate stressors and to formulate targeted adaptation strategies. For example, some neighbourhoods may lack sufficient green space to mitigate heat stress, while others may be prone to waterlogging due to high levels of paved surfaces (Kluck et al., 2017; Hove et al., 2014).

In the national typology map, fourteen distinct neighbourhood types have been identified, following the classification introduced by Kleerekoper (2016). This classification is based on factors such as year of construction, building height, housing density, percentage of green space, and the functional use of the built environment.

The Netherlands consists of fourteen street typologies (Kleerekoper et al., 2016)

Using this framework, the relative exposure of each typology to heat stress and water nuisance was calculated (table 3.1). As the purpose of this study is to explore design interventions, analysing all fourteen typologies in detail would be excessive, particularly since not all of them are equally relevant to the research

focus on climate-related challenges. To narrow down the scope, the selection was guided by the most common typologies present in Amersfoort and their levels of climate stress (appendix B).

From this analysis, three typologies were identified as both representative and complementary in relation to the broader patterns of extreme climate stress outlined in table 3.1. These are the garden village (tuindorp), the working-class district (volkswijk), and the garden city low-rise (tuinstad laagbouw). Drawing on Kleerekoper (2016), the defining characteristics of these typologies have been translated in table 3.2 (the full Dutch table is included in appendix A). These three typologies form the basis for the subsequent research.



Table 3.1: classification of neighbourhood typologies on the characteristics year of construction (bouwjaar), building height (hoogte), percentage of green space (groen), their contribution to heat stress (hitte) and water nuisance (wateroverlast) (Kluck et al., 2023)

Typologies	Construction period	Characteristics
Garden village (tuindorp)	1910-1930	Spacious front and backyard, 2-3 floors, lots of parallel parking, limited communal greenery, often no street trees
Working-class district (Volkswijk)	1930-1940	No front yard, little communal greenery, 2-3 floors
Garden city low rise (tuinstad laagbouw)	1945-1955	Open building blocks with a lot of green, 2-3 floors

Table 3.2: Characteristics of neighborhood typologies based on Kleerekoper (2016)

STREET TYPOLOGIES

Relation climate extremes

Urban areas differ in their resilience to climate extremes, depending on street morphology, surface materials, and the presence of green and blue elements. The Dutch typologies garden village (tuindorp), working-class district (volkswijk), and garden city low-rise (tuinstad laagbouw) illustrate how differences in street width, vegetation, and hard surfaces shape exposure to the four key climate-related stressors: too cold, too hot, too wet, and too dry.



Too hot

Heat stress results from high proportions of impermeable surfaces, limited ventilation, and insufficient greenery. Asphalt and concrete absorb and re-radiate solar energy, while broad street profiles without trees offer little shading (Kluck et al., 2020). Vegetation mitigates heat through both shading and evapotranspiration, lowering perceived temperatures by up to 15°C (Kleerekoper et al., 2024). Street orientation and ventilation corridors further determine whether warm air accumulates or disperses.



Too Wet

Water nuisance emerges when precipitation exceeds drainage and infiltration capacity. Elevated levels of surface sealing combined with limited infiltration provisions, such as bioswales, permeable pavements, or retention greens, lead to rapid runoff and localized flooding (Kluck et al., 2017; De Voogt et al., 2022b). The presence of green elements provides temporary storage and infiltration capacity, buffering peak rainfall and reducing surface water accumulation (Rovers et al., 2014; Kluck et al., 2017).



Too cold

Cold stress in urban streets is primarily influenced by the degree of shelter and the width of the street profile. Wide streets with little vegetation or built shading are exposed to

cold winds, amplifying discomfort during winter (Kleerekoper et al., 2024). Narrower streets, by contrast, provide more shelter and reduce exposure, although this may also limit sunlight penetration (De Voogt et al., 2022a).



Too Dry

Periods of drought expose the dependency of vegetation on adequate water supply. Hard surfaces prevent infiltration and groundwater recharge, while vegetation without sufficient irrigation is prone to desiccation (Kleerekoper et al., 2024). Larger green areas may also face water stress if soils lack retention capacity. Consequently, balancing green provision with water availability is central to long-term resilience.

Factors influencing the 4 scenarios



Figure 3.3: Relation of street typology garden city and climate extremes (Author, 2025)

Garden village (Tuindorp)

The garden village (tuindorp) is characterized by broad streets and private front gardens, with little collective greenery (figure 3.3). The resilience of the area depends strongly on how residents maintain their private plots: paved gardens decrease the amount of runoff and heat accumulation, while green gardens provide local cooling and retention (De Voogt et al., 2022a). Overall, the street profile exhibits multiple challenges, including excessive heat from surface sealing, water accumulation due to limited infiltration, and drought risks for poorly irrigated gardens.

Working-class district (Volkswijk)

The working-class district (volkswijk) represents a narrow, highly paved urban fabric with minimal private gardens (figure 3.4). Limited vegetation and shading intensify summer heat stress, while impermeable surfaces prevent infiltration, heightening flood risks (Willems, 2017). The narrow profile does provide shelter from cold winds but reduces solar exposure in winter, creating risks of cold discomfort. The cumulative effect is a high vulnerability to both thermal and hydrological extremes.

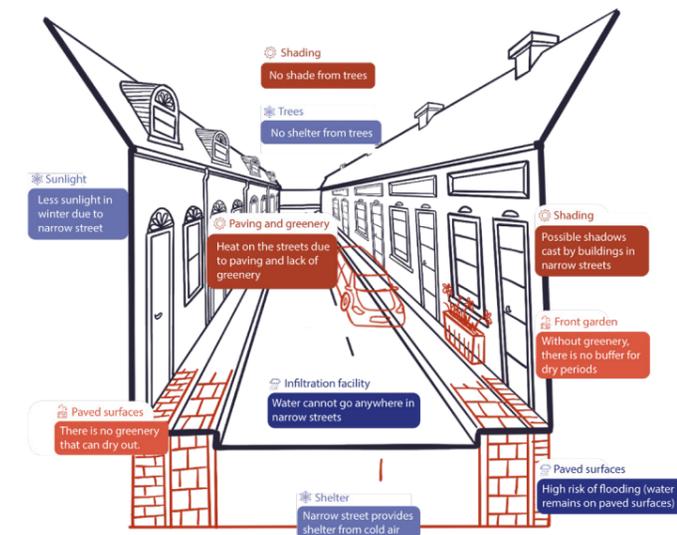


Figure 3.4: Relation of street typology working-class district and climate extremes (Author, 2025)

STREET TYPOLOGIES

Garden city low-rise (Tuinstad Laagbouw)

The garden city low-rise (tuinstad laagbouw) is more spaciouly designed, with wider streets and significant amounts of collective green space (figure 3.5). Shared green structures improve retention and infiltration, while tree cover provides shading and reduces heat stress (Kleerekoper et al., 2024). However, wider streets without building cover are more exposed to wind, potentially intensifying cold stress. While better equipped for infiltration and cooling than the other typologies, its broad surfaces also risk warming if dominated by pavement.

These typologies illustrate how urban form mediates climate exposure. Narrow, paved streets concentrate both heat and water, while broad, unshaded profiles are exposed to wind and solar gain. Vegetation emerges as a critical factor in addressing all four scenarios, providing shading, retention, and evapotranspiration, yet its effectiveness depends on integration with infiltration systems and long-term water availability. By tailoring strategies such as shading, permeable surfaces, and collective greenery to each typology, cities can enhance their climate resilience across diverse neighbourhoods.

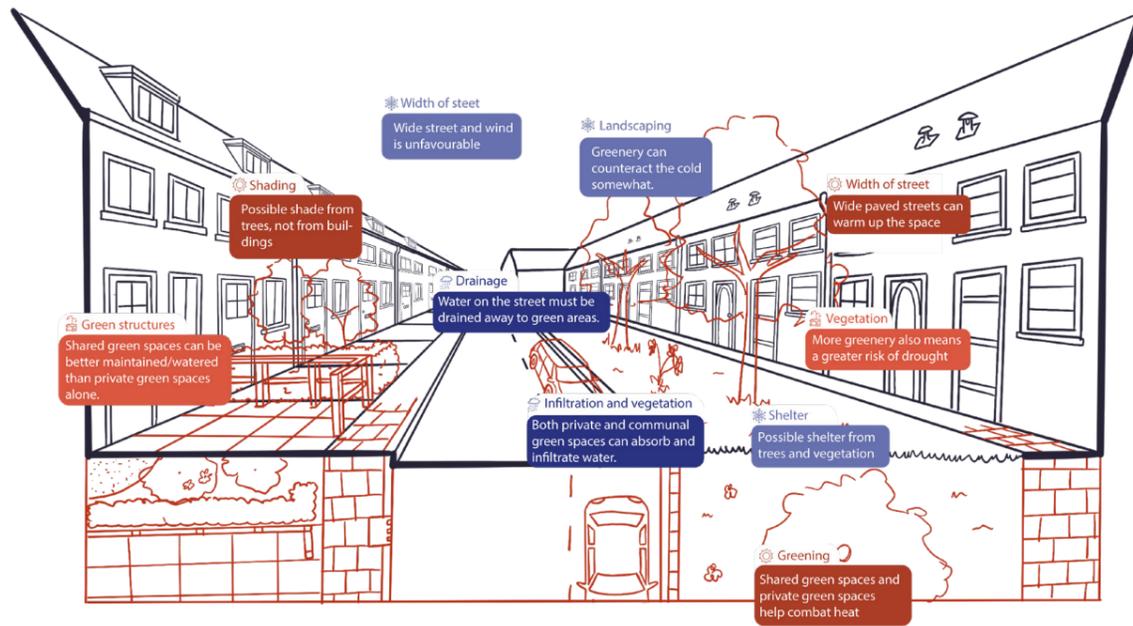


Figure 3.5: Relation of street typology garden city low-rise and climate extremes (Author, 2025)

WIND DIRECTION AND SUN ORIENTATION

Wind direction

The impact of wind and solar radiation in public space varies significantly depending on street orientation, width, and building height. For example, tall buildings can obstruct direct solar radiation at street level, while prevailing wind directions influence ventilation and thermal perception. In the Netherlands, easterly winds occur less frequently than winds from the southwest, which affects how heat is perceived in urban streets.

An analysis of wind directions between 1991 and 2020 (figure 3.6) illustrates the monthly distribution of prevailing wind directions (KNMI, 2021). Seasonal variation is clearly visible. Throughout the year, south-westerly winds dominate. During autumn and winter,

wind directions tend to shift more towards the south, whereas in spring, northeastern winds become more prominent. In summer, winds from the west and northwest occur more frequently. Projections by KNMI (2023) indicate that by 2100, wind directions will increasingly concentrate in the southwest.

Understanding street orientation in relation to wind is essential for designing public space that either promotes cooling during hot conditions or provides shelter during cold periods. Figure 3.7 translates the monthly wind roses into an abstracted seasonal diagram, combining the four seasons and highlighting the most frequent wind directions. Together, these directions account for more than 50%

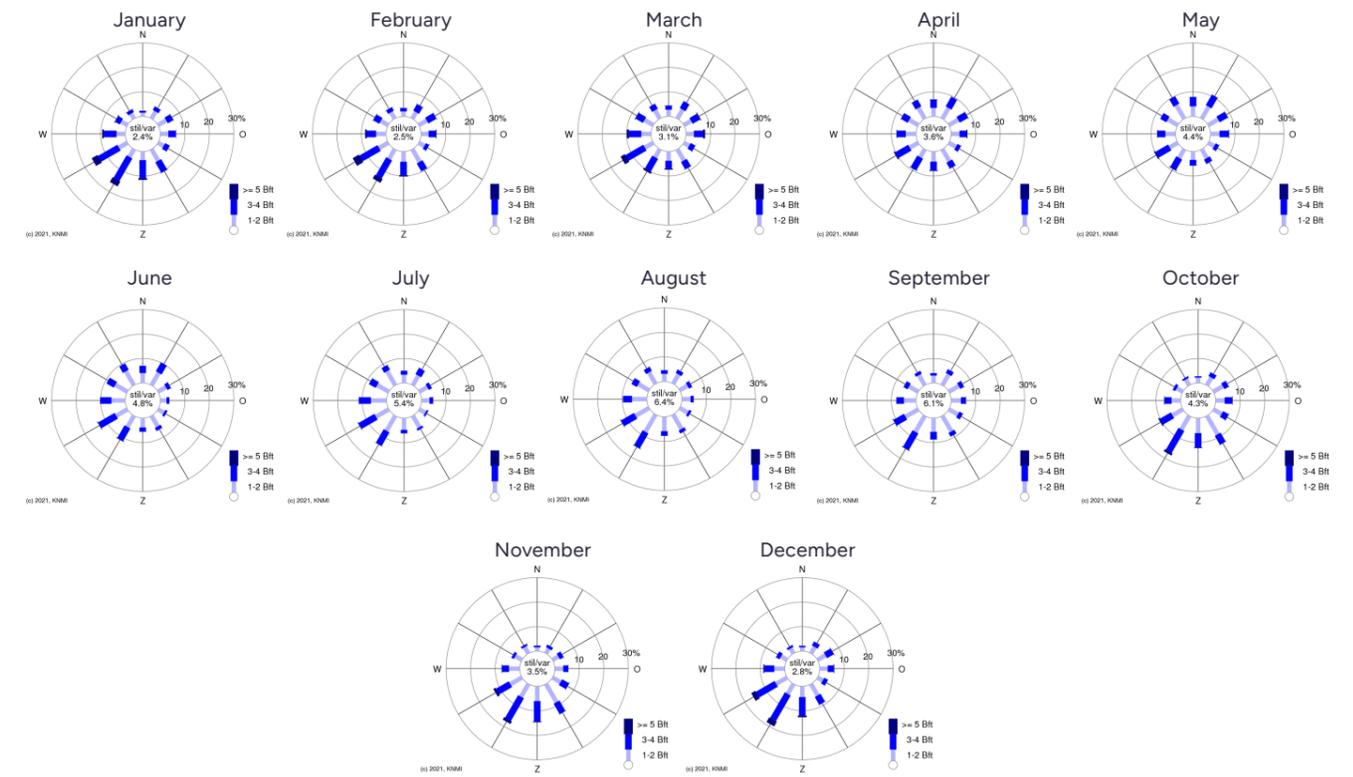


Figure 3.6: Long-term (1991-2020) average wind roses from the months jan-dec (KNMI, 2021)

WIND DIRECTION AND SUN ORIENTATION

of seasonal wind occurrence. A street profile is placed at the centre of the diagram to assess how different street typologies interact with prevailing winds.

The varying thickness of the wind vectors represents differences in wind strength, with winter winds exhibiting higher Beaufort scale values than those in spring. The central circle of

the diagram indicates the percentage of quiet conditions, showing that windless periods occur more frequently in summer and autumn than in winter and spring.

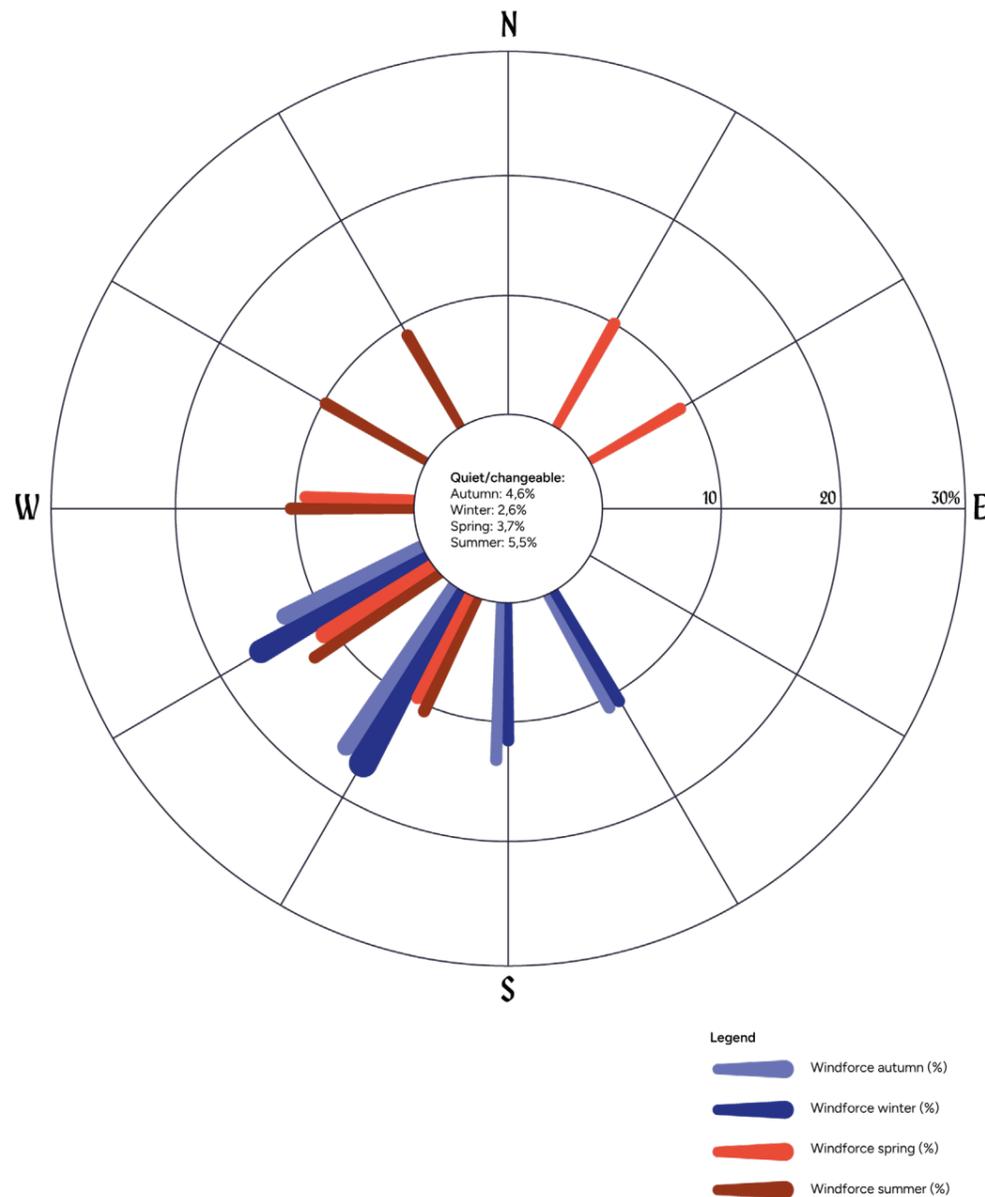


Figure 3.7: Wind rose of the average most common windforce of the four seasons between 1991 and 2020 (author, 2025)

WIND DIRECTION AND SUN ORIENTATION

Sun orientation

Street orientation also significantly influences solar exposure. In the Netherlands, the sun rises in the east and follows a southern trajectory before setting in the west, with daylight duration varying seasonally (figure 3.8). Winter is characterised by shorter daylight hours, while summer experiences extended periods of solar exposure. Solar altitude angles range from approximately 14.3° in winter to 61.2° in summer (Zonnewijzerkring, z.d.). The blue lines

explain the sun orientation during a day and the red lines connect the hours and the shift of the sun orientation due to shifting angles during the year. Consequently, street width and building height play a crucial role in determining the amount of sunlight reaching street level. Figure 3.9 illustrates how a street composition receives varying hours of sunlight across seasons and times of day.

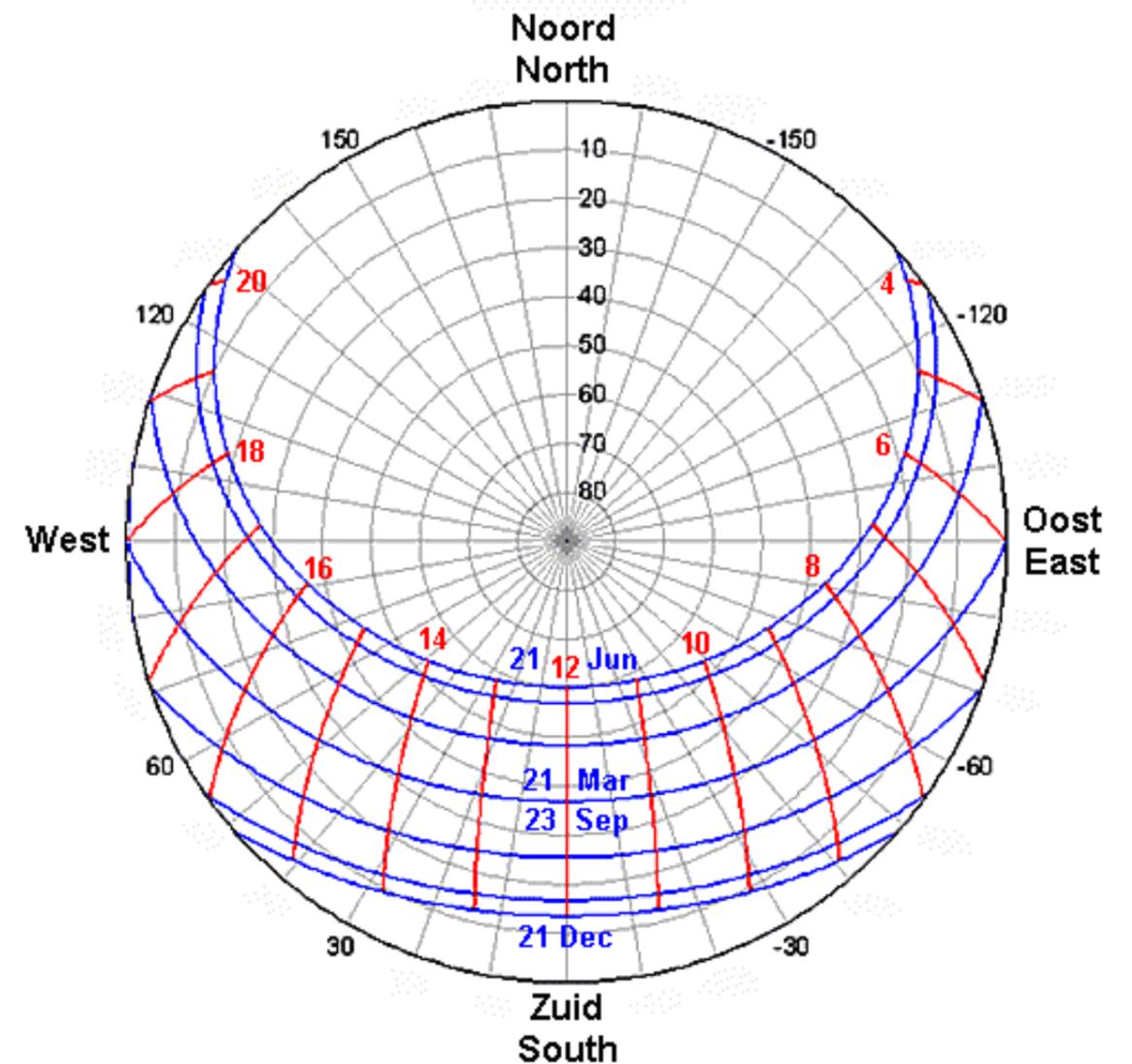


Figure 3.8: Solar orbits in North-Netherlands (de Zonnewijzerkring, z.d.)

WIND DIRECTION AND SUN ORIENTATION

By combining wind and solar analyses, this study introduces a design tool that allows users to position their own street orientations and evaluate the resulting microclimatic effects (figure 3.10). Wind patterns are represented horizontally, providing insight into seasonal airflow and potential ventilation or shelter, while solar exposure is visualised vertically to indicate seasonal variations in sunlight hours. Together, these elements support informed street design decisions aimed at improving thermal comfort and climate resilience.

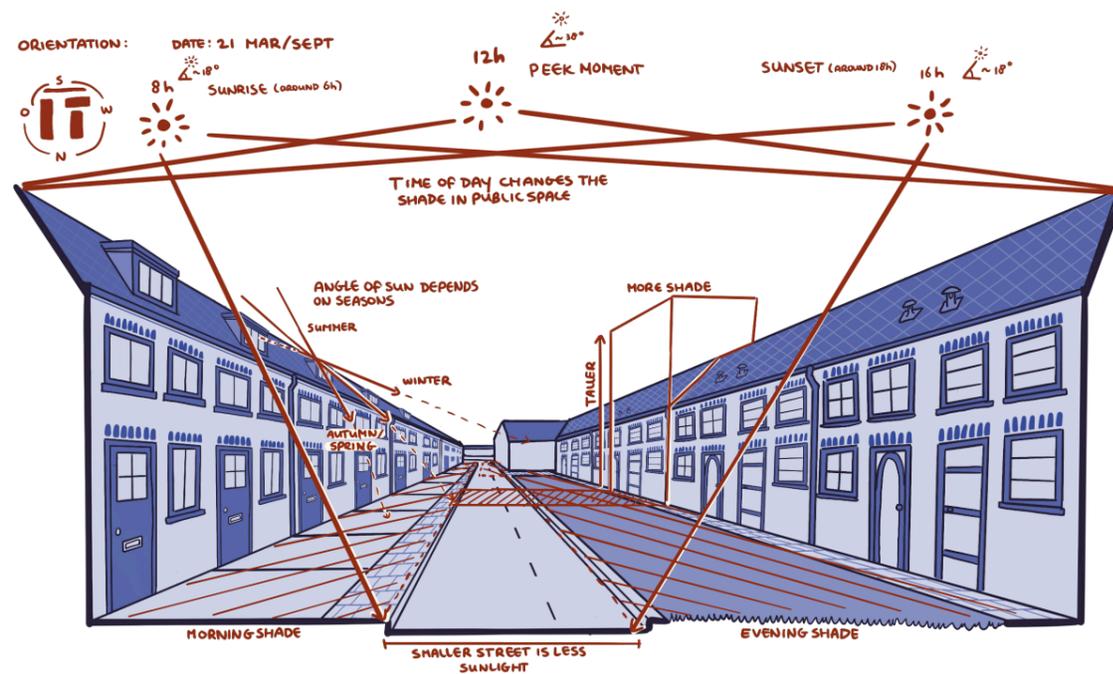


Figure 3.9: Analysis impact height of buildings, width of street, angle of the sun and time of day on the perception within a street (author, 2025)

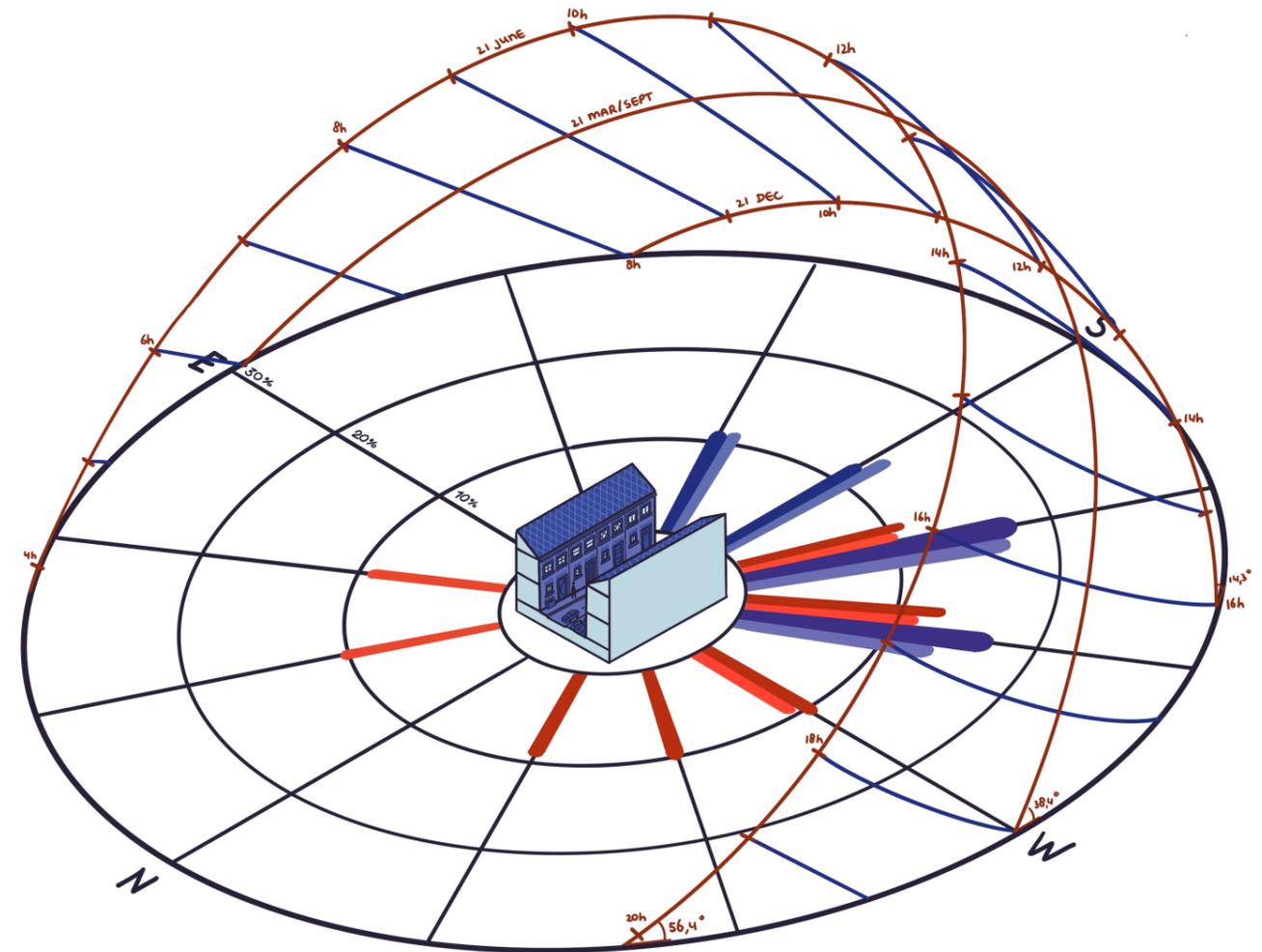


Figure 3.10: Wind direction (horizontal) and sun orientation (vertical) model. Street typology can be placed in the middle (author, 2025)

CLIMATIC PROCESSES

In the beginning of chapter 3, the extremes too hot, too wet, too cold, too dry are described as the climate challenges that public space has to deal with. In the thesis the scenario too hot-too wet is analysed and which climate processes would contribute to reducing the impact. The cause and objective are described to demonstrate where the climate processes come from.



Too hot extreme

Climate change has led to a growing number of extremely warm days and heatwaves in the Netherlands and elsewhere (Kluck et al., 2020). Urban environments intensify these effects due to their physical and structural characteristics (see appendix A for energy balance of the urban environment). Impermeable surfaces such as asphalt and concrete absorb and radiate solar energy, while dense building patterns limit ventilation and trap heat (Kleerekoper et al., 2024). The lack of urban greenery further reduces cooling through shade and evapotranspiration (de Voogt et al., 2022a). In addition, anthropogenic heat production from traffic, industry, and households contributes to elevated temperatures. Together, these processes result in urban heat islands, with

recorded differences of up to 8–12°C compared to surrounding rural areas (Hiemstra, 2018).

The health implications are severe. Heat

stress can cause dehydration, respiratory issues, cardiovascular strain, and in extreme cases premature mortality. During heatwaves, mortality rates can increase by more than 10%, disproportionately affecting elderly individuals and chronically ill patients (De Voogt et al., 2022a). With an ageing population, this public health risk will only intensify in the coming decades (Kluck et al., 2020).

On a global scale, the Paris Agreement (2015) aims to limit global warming to well below 2°C, preferably 1.5°C. However, recent projections suggest that global warming is likely to exceed 2°C, with scenarios pointing toward increases of 3–4°C by the end of the century (Kluck et al., 2020). In the Dutch context, the Planbureau voor de Leefomgeving (PBL) emphasizes that climate change is occurring faster than expected, with record-breaking heat events already surpassing earlier projections (van Gaalen et al., 2024). Although adaptation strategies are underway, policies addressing heat are less developed compared to those for flooding or drought. Without accelerated adaptation, urban populations will remain highly exposed to the risks of heat stress.

A 10% increase in urban greenery can reduce average air temperature by approximately 0.5°C

The primary objective of urban climate adaptation is to reduce both air temperature and perceived thermal stress, measured through the Physiological Equivalent Temperature (PET). Effective strategies aim at two complementary goals: lowering average urban air temperature through increased evapotranspiration, and reducing perceived temperature by creating shaded, cool spaces in the public realm (Kluck et al., 2020). Research shows that a 10% increase in urban greenery can reduce average air temperature by approximately 0.5°C, while shading can lower perceived temperature by 10–15°C (Kluck et al., 2020). Climate processes for reducing urban heat stress are divided in five categories: shading, evaporation, evapotranspiration, ventilation, and reflection.



Too wet extreme

Climate change increases both the intensity and frequency of heavy precipitation events.



Warmer air masses can store more moisture, leading to increasingly extreme downpours in both summer and winter (Willems, 2017).

Urban areas are particularly vulnerable because of their extensive surface sealing. Rainfall that cannot infiltrate rapidly overloads drainage networks, resulting in water accumulation on streets and in basements (De Voogt et al., 2022b). Impacts include property damage, traffic disruption, and economic losses, but also health risks if combined sewer systems overflow and release contaminated water (Rovers et al., 2014).

The primary objective in adapting cities to flooding is twofold: preventing direct damage from waterlogging while ensuring that excess water can be retained and reused to strengthen water availability during dry periods. The Dutch framework of “retain, store, and drain” (vasthouden, bergen en afvoeren) emphasizes the prioritization of local retention and above-ground storage before discharge into sewers or surface waters (De Voogt et al., 2022). Beyond technical measures, governance and public awareness are crucial. Research highlights an “awareness gap” between experts and citizens, where residents often underestimate rainfall risks and are unclear about their own responsibilities (Willems, 2017).

With the framework of retain, store and drain, the climate processes for reducing urban flooding are divided in water retention (retain and drain) and water storage.

Climatic processes

Too hot



SHADING



EVAPORATION



EVAPOTRANS-PORTATION



REFLECTION



VENTILATION

Too wet



WATER RETENTION



WATER STORAGE

CLIMATE INTERVENTIONS

Shading

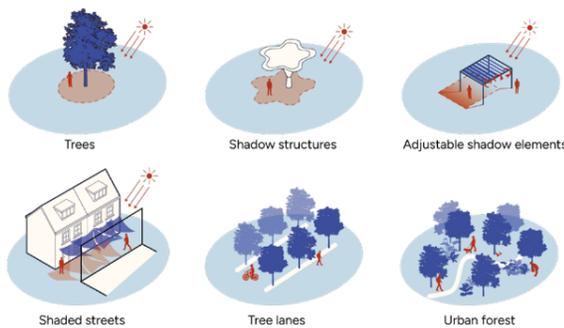
The principle of shading is based on blocking solar radiation, thereby reducing the amount of energy that reaches urban surfaces. When incoming radiation is blocked, the available solar energy to heat surfaces, such as pavements, building facades, or even human skin, decreases drastically (Pötz & Bleuzé, 2012). Studies demonstrate that shading can reduce incoming solar radiation by up to a factor of ten, resulting in significantly lower surface and body temperatures (Klok et al., 2019). Consequently, the difference in perceived temperature between a sun-exposed location and a shaded area beneath a tree can cool up to 19°C, making shading the most effective single measure to lower physiological equivalent temperature (PET) (Kleerekoper et al., 2024).

The temperature reduction under shaded area beneath a tree can cool up to 19°C

environments. By blocking solar radiation during peak hours and being removed in the evening, they allow heat stored in buildings and pavements to dissipate more effectively, thus accelerating nighttime cooling (De Voogt et al., 2022). This dual function, cooling during the day and releasing heat at night, enhances the resilience of urban areas to prolonged heat events.



Interventions



Shading can be achieved through a variety of interventions: trees, canopies, overhangs, pergolas and removable shading elements (See appendix A for table of shading elements). Trees are the most effective, as they not only block direct radiation but also contribute to cooling through evapotranspiration, further reducing air temperature (Kleerekoper et al., 2024). Dense foliage in summer provides optimal shade, while leaf loss in winter allows solar radiation to penetrate and contribute to passive heating of urban areas, thus supporting energy efficiency in both cooling and heating cycles. Built structures, such as overhangs, pergolas, or canopies, also provide shade and can be particularly valuable in narrow shopping streets where limited space prevents the planting of large trees (Kramer & Zonneveld, 2021).

Importantly, temporary or removable shading elements, such as parasols or textile canopies, can play a complementary role in urban

CLIMATE INTERVENTIONS

Evaporation

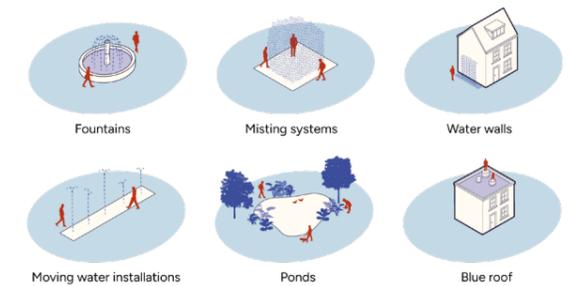
Evaporation from water surfaces is a smart way to reduce the perceived air temperature in public space. Urban areas typically experience 200–250 mm less annual evaporation compared to rural landscapes due to extensive surface sealing and limited vegetation (Kluck et al., 2020). Enhancing evaporation is therefore considered one of the most impactful strategies for lowering city-wide air temperatures (Kleerekoper et al., 2024).

Fine misting systems can achieve localized air temperature reductions of 0.7 to 3°C

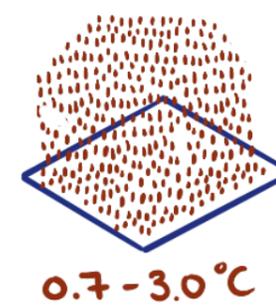
while fine misting systems can achieve localized reductions of 0.7 to 3°C (Ishii et al., 2009; Farnham et al., 2011; Yamada et al., 2008). Larger water surfaces in or around the city could noticeably lower the air temperature by 4°C (Völker et al., 2013)

The cooling effect of evaporation is most pronounced during the daytime, when solar radiation drives both direct evaporation and plant transpiration. A range of interventions can harness evaporative cooling. Water features, such as ponds, waterfalls, or fountains, reduce local air temperatures by increasing latent heat flux (Pötz & Bleuzé, 2012). The effectiveness of water bodies depends strongly on surface characteristics: systems that atomize water into small droplets, such as misting installations, create a larger evaporation surface area, thereby enlarge cooling capacity. Empirical studies indicate that open water can reduce local air temperature by approximately 1°C,

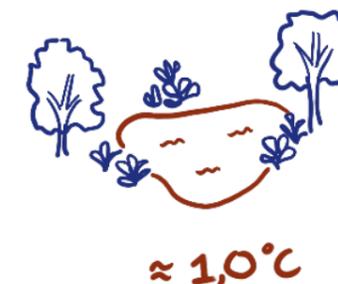
Interventions



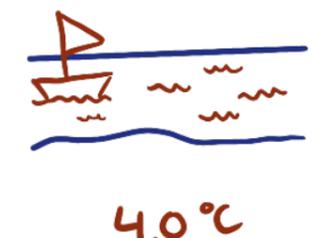
Fine misting systems



Small water surfaces



Large water surfaces



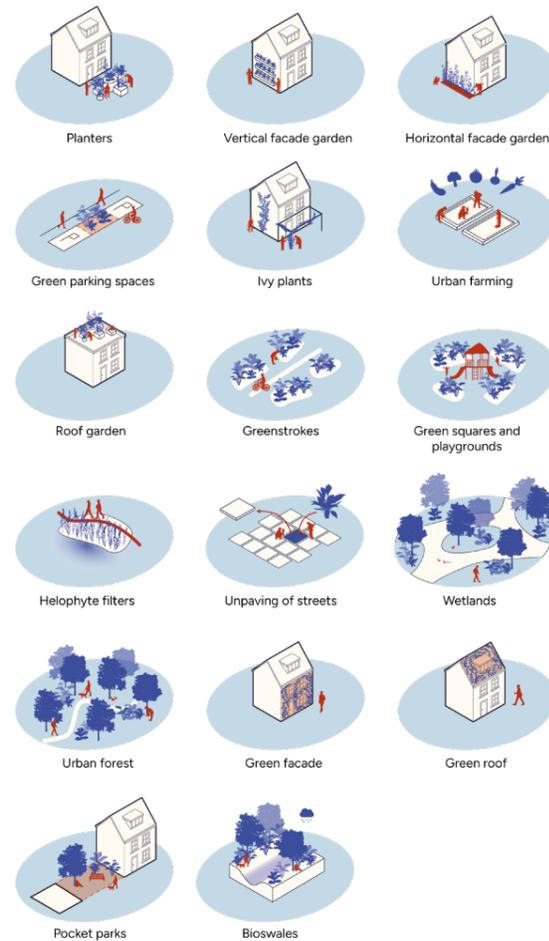
CLIMATE INTERVENTIONS

Evapotranspiration

Evapotranspiration from vegetation is among the most effective mechanisms for reducing air temperature in urban environments. Process requires a substantial energy input of approximately 2260 kJ per liter of water to transform liquid into vapor, energy that would otherwise contribute to heating surfaces and the surrounding air (Kluck et al., 2020). The process of evapotranspiration reduces the air temperature during the day. However, reducing heat storage in urban materials, evapotranspiration also delays nighttime heat release, mitigating the persistence of the urban heat island effect into the evening and night (De Voogt et al., 2022a). Therefore, only implementing green structures in cities will not contribute to lowering the air temperature over a long period of time.

Vegetated elements such as parks, tree canopies, lawns, and green roofs contribute to evapotranspiration-based cooling (Kramer & Zonneveld, 2021; Pötz & Bleuzé, 2012). Yet, the resilience of vegetation-based cooling depends on hydrological conditions. During drought or extreme heat, plants may limit transpiration to conserve water, thereby reducing their cooling capacity (van Gaalen, 2024).

Interventions



CLIMATE INTERVENTIONS

Ventilation

Urban ventilation could play a role in moderating heat stress by removing warm air and replacing it with cooler air masses from surrounding areas. In addition, to altering the thermal environment, wind directly affects human thermal comfort through convective cooling, thereby lowering perceived temperature (PET) even when air temperature remains unchanged (Kluck et al., 2020).

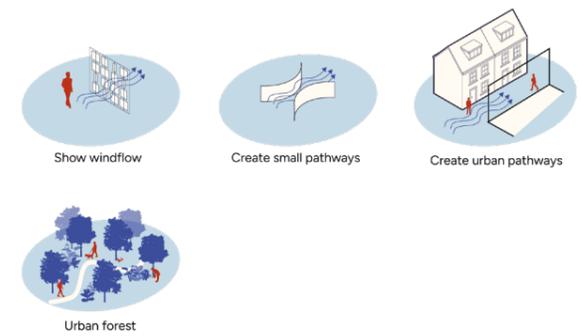
Achieving effective urban ventilation, however, is challenging. The most straightforward strategy is to preserve existing wind corridors and avoid blocking them with dense construction or high-rise developments (Kleerekoper et al., 2024). Large, open green-blue structures such as parks, rivers, and canals can function as ventilation channels, guiding airflow into urban areas (Pötz & Bleuzé, 2012). For example, a relatively straight river or canal with unobstructed banks can enhance wind penetration, producing localized cooling along the water's edge. Even a light breeze in these contexts, particularly when combined with shading from trees, can create comfortable microclimates (De Voogt et al., 2022a).

On a smaller scale, open surfaces such as sports fields, parking lots, or long, wide roads may also promote local air circulation (Pötz & Bleuzé, 2012). However, their effectiveness depends strongly on orientation relative to prevailing winds. In the Netherlands, prevailing winds during both summer heatwaves and winter cold periods often originate from the east. During heatwaves, wind speeds tend to decrease, reducing the natural capacity of ventilation to counteract extreme heat (Kleerekoper, 2016). Seasonal differences in wind direction and speed thus pose a challenge for urban design. While the potential for ventilation to lower air temperatures during heatwaves is limited

compared to shading or evapotranspiration, its importance lies in creating pathways for air exchange. Furthermore, combining ventilation solutions with other cooling interventions, to enhance thermal comfort at the microclimatic level.

Interventions

Combine with other cooling tools

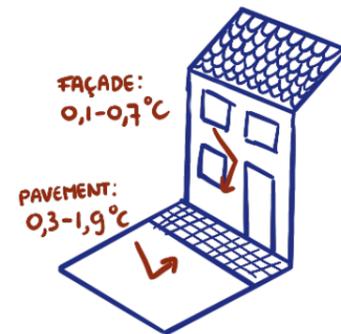
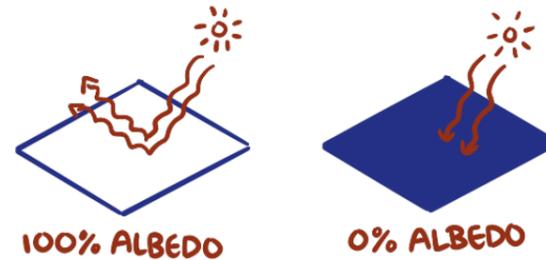


CLIMATE INTERVENTIONS

Reflection

The concept of reflection in urban environments is primarily expressed through albedo, the proportion of incoming solar radiation reflected by a surface. Highly reflective, or “white,” surfaces have an albedo close to 100%, whereas black surfaces approach 0% (Pötz & Bleuzé, 2012). Typical urban materials such as asphalt and dark roofing have an average albedo of only about 5%, in contrast to rural areas where surfaces average around 25% (Oke et al., 2017). This difference means that cities absorb far more solar energy than surrounding landscapes, intensifying the urban heat island effect. Increasing albedo therefore directly reduces the thermal load on surfaces and the subsequent re-radiation of heat into the urban atmosphere.

facades or pedestrians, potentially increasing perceived thermal stress (Kluck et al., 2020). Thus, reflective interventions are most effective in wide streets or large open surfaces where reflected radiation can dissipate.



Urban materials such as asphalt have an average albedo of only about 5%

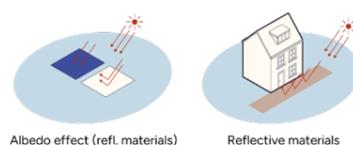
or “cool” roofs not only reduce rooftop surface temperature but also lower indoor heat gain, improving thermal comfort and decreasing energy

demand for cooling (Kramer & Zonneveld, 2021). Similarly, replacing dark asphalt with lighter concrete or reflective asphalt reduces surface heating, thereby limiting the longwave radiation pedestrians experience at street level.

However, reflective materials are not without drawbacks. Excessive reflection may increase glare and redirect solar radiation toward building

Interventions

Combine with other cooling tools



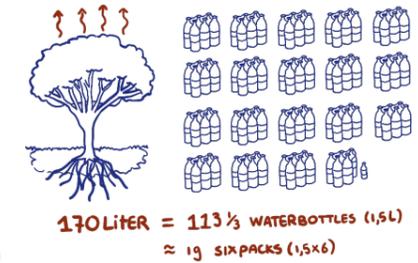
CLIMATE INTERVENTIONS

Water retention

Water retention refers to the capacity of urban landscapes to hold rainfall where it falls, delaying runoff and allowing gradual infiltration or controlled release into drainage systems. Vegetation plays a critical role in this process, both by intercepting rainfall and by enhancing infiltration into the soil. Roots improve soil permeability, enabling greater water storage in the subsurface and reducing the burden on sewer networks during extreme rainfall (Kleerekoper et al., 2024).

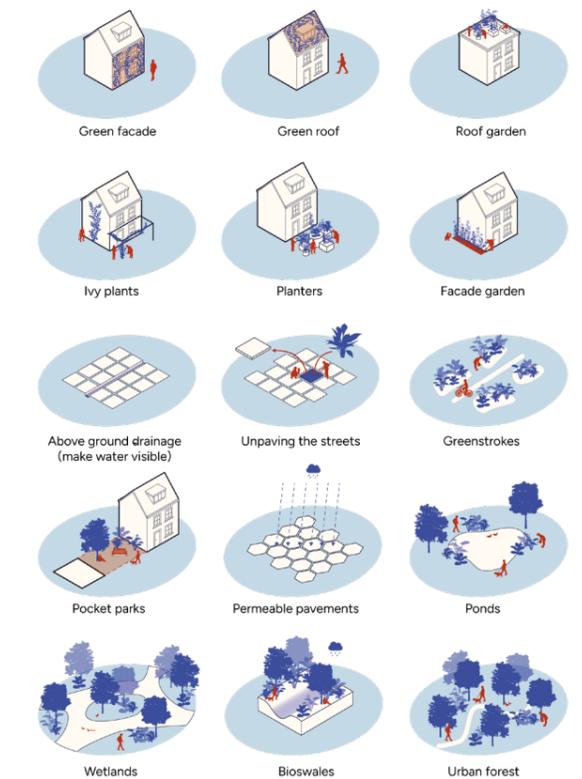
In urban settings, retention is particularly important because extensive paved surfaces accelerate runoff. By increasing vegetated areas, such as parks, tree-lined streets, green roofs, and bioswales, rainfall is absorbed and delayed, preventing peak flows from overwhelming sewer capacity (De Voogt et al., 2022). Such green elements can function as temporary buffers, holding water until it infiltrates or evaporates. A mature tree could for example evaporate up to 170 litres of water in one day (Waternet, 2019). Infiltration and evaporation not only reduce flooding risks but also contributes to maintaining groundwater levels and ensuring water availability during subsequent dry periods (Rovers et al., 2014).

The effectiveness of vegetative retention depends on soil quality, available space, and hydrological conditions. During prolonged wet periods, retention areas must be carefully designed to avoid waterlogging or damage to vegetation. Nonetheless, when properly maintained, vegetative retention provides a multifunctional solution: it mitigates urban flooding, enhances urban green space, and secures water resources for future dry forecasts.



A mature tree could for example evaporate 170 liter of water in one day

Interventions



CLIMATE INTERVENTIONS

Water storage

Water storage is a central strategy in climate-resilient urban design, aimed at capturing and temporarily retaining rainfall during extreme precipitation events (Pötz & Bleuzé, 2012). Unlike underground infrastructure, visible storage interventions in the public realm are multifunctional: they mitigate flooding, enhance urban liveability, and often contribute to ecological or social values.

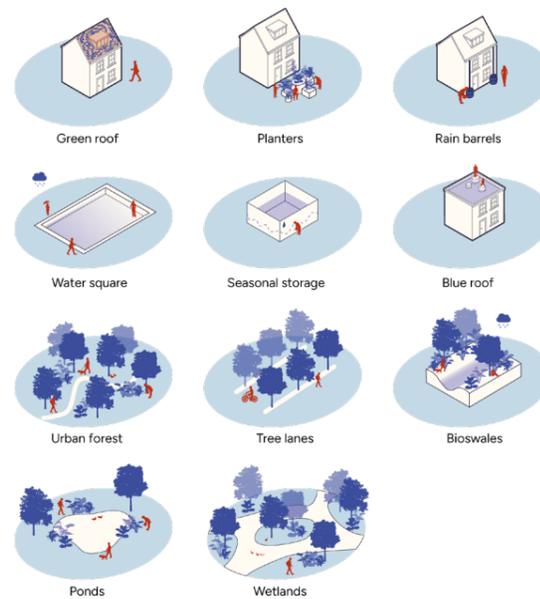
A prominent example of visible storage in cities is the water square. These multifunctional spaces operate as recreational plazas under normal conditions but transform into temporary basins during heavy rainfall, buffering excess water until sewer capacity is restored (Pötz & Bleuzé, 2012). By combining spatial quality with hydraulic functionality, water squares simultaneously reduce flood risk and create attractive urban environments (De Voogt et al., 2022b).

At the household or small-community level, rain barrels and façade- and roof-integrated storage systems collect roof runoff, reducing immediate pressure on drainage systems. Although their individual storage capacity is modest, widespread adoption across neighbourhoods can significantly reduce peak runoff volumes while also providing residents with water for irrigation or sanitation, thereby bridging resilience with water reuse (Willems, 2017).

Green infrastructure could also function as visible forms of storage. Bioswales and vegetated strips allow rainwater to collect temporarily before infiltrating into the soil or draining gradually into sewers (Pötz & Bleuzé, 2012). These interventions reduce surface runoff, improve groundwater recharge, and add green quality to dense neighbourhoods (Kleerekoper et al., 2024).

Visible storage measures are not without challenges. They require adequate space, careful integration with urban functions, and ongoing maintenance to ensure safety and usability. By making water flows visible, such interventions also raise public awareness of hydrological processes, narrowing the gap between citizens and experts in urban water management (Willems, 2017).

Interventions



TOOL FIELD

The climate processes, such as shading, evaporation, evapotranspiration, ventilation, reflection, water retention, and water storage, each contribute to improving climate resilience within the extreme scenario of too hot-too wet. To show the relationships between these processes, the tool field in figure 3.11 visualises their interactions. Remarkably, several interventions overlap across multiple climate processes, demonstrating how individual measures can simultaneously reduce heat stress and strengthen water management in public space.

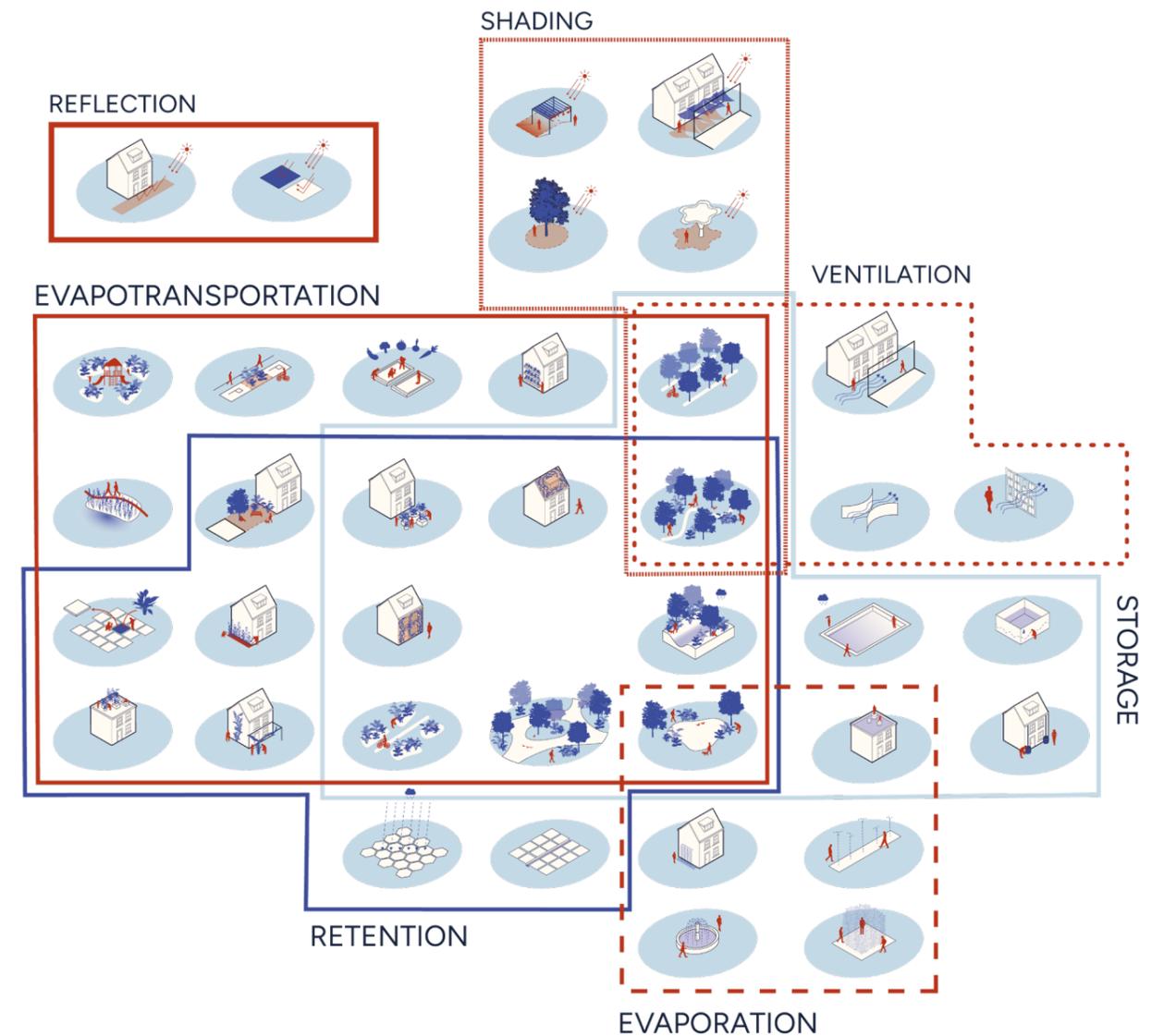


Figure 3.11: Tool field of the climatic processes (Author, 2025)

SPATIAL SCALES

Climate challenges differ on different scales. From the micro-meso-macro scale the objectives of climate resilience changes. On micro scale it talks about the details in the micro-climate of the direct surrounding of a public space, such as plots, materials, and vegetation. The meso-scale is the bridge between macro and micro scales, which connects to the interpretation of open public space. The macro-scale is the connection of all the different meso-scale elements through planning decisions (Ardıçoğlu, 2022).

Art in a sense, can be seen through these scale lenses as well. From small art on a plot in public space to a forming network of art infrastructures. The thesis uses the definitions object, ensemble and network for the different scales that define art in public space.



Network

Networks refer to macro-scale art installations, which are embedded within environmental and infrastructural systems of the urban environment, such as wetlands and an urban forest. From the human eye perspective, the art is less visual. However, it is linking the multiple sites and functions to create a resilient urban environment.

In examining the challenges in urban areas, it is essential to first analyse the existing spatial configuration of the street. What elements in the street improve or deteriorate the scenarios. The key street profiles, related to Amersfoort are researched to analyse the potential in public space.



Object

Objects refer to micro-scale art that function as singular interventions within the urban environment. This art focus on a specific element or objective, such as a rain barrel or a water fountain, highlighting a localized aspect of climate resilience. They operate independently from other art installations.



Ensemble

Ensembles represent to meso-scale art, which are in a cohesive compositions of multiple interconnected elements. These works integrate a certain level of interaction, which could encourage engagement and participation with users. Examples include adjustable shading elements or green playgrounds and squares. Through their scale and collective composition, ensembles influence broader spatial and social dynamics in the urban environment.

THE TOOLBOX

Figure 3.13 presents the final overview of the interventions in toolbox, in which all analysed interventions are displayed. They are organised according to their climatic processes and the spatial scale at which they operate. This provides a comprehensive overview of all climate resilient interventions integrated into the project. In a separate document the completed toolbox with all the tools is made tangible and the interventions are described on the spatial scale, climate processes, street typology, climate extremes, the triangle of awareness and the gradient of awareness, of the intervention. These two awareness models are explained in detail in chapter 4. Figure 3.12 presents an overview how the the tools are elaborated.

The objective with the toolbox is to synthesise the knowledge on climate resilience by defining a set of interventions that both support climate resilience and can be incorporated as forms of art in public space. Users can filter the interventions according to the factors discussed in this chapter, enabling them to identify the most suitable measures for their specific context.

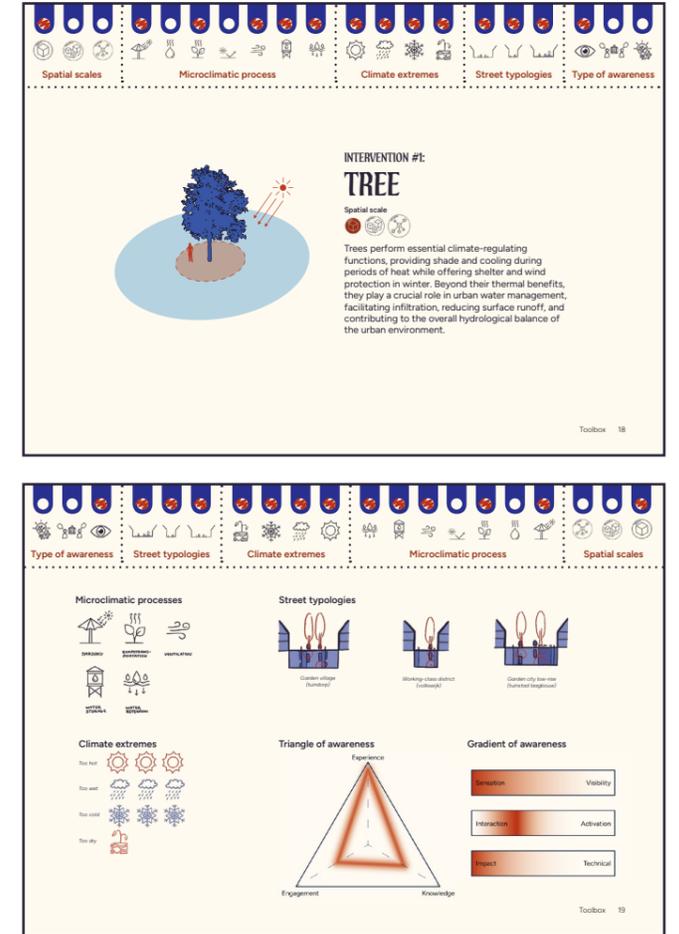
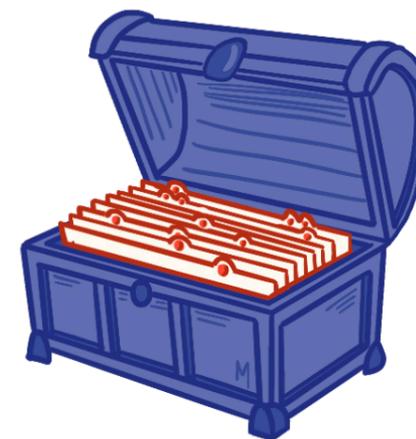


Figure 3.12: Overview of a tool from the toolbox. Front (top) and back (bottom) (Author, 2025)



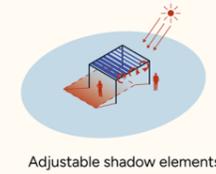
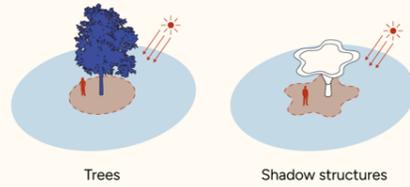
INTERVENTIONS TOOLBOX

OBJECT

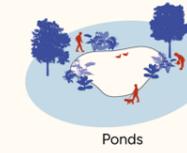
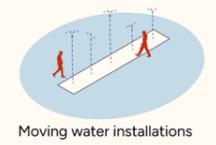
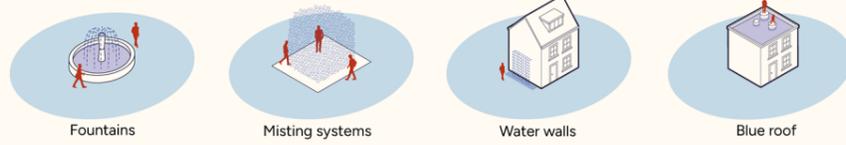
ENSEMBLE

NETWORK

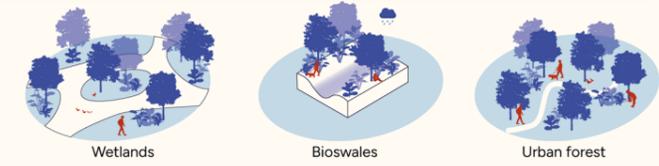
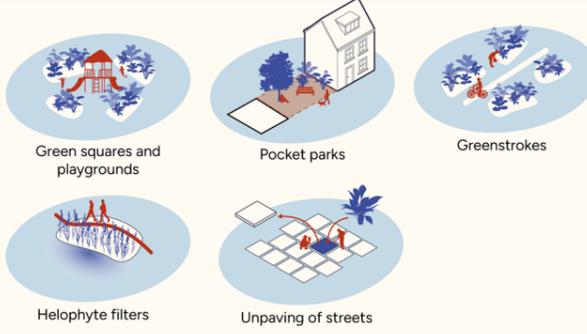
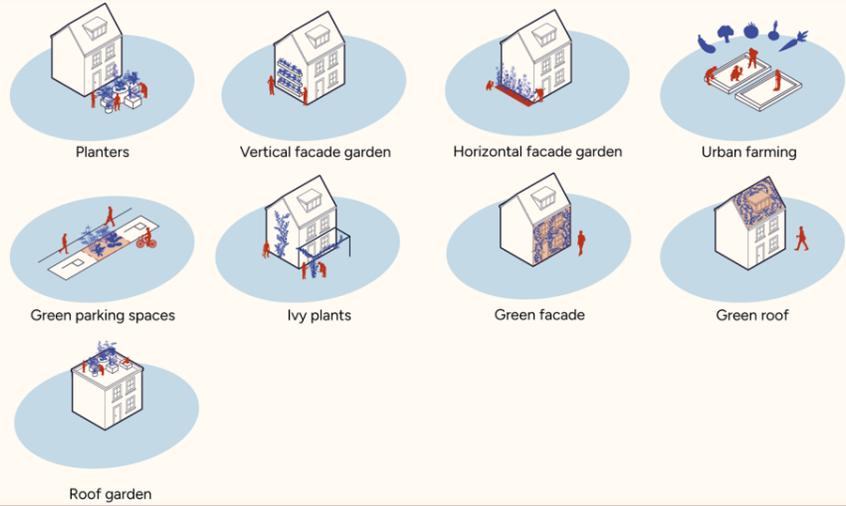
SHADING



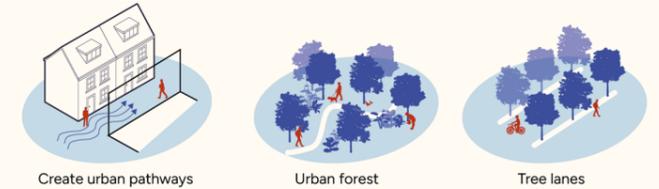
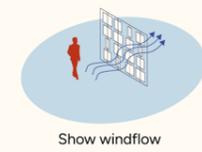
EVAPORATION



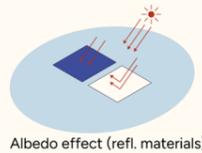
EVAPOTRANSPORTATION



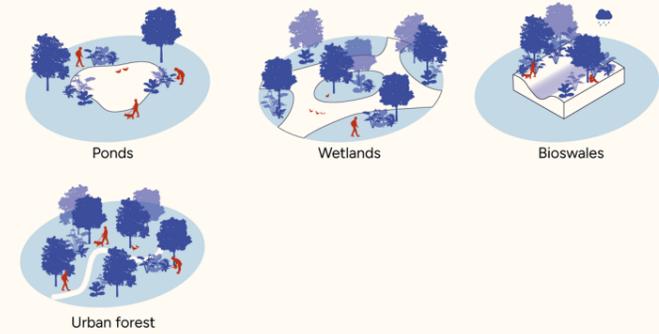
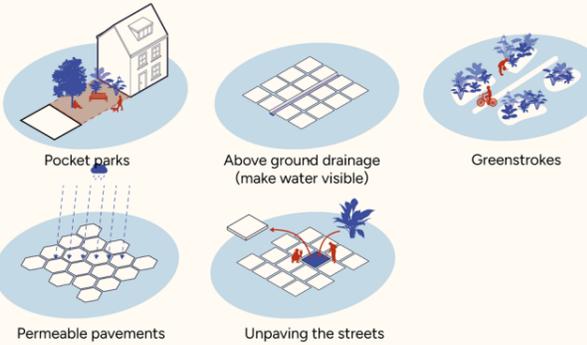
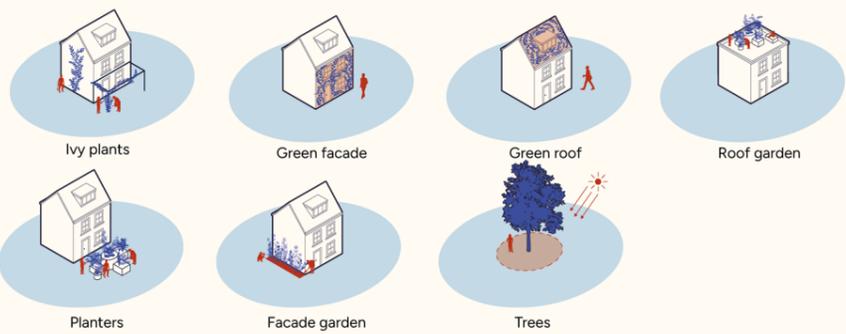
VENTILATION



REFLECTION



WATER RETENTION



WATER STORAGE

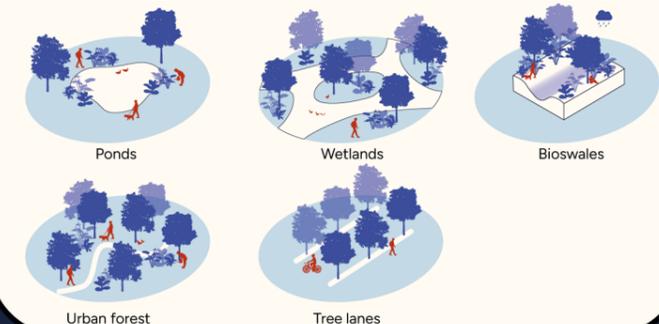
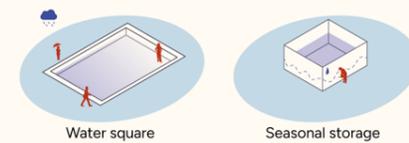
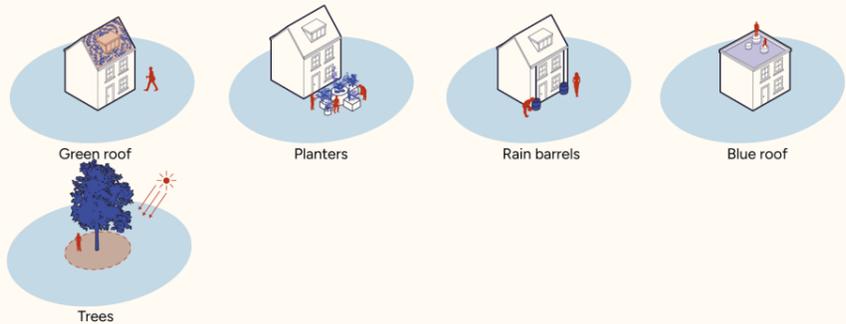
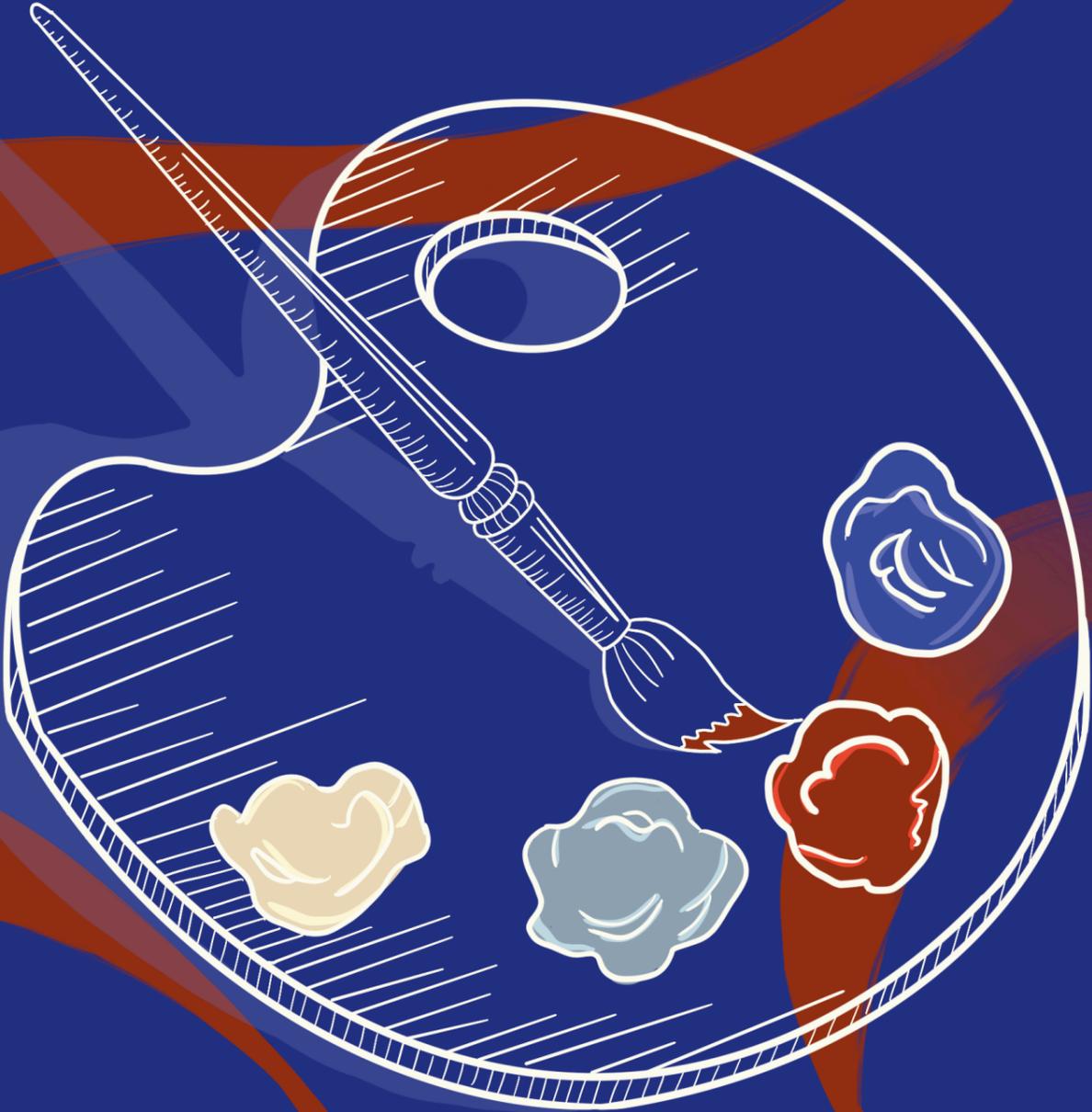


Figure 3.12: climate interventions divided by spatial scale (Author, 2025)

CHAPTER 4

CLIMATE AWARENESS

Colour palette



AWARENESS MECHANISM

Climate awareness begins with understanding the causes and consequences of climate change. As outlined in the introduction, human activity is one of the drivers of climate change (Riebeek, 2010; Kaddo, 2016; Nijs et al., 2019). Recent data show that 53% of Dutch citizens believe their behaviour has an influence on climate change (CBS, 2023). Moreover, individuals increasingly observe climate-related changes in their daily lives. According to another research from Akerlof et al. (2012) concludes that most frequently described individual experiences of global warming were shift in seasons, unusual weather conditions, declining lake levels, changes in animal and plants species, and variations in snowfall. These findings highlight that people possess some experiential awareness of climate impacts, even if their understanding remains incomplete.

Measuring climate awareness is a challenging task. Therefore, this thesis uses the framework of Iturriza et al. (2020) as the foundation to understanding climate awareness. In the framework the concept of climate awareness and conceptualised awareness-related behaviour show the interaction between three key mechanisms: experience, attention and knowledge (figure 4.1). Their definition of climate awareness is based on United Nations Office for Disaster Risk Reduction (UNISDR, 2009) which states that climate awareness is the process of informing citizens, increasing their understanding of climate risks, and demonstrating ways in which they can act to reduce the impacts of climate change. This thesis embraces these three mechanisms as a framework for creating climate awareness in public space. However, for the purpose of enhancing resilience through art, the term attention is replaced with engagement, as it better aligns with the scope of the thesis.

In addition, this research introduces a gradient for the three mechanism to clarify that

art interventions can have different objectives within the awareness mechanisms. These gradients illustrate the distinction between short-term and long-term forms of awareness that art can generate.

Experience relates to real life interactions with climate impacts (Anguelovski et al., 2014). It involves the dimensions of perception: feeling, hearing, and seeing. Experience can be lived in first- or second-hand. First-hand refers to experiences that are experienced by individuals themselves (Weber, 2010). For example, one could feel the intensity of heat in the street. Second hands arise when hearing someone has lived experience of climate related events, such as witnessing rising river levels. In this case, the gradient of experience ranges from art for sensation (short-term) to art for visibility (long-term).

Engagement, formerly referred to as attention, reflects on the proactive behaviour someone acts upon climate challenges (Sollberger et al., 2017). Higher engagement implies that more individuals act and participate in creating resilient streets. The gradient assembled for engagement spans from interaction to activation. Interaction invites and encourages individuals to engage with the art (short-term), whereas activation contribute to action and participation in resilience-building (long-term).

Knowledge refers to the quantity and quality of information available about climate challenges and solutions (Iturriza et al., 2020). Understanding climate impacts and resilience measures are essential for creating awareness. Therefore, the gradient is divided into impact to technical. Impact represent art that makes climate impacts and solutions visible, while on the contrary technical communicates the technology and systems of climate solutions.

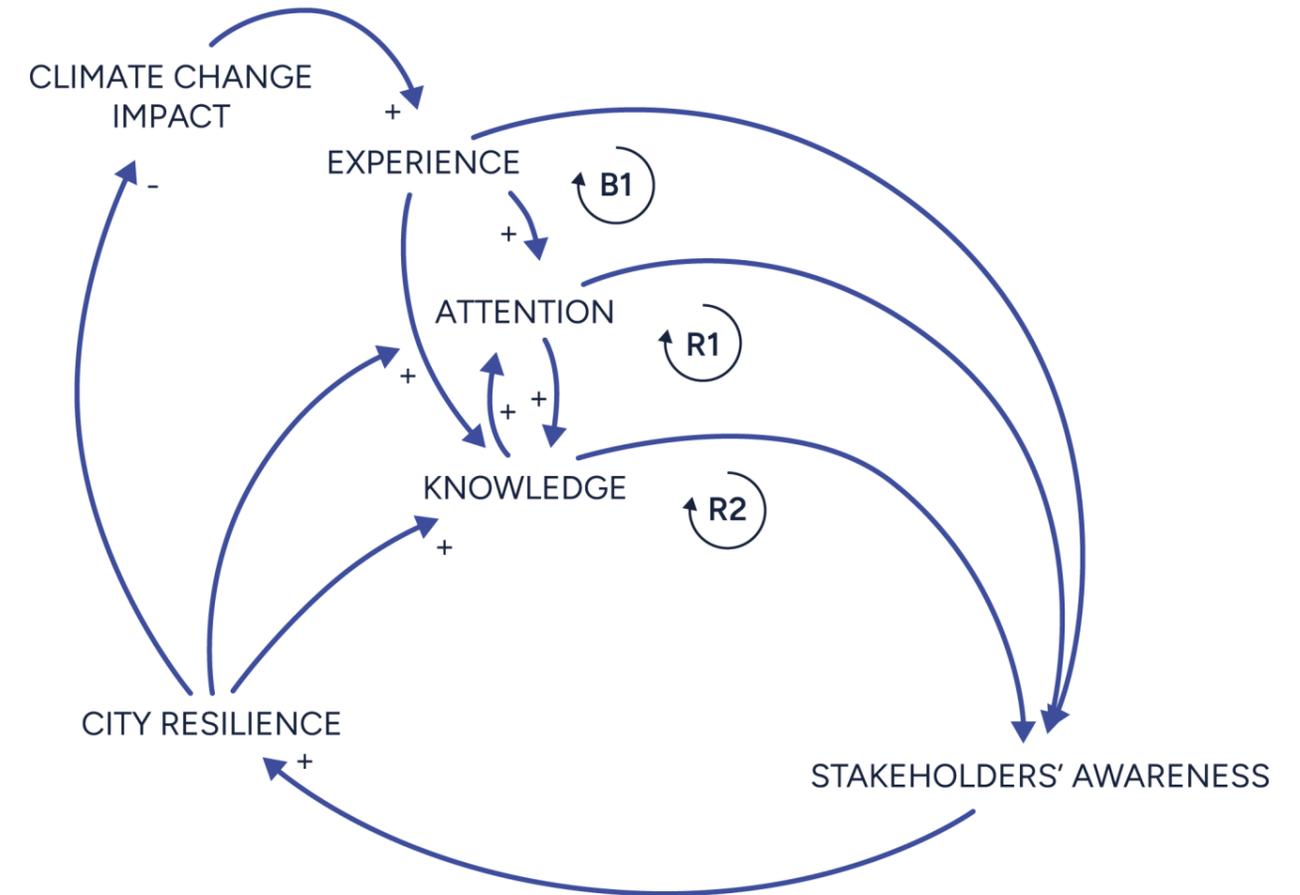


Figure 4.1: Awareness mechanisms in the development process (Iturriza et al., 2020)

AWARENESS MECHANISM

The three mechanisms are interrelated to each other, influencing one another in numerous ways. The plus (+) and minus (-) symbols along the arrows indicate whether a mechanism enhances or diminishes the effect of one another. The loop of B1, R1 and R2, show the relationship of the mechanisms.

Furthermore, the research of Iturriza et al. (2020) presents a schematic graph of the period in which the mechanism arises (figure 4.2). The graph is divided in four steps: reactive, active, proactive, and synergies. This timeline illustrates how awareness evolves through the interaction between climate events, resilience measures and the three mechanisms. Experience tends to occur during or immediately after the climatic impact, whereas engagement and knowledge develop during the active phase and continue to evolve over time. Together, these mechanisms contribute to the gradual building of climate awareness and resilience across multiple events.

To translate the framework into a system for this thesis, the mechanisms experience, engagement and knowledge, are conceptualised as a triangle, where the outer edges represent prominent levels of climate awareness for each mechanism. This model highlights that different climate interventions can generate similar overall levels of awareness while operating through different mechanisms. The gradient is a further extension of the model by illustrating the way in which climate awareness is created. Together, the triangle and gradient form a complete climate awareness framework, visualised in figure 4.3.

To apply this framework, all climate interventions described in chapter 3 were evaluated using both the triangle and gradient of climate awareness (figure 4.4). The results illustrate which interventions are most effective in generating experience, engagement, or knowledge.

For experience, interventions such as shadow structures provide sensory cooling by allowing users to feel reduced heat while visually perceiving blocked sunlight. Green strokes similarly generate experience by displaying ecological forms and biodiversity.

For engagement, climate interventions such as rain barrels or horizontal façade garden encourage citizens to participate in climate action. Both of the climate interventions contribute to social interaction, inspire neighbours, and strengthen collective responsibility for resilient public space.

For knowledge, climate interventions, such as vertical façade gardens and the albedo effect communicate technical information. Reflective versus non-reflective materials illustrate street materials influence thermal comfort, while vertical façade gardens demonstrate the climatic benefits of vertical vegetation and using plants.

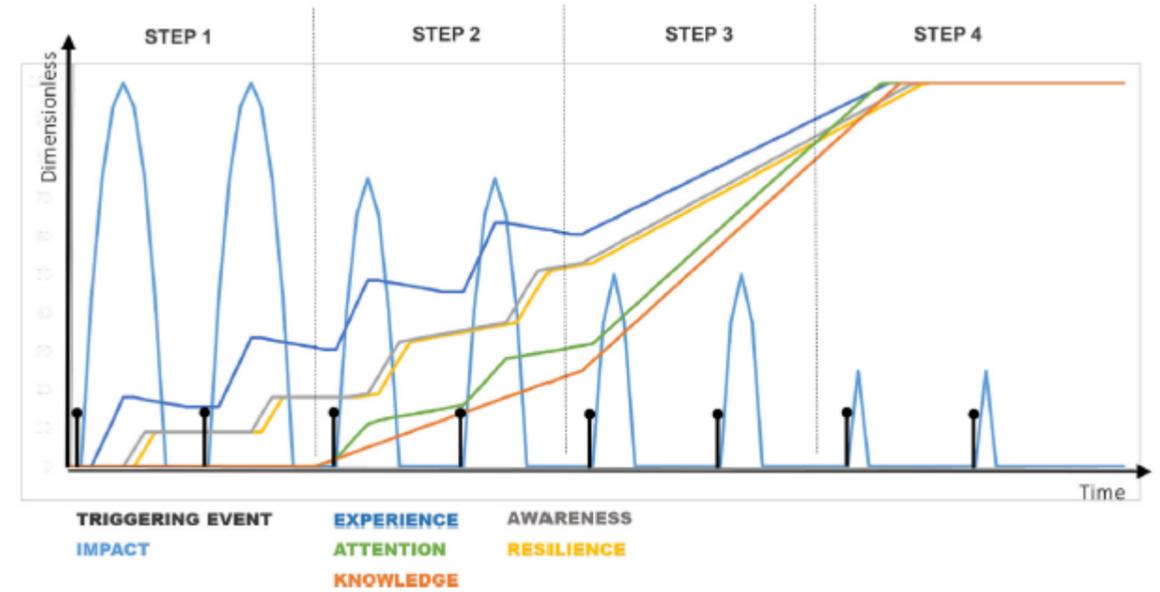


Figure 4.2: Awareness development graph (Iturriza et al., 2020)

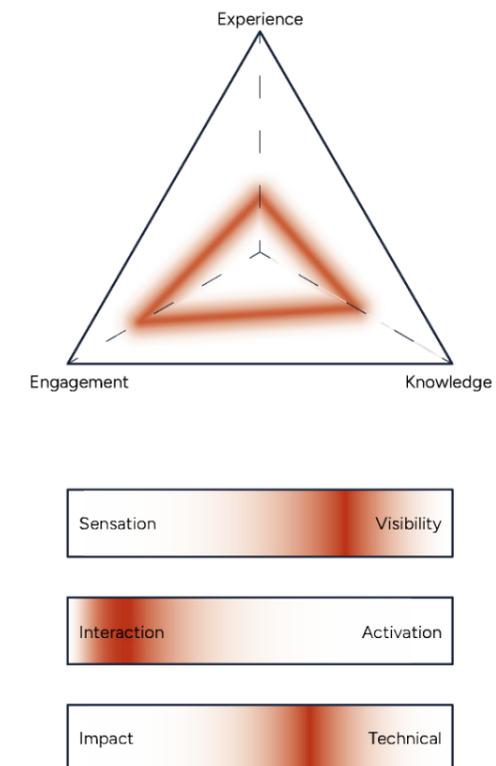


Figure 4.3: Triangle and gradient of climate awareness (Author, 2025)

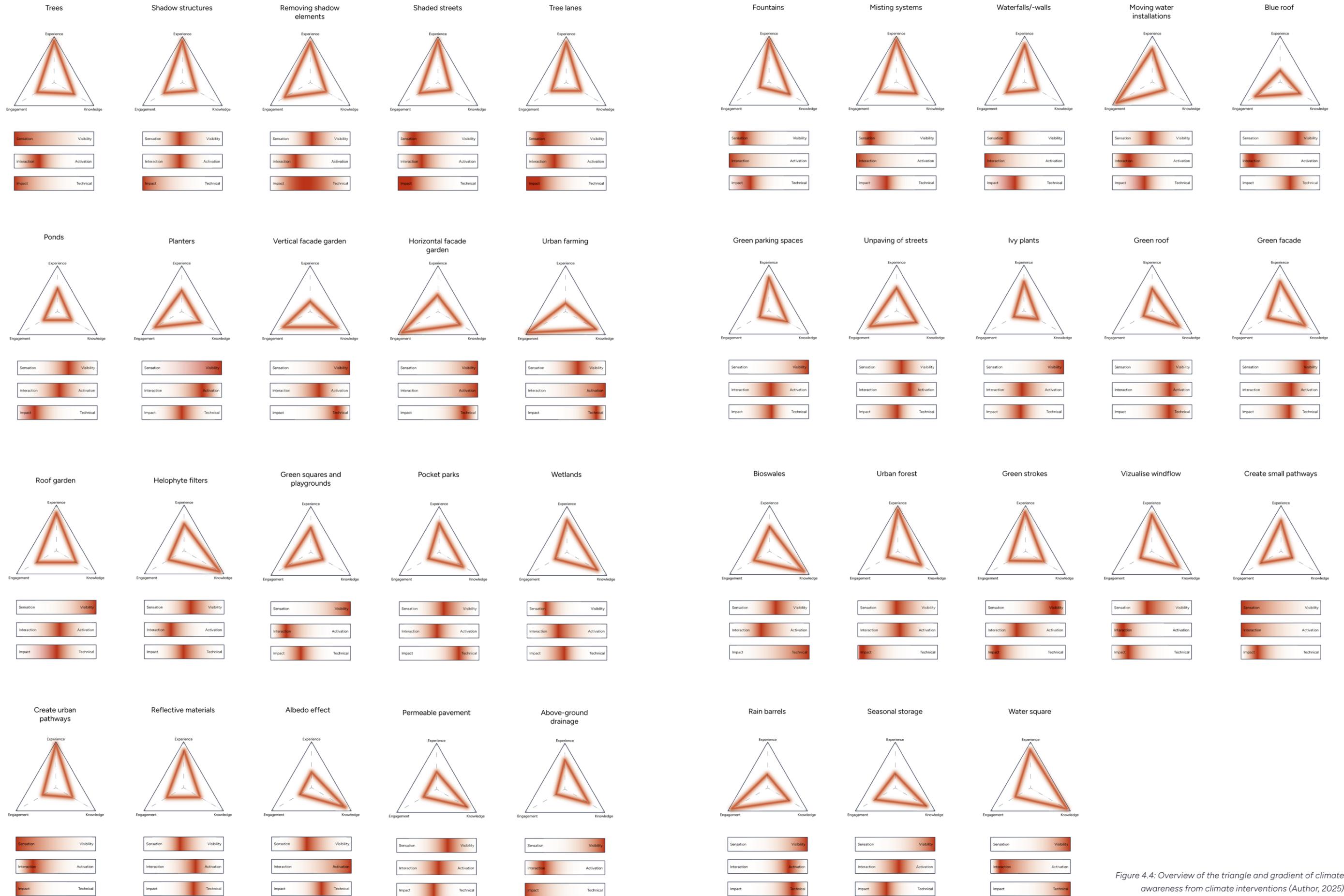


Figure 4.4: Overview of the triangle and gradient of climate awareness from climate interventions (Author, 2025)

TOOL FIELD OF AWARENESS

The gradient field positions all interventions along the spectrum of awareness creation (figure 4.5). Within the mechanism of experience, visible solutions such as above-ground drainage systems or water squares enhance the understanding through perceptible processes. Whereas creating urban wind pathways or integrating wetlands can evoke the sensation of cooling the public space.

Engagement can be stimulated through interactive elements, for example water features that allow users to feel evaporation, or activation, for example community-managed planters and urban farming, by inviting citizens to participate actively in maintaining vegetation and contribute to resilience of their street.

For knowledge, awareness can be strengthened by demonstration the impact or technical aspect of climate interventions. Increasing the number of street trees can show impact of trees for cooling the public space, while more technical interventions, such as bioswales, can help citizens understand how public space simultaneously supports ecological processes and water storage. These measures make the underlying technologies of climate resilience more legible and accessible for the public.

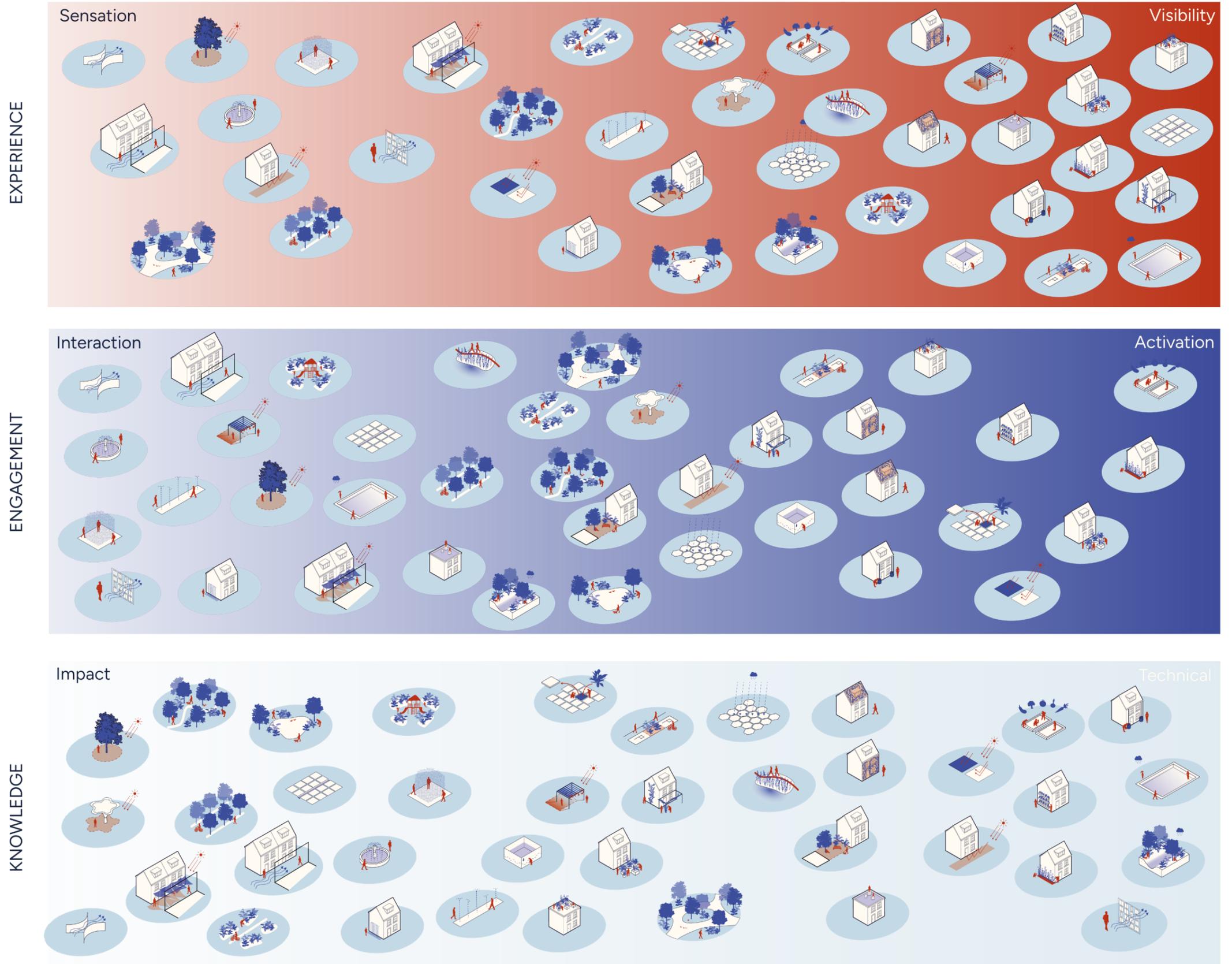


Figure 4.5: Positions climate interventions on gradient from the awareness mechanisms: experience, engagement and knowledge (Author, 2025)

THE INFLUENCE OF PUBLIC SPACE

Factors that influence awareness

The built environment has significant impact on the created awareness in public space. Contextual and environmental effects can either decrease the power of awareness or enhance levels of experience, engagement and knowledge. By acknowledging these influences, designers can effectively integrate climate awareness into street design. Figure 4.6 illustrates how the three mechanisms of awareness operate and which effects play a role in the mechanisms. The effects can be positive and/or negative. The degree of awareness experienced differs between individuals.

From this analysis, several key factors can be identified that influence awareness in public space: space, functions and activities, weather conditions, seasonality, time, and knowledge exchange. Figure 4.7 visualizes the relation between these factors by positive influences (blue lines) and negative influences (red lines). The relations are further elaborated in this chapter

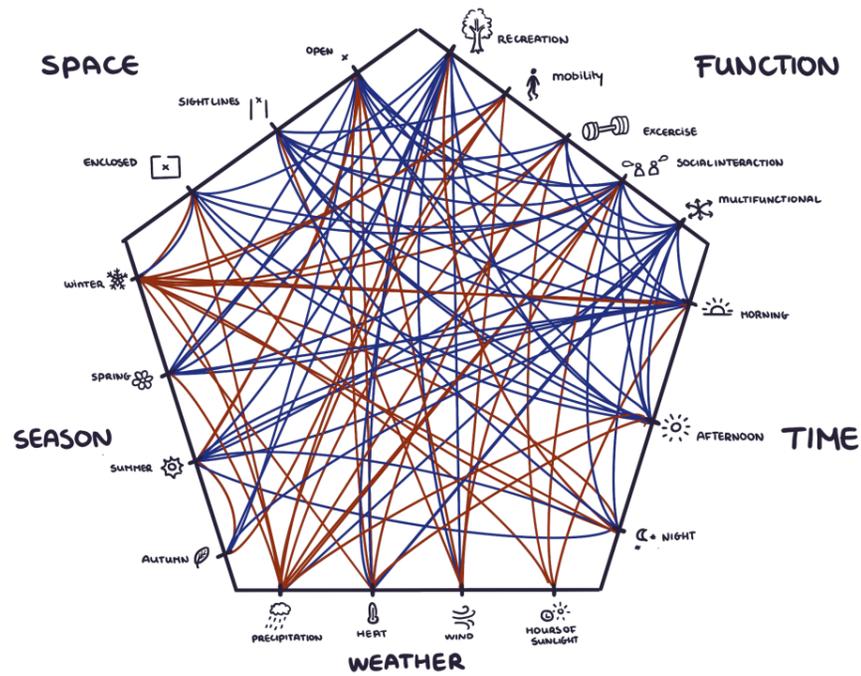


Figure 4.7: Relation between the factors space, function, weather, season and time. The red lines are negative influences and the blue are positive influences (author, 2025)

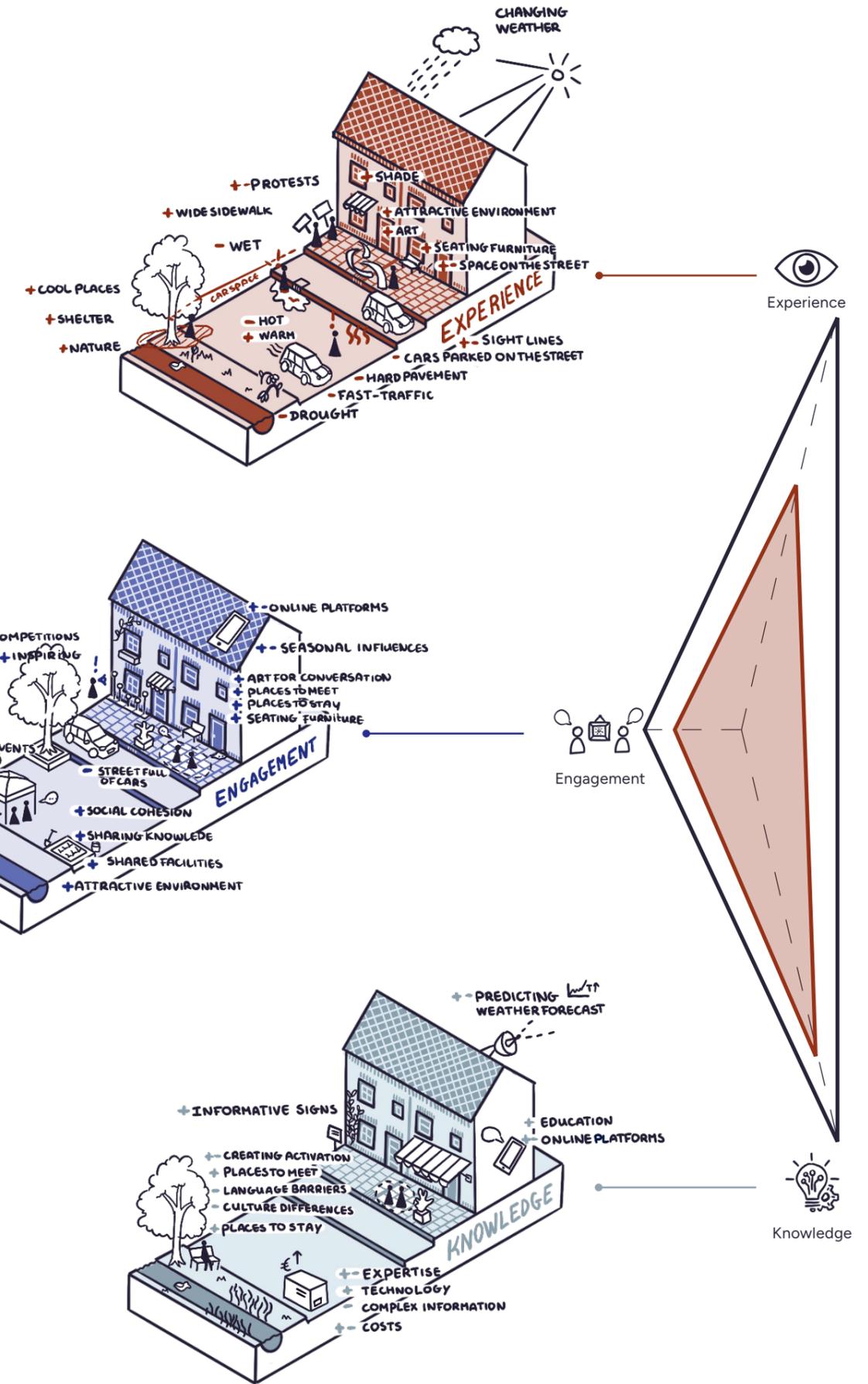


Figure 4.6: Influences of the built environment on the awareness mechanisms: experience, engagement & knowledge (author, 2025)

THE INFLUENCE OF PUBLIC SPACE

Space

Space refers to the spatial lay-out of streets. These characteristics could determine the visibility, legibility and curiosity of art. For example, art placed in a square offers a different level of exposure and visibility compared to art located in a narrow alley. It depends on the objective of the art in the location in which needs to be situated. Elements such as sightlines, openness, enclosure and spatial hierarchy shape how individuals encounter and interpret art interventions.

For instance, in figure 4.8 presents that open spaces have a positive impact on functions and time, however a bad influence on weather conditions such as heat and wind. In addition, evenings have a bad influence on closed spaces because of their uninviting dark spaces.

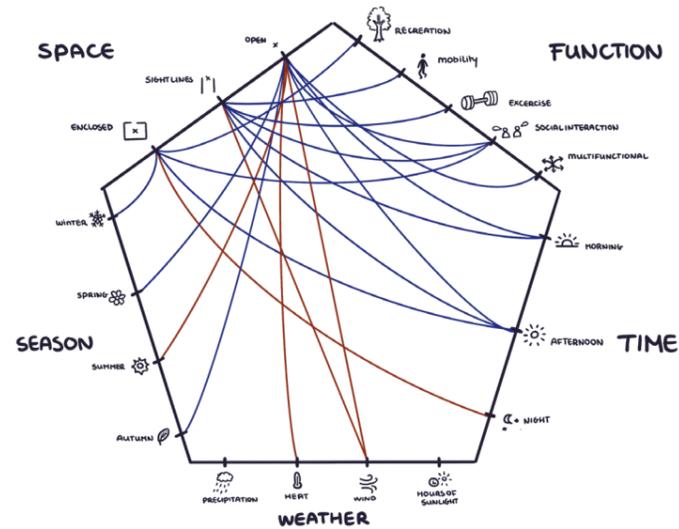


Figure 4.8: Relationships of the factor space. The red lines are negative influences and the blue are positive influences (author, 2025)

Function and activity

The functions present at a given location, such as recreation, social interaction, mobility, sport, affect how individuals engage with art. Interventions should align with, or enhance, the functions of the space. Climate interventions often can be implemented with multifunctional functions. It creates flexibility and increases the relevance of both climate solutions and social interactions. Public space could adopt more effectively to the changing conditions driven by climate change, while creating space for social functions such as sports, meeting and playing. For instance, in figure 4.10 multifunctional spaces for the water square, trees, shadow elements, and a water fountain are shown. Figure 4.9 displays the relation with the other factors, where multifunctional spaces have several links between the other factors with makes it favourable for public space

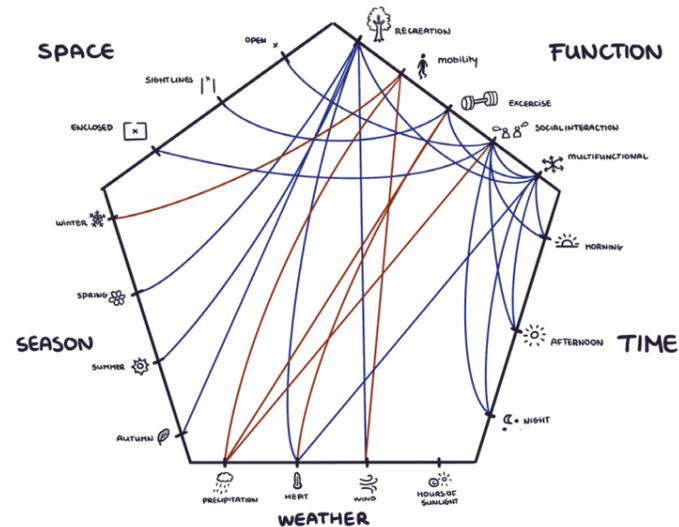


Figure 4.9: Relationships of the factor function. The red lines are negative influences and the blue are positive influences (author, 2025)

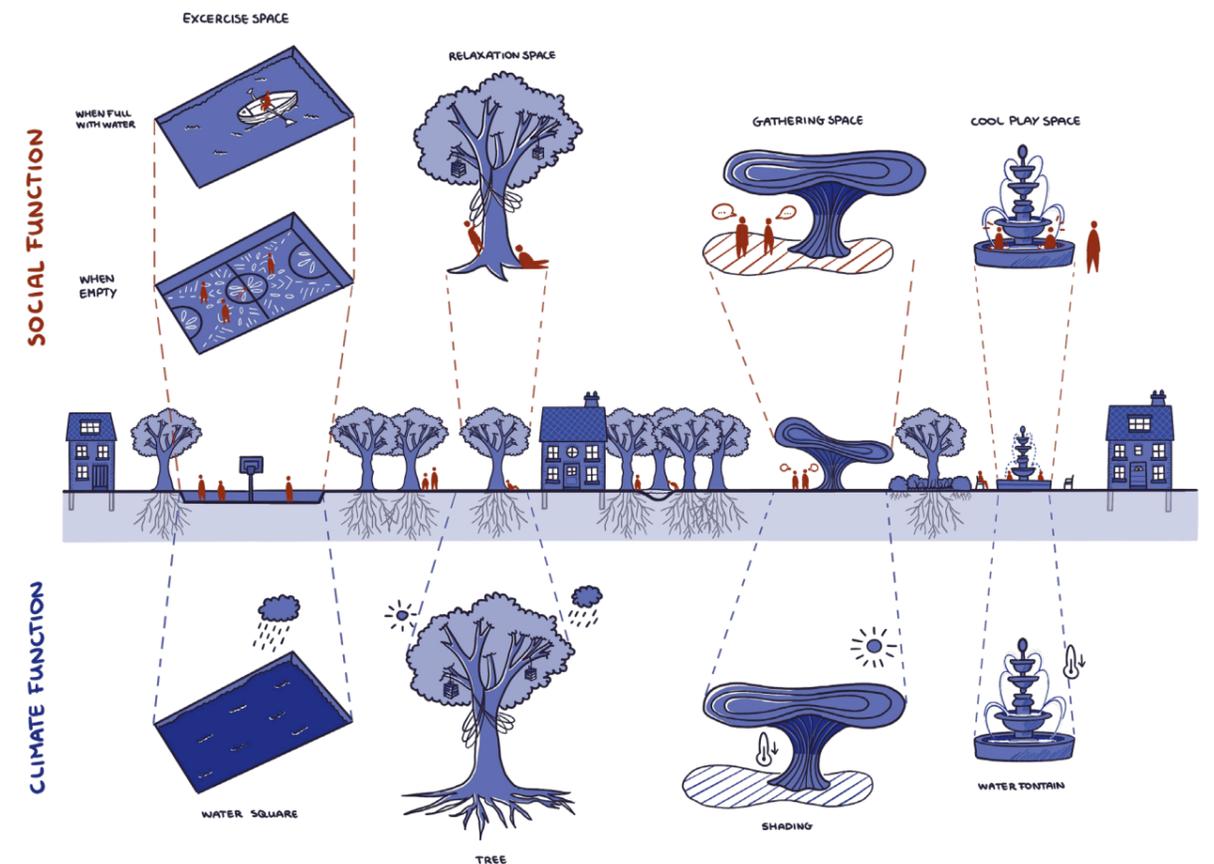


Figure 4.10: Multifunctional (climate and social aspects) use of the watersquare, tree, shading element and a water fountain (author, 2025)

THE INFLUENCE OF PUBLIC SPACE

Weather conditions

Weather strongly influences whether people are willing and able to engage with art. Certain conditions create comfort and stimulate interest, while other discourage interaction. The research of Howarth & Hoffman (1984) analysed the relationship between a range of mood variables, such as concentration, cooperation, anxiety, potency, aggression, depression, sleepiness, scepticism, control, and optimism, and the weather variables, including hours of sunshine, precipitation, temperature, wind direction, wind velocity, humidity, change in barometric pressure and absolute barometric pressure. Table 4.1 illustrates the diagram that incorporates the correlation between the variables. Their findings suggest that the hours of sunlight, precipitation, temperature and humidity are particularly influential in shaping individual's climate awareness and behaviour in public space, and may negatively affect engagement with art.

	Hours of sunlight	Precipitation	Temperature	Humidity
Concentration				
Potency				
Sleepiness				
Scepticism				
Optimism				

Excluded moods (no correlation): cooperation, aggression, depression, control, and optimism
 Excluded weather variables (no correlation): wind direction, wind velocity, change in barometric pressure and absolute barometric pressure.

Table 4.1: Correlation between the variable mood and weather (author, 2025 cited from Howarth & Hoffman, 1984)

The relationships between the other factors shows the negative influences that weather could have on public space (figure 4.11). Seasons and weather conditions strengthen or diminish each other and has an impact on the use of public space. Individuals are less likely to exercise or interact with each other during wet periods or short periods of sunlight.

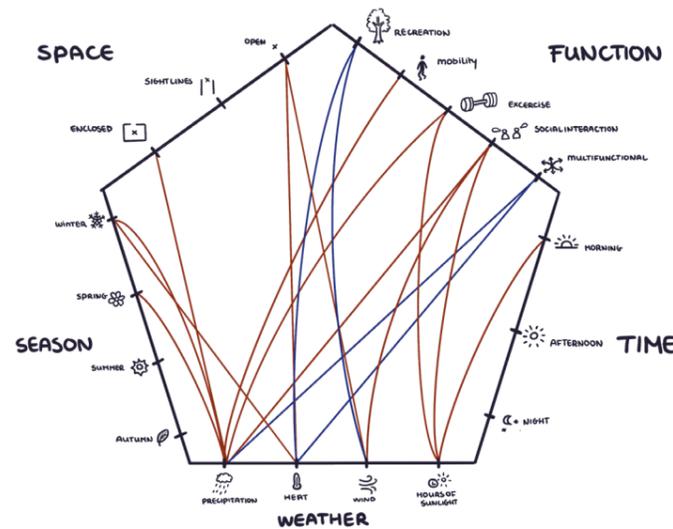


Figure 4.11: Relationships of the factor weather. The red lines are negative influences and the blue are positive influences (author, 2025)

THE INFLUENCE OF PUBLIC SPACE

Seasonality

The seasonal changes also influence the experience and engagement of art in public space. It shapes the climate awareness that the climate is changing due to seasonal changes (Capstick & Pidgeon, 2014). According to KNMI (2023), the Dutch climate is increasingly characterised by a wet season (dec-april) and a dry (may-nov) instead of winter, spring, summer and autumn. This is the result that autumn is becoming milder and springs wetter (KNMI, 2024). These seasonal patterns, combined with weather conditions, frame the challenges that individuals encounter throughout the year, ranging from heat and cold to flowering and withering of vegetation, and variations in daylight.

Winter has a negative influence on the functions of public space and the time that individuals can spend in public space, whereas summer has results in people to go outside and meet with each other (figure 4.12).

Figure 4.13 illustrates the link between weather conditions and seasonality. When designing public space to enhance climate awareness, it is essential to consider these temporal factors to ensure year-round experience, engagement and knowledge. For example, individuals are unlikely to stand in the rain to observe or interpret art. Incorporating shelter can facilitate climate awareness by providing a place for individuals to wait while stay dry (figure 4.14), while simultaneously offering shade during periods of extreme heat. A single intervention can therefore address multiple weather and seasonal conditions, supporting continuous climate awareness throughout the year.

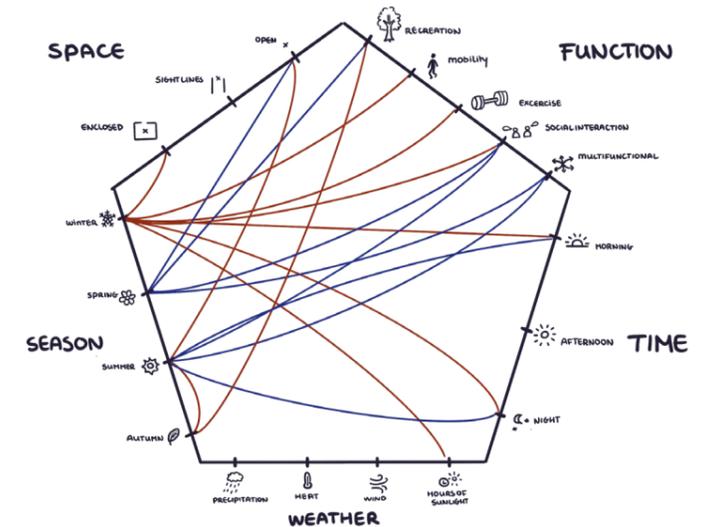


Figure 4.12: Relationships of the factor season. The red lines are negative influences and the blue are positive influences (author, 2025)

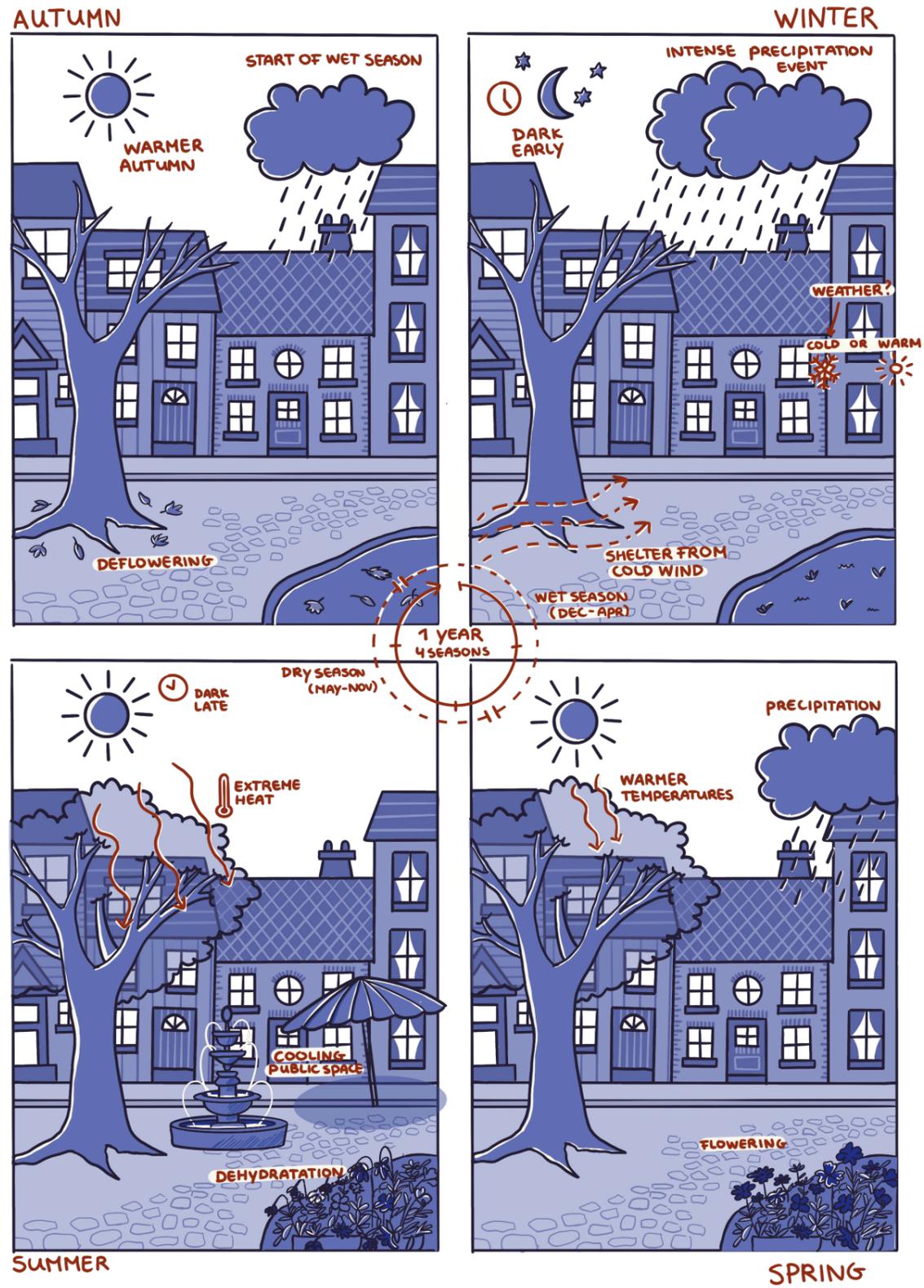


Figure 4.13: Relationship between seasons and weather conditions (author, 2025)

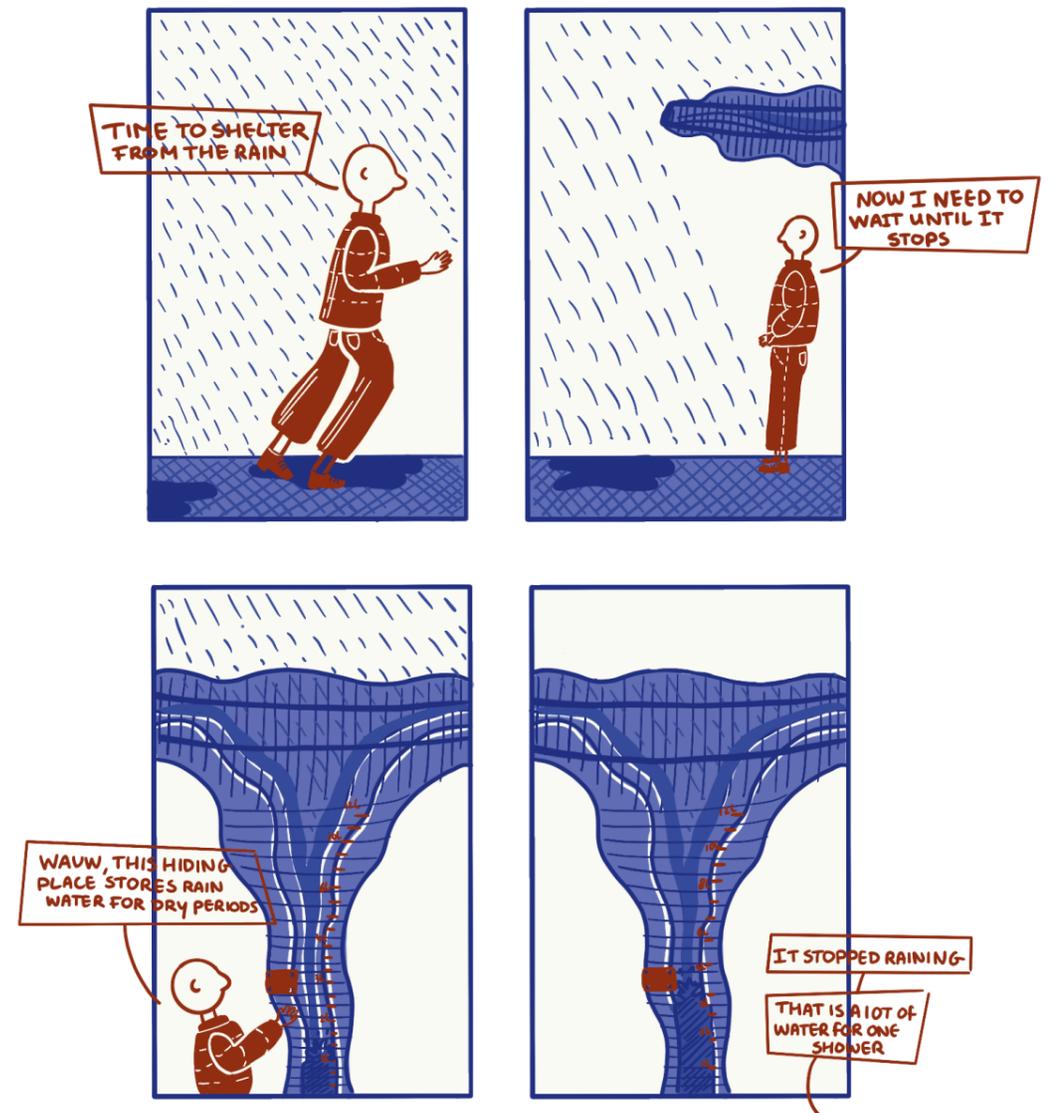


Figure 4.14: Cartoon human perception of art during precipitation (author, 2025)

THE INFLUENCE OF PUBLIC SPACE

Time

The use of streets varies throughout the day, affecting how individuals could encounter art. Daily routine, from going to work and school, shopping, playing outside, walking pets or exercising, understand the opportunities of time which shapes moments of awareness (figure 4.17). During darker hours, artificial lighting becomes essential to maintain visibility and ensure continuous engagement with the art (figure 4.15).

Another way in which time could play a role is temporary art. Temporary art gives the opportunity to create short-term awareness on one location and be replaced with something else later on (figure 4.16). Public space can be seen as a test ground for the future, which creates a 'space of possibilities' (DeLanda, 2006; Stevens and Dovey, 2022). A space is occupied for a brief period of time and serves as high development of experience, engagement and knowledge.

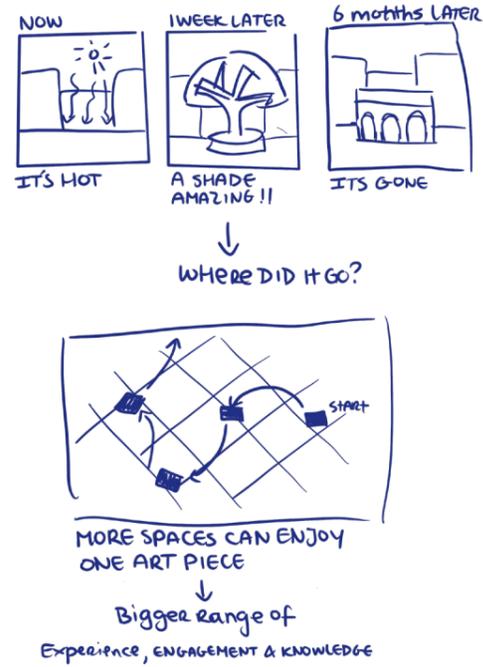


Figure 4.16: Concept of a temporary art installation (author, 2025)

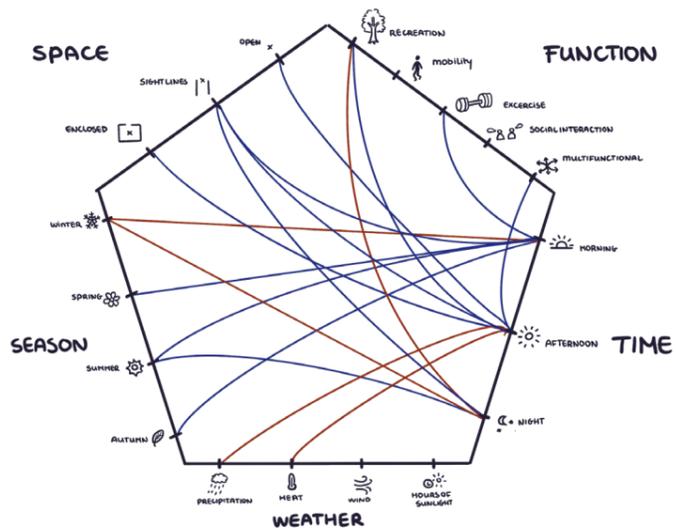


Figure 4.15: Relationships of the factor time. The red lines are negative influences and the blue are positive influences (author, 2025)

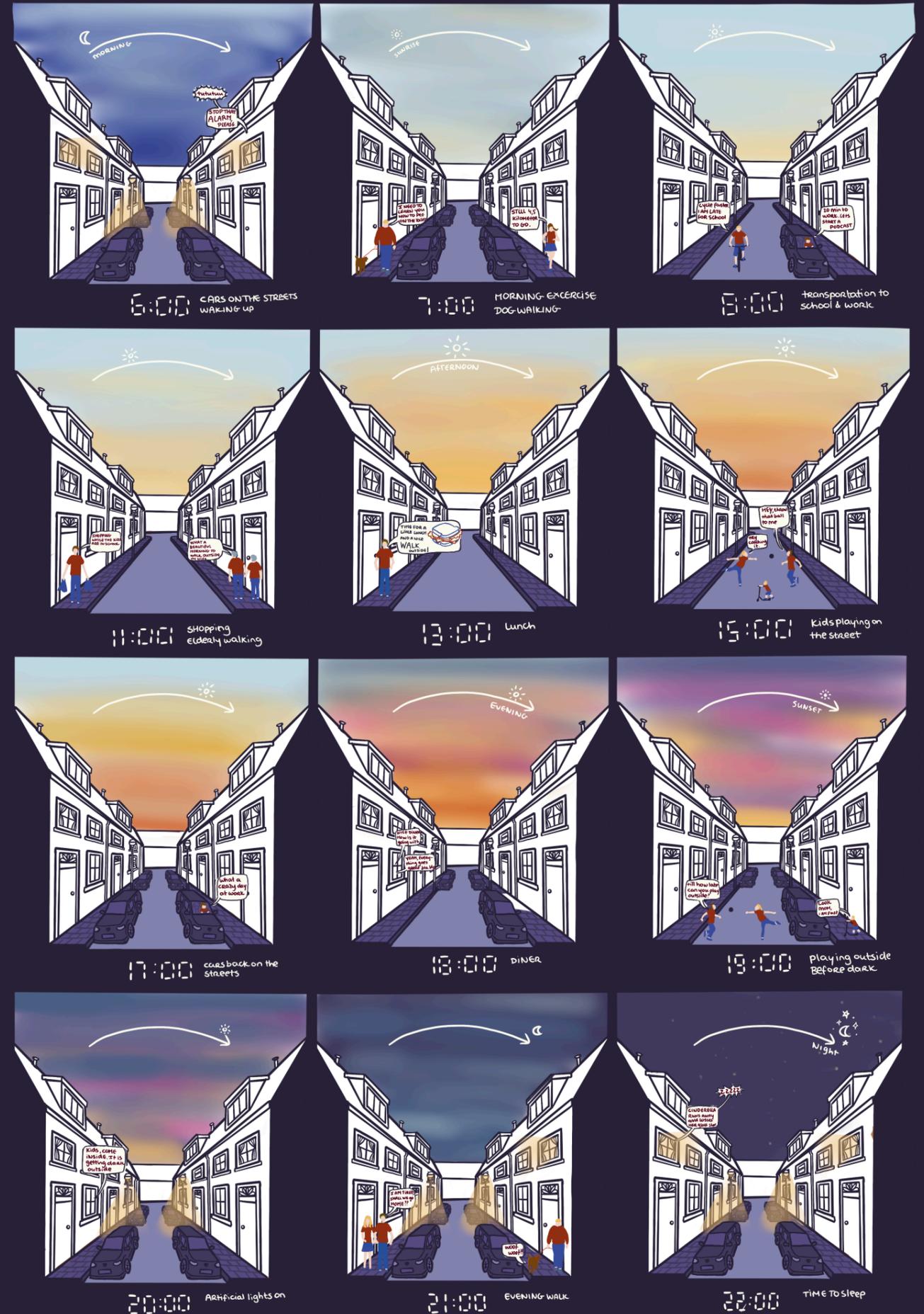


Figure 4.17: Use of street on a typical day around 21.mar/21okt (author, 2025)

FORMS OF KNOWLEDGE

Communication and sharing information play a crucial role in raising awareness. Knowledge exchange through art can occur in various formal and informal formats, including flyers, posters, books, exhibitions, protests, competitions, information signs, social or digital platforms, events or conversations with neighbours, friends or family. This thesis highlights several illustrative examples.



Image 4.1: Photo of page 38&39 from the book *Urbanisten en het wonderlijke waterplein* by Boer et al. (2010) (Author, 2025)

Books

A notable example of a book that uses artistic expression to explain the technology behind a climate intervention is *de Urbanisten en het wonderlijke waterplein* (The urbanists and the remarkable water square) by Boer et al. (2010). Though playful cartoons, the book educates readers about the multifunctional potential of the water square as both a climate resilient and social space.

Information signs

The initiative Treetag by Pius Floris is an example how intangible information about trees are communication in public space. Trees in the Netherlands, Belgium, United Kingdom and Sweden are tagged with signs containing information about the ecological services they provide, such as rainwater retention, oxygen supply, cooling through shade and air pollution capture. This approach visualises the value of trees for humans and society.

Image 4.2: Information sign of a tree (Straatbeeld, 2025)

Competitions

In the Netherlands, the annual competition NK towel hooks (NK tegelwippen) demonstrates how artistic communication can stimulate climate-resilient behaviour (NK Tegelwippen, z.d.). The competition encourages citizens to remove paving tiles and replace them with vegetation. Municipalities compete to achieve the highest number of replaced tiles, which makes it important that more citizens contribute to the competition. The competition uses videos, graphic design and visual communication to engage and motivate participants across the country.

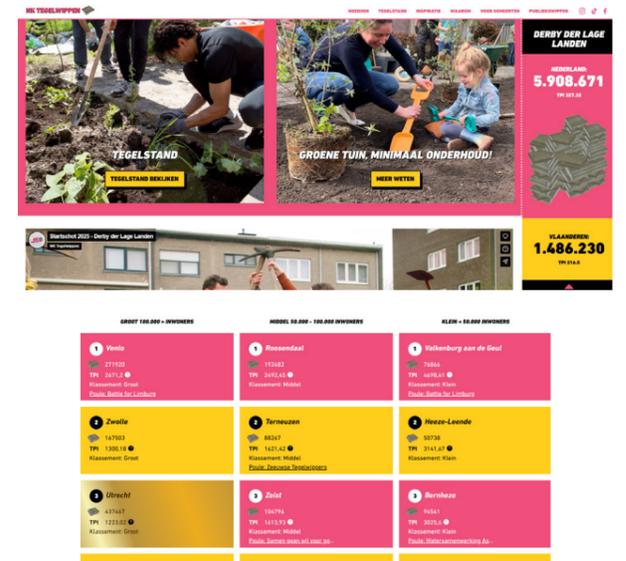


Image 4.3: website of the Dutch competition NK Tegelwippen (Author, 2025 from www.nktegelwippen.nl)

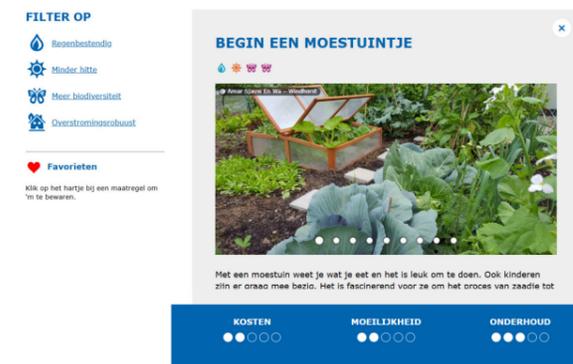
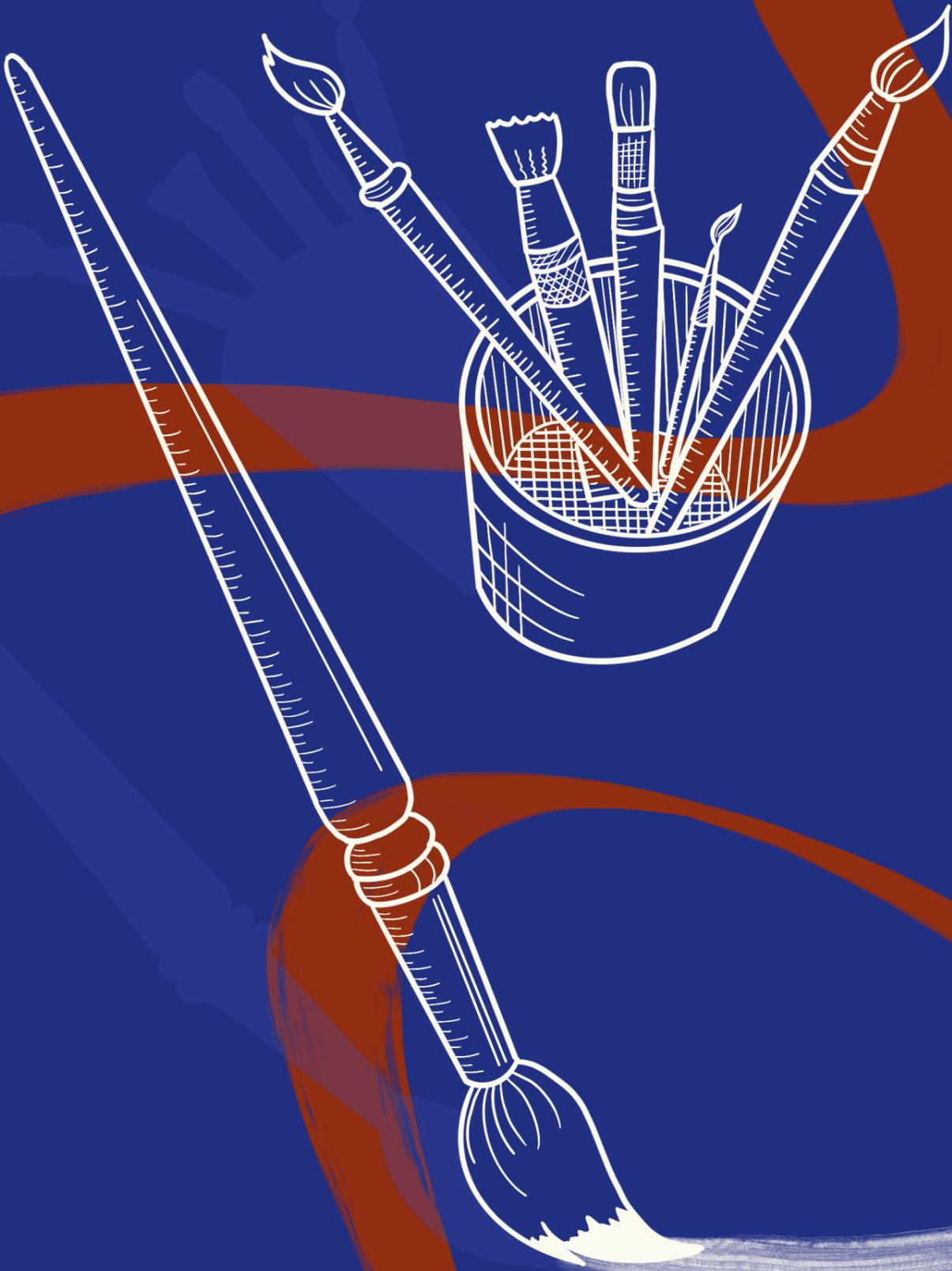


Image 4.4: website of climate interventions (Author, 2025 from www.groenblauwdordrecht.nl)

Digital platforms

Many municipalities maintain digital platforms that communicate climate-resilient measures that can be done by citizens. Examples include Rainproof Amersfoort, Groenblauw Dordrecht and Klimaatmaat Delft. These platforms present lists of interventions that citizens can implement themselves. Information about the cost, difficulty and maintenance are illustrated with scores, to lower the action to engagement with the interventions (Groenblauw Dordrecht, z.d.).



CHAPTER 5

ART IN PUBLIC SPACE

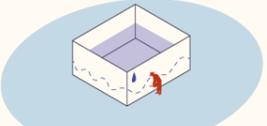
Brushes

ART EXAMPLES IN THE WORLD

Art in public space can appear in many shapes. Rather than designing new climate resilient art in this project, this thesis adopts an analytical approach by examining existing art from around the world. The selection criteria were that each piece must be located in an outside public space, be visually accessible to the public and engage with the theme of climate change, preferably with a direct link to climate resilience. This process resulted in a catalogue of fifteen art installations, thirteen of which contribute directly to climate resilience, while the remaining two address climate change primarily through strong climate awareness-raising narratives. Figure 5.1 maps a geographical distribution of these art, demonstrating their international range. The following pages present the art and explain how each contributes to climate resilience. A more extensive analysis is available in the accompanying book Awareness by art: examples.



ART X CLIMATE RESILIENCE

 <p>NAME: The Many Tree ARTIST: Joshua Russo-Batterham LOCATION: Eindhoven, NL SCALE: Object</p>    <p>Shadow structures</p>	 <p>NAME: Portraits of Overwhelm ARTIST: Kåre Frang LOCATION: Egeskov, DK SCALE: Open square</p>  <p>Showing the urgency and impact of climate change</p>
 <p>NAME: Roombeek ARTIST: Buro Sant en Co LOCATION: Enschede, NL SCALE: Ensemble</p>    <p>(Seasonal) storage</p> 	 <p>NAME: Coloring Life ARTIST: The Umbrella Sky Project LOCATION: Águeda, Portugal SCALE: Ensemble</p>    <p>Shaded streets</p>
 <p>NAME: Cool Community Pacoima ARTIST: GAF, Climate Resolve, and local community organizations LOCATION: Los Angeles, US SCALE: Network</p>    <p>Reflective materials</p> 	 <p>NAME: Supertrees ARTIST: Grant Associates LOCATION: Singapore, SG SCALE: Network</p>     <p>Shadow structures (Seasonal) storage</p>

Contributing to reducing...



too hot extreme



Community engagement



too wet extreme

Figure 5.1: Geographical map with the locations of the fifteen art installations (Author, 2025)

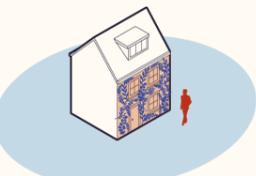
NAME: De Parkpergola
ARTIST: Adrian Geuze
LOCATION: Utrecht, NL
SCALE: Network





Ivy plants Urban forest

NAME: Caixa Forum
ARTIST: Patrick Blanc
LOCATION: Madrid, ES
SCALE: Object

Green facade

NAME: Windfence
ARTIST: Ned Kahn
LOCATION: Oregon, US
SCALE: Object




Show windflow

NAME: Tanner Springs Park
ARTIST: Herbert Dreiseitl
LOCATION: Oregon, US
SCALE: Ensemble




Pocket parks

NAME: Waterlicht
ARTIST: Daan Roosegaarde
LOCATION: Worldwide
SCALE: Ensemble




Showing the urgency and impact of climate change

NAME: Waterplein Annie M.G. Schmidtplein
ARTIST: Karres Brands
LOCATION: Rotterdam, NL
SCALE: Ensemble





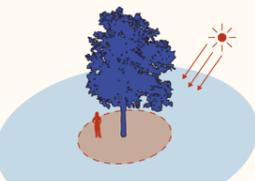
Water square Fountains

NAME: De Leeuwenhoekpark fontein
ARTIST: Baljon
LOCATION: Delft, NL
SCALE: Object




Fountains

NAME: Treetag
ARTIST: Pius Floris Boomverzorging
LOCATION: All over NL, BE, UK & SE
SCALE: Object


Trees Showing the importance

NAME: Halle Puket #2 Le Jardin
ARTIST: Têtes de l'Art & Colectif etc
LOCATION: Marseille, FR
SCALE: Ensemble




Planters

Contributing to reducing...

 too hot extreme  Community engagement

 too wet extreme

Contributing to reducing...

 too hot extreme  Community engagement

 too wet extreme

ART ACROSS SCALES

Figure 5.2 presents the spatial scale of the analysed art, ranging from micro to meso, and macro, and illustrates how these scales relate to the three awareness mechanisms: experience, engagement, and knowledge. The diagram shows that art operates across multiple layers of public space. For example, at the micro scale, the Leeuwenhoekpark fountain cools its immediate surroundings through evaporation. At the macro scale, the Parkpergola functions within the same awareness of experience, yet produces its effect through shading structures and evapotranspiration generated by climbing plants.

This layered positioning highlights the potential of art in public space to enhance climate resilience in diverse ways and at various spatial scales. The examples also demonstrate that art could span among multiple awareness mechanisms. For instance, Halle Puket #2 Le Jardin highlights that through community engagement while simultaneously promoting knowledge about plant species. Similarly, Coloring Life invites interaction through photography and offers experiential awareness by enabling users to sense the cooling effect of shaded streets.

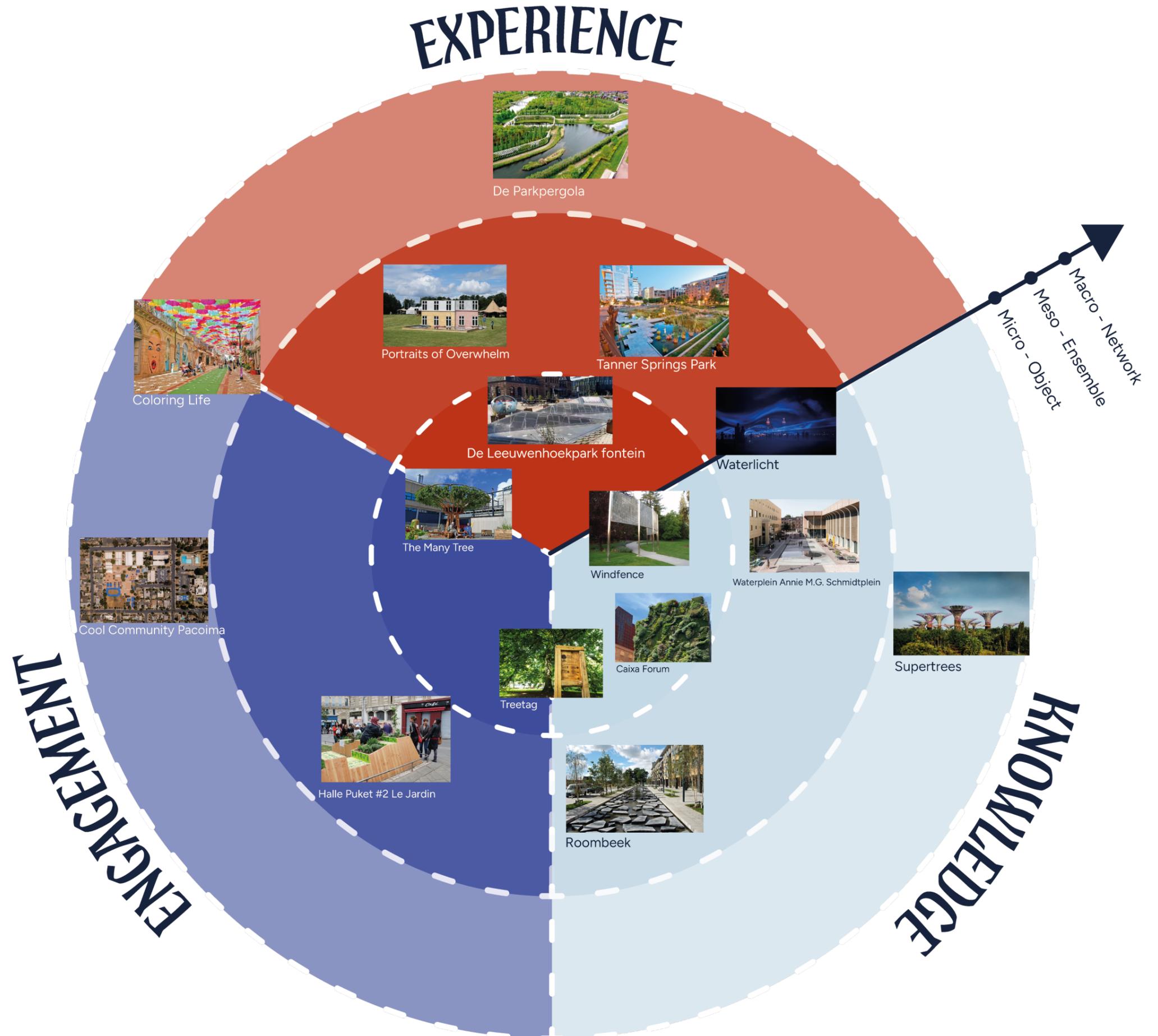


Figure 5.2: Circle diagram with the art installations that show the relationship between the spatial scale and awareness mechanisms: experience, engagement, and knowledge (Author, 2025)

ART X CLIMATE AWARENESS

Figures 5.3 and 5.4 present the in-dept analysis of the climate awareness generated by each art, shown through the triangle of awareness and the gradient of awareness. The triangle visualises the relative contribution of each art installation to experience, engagement, and knowledge, allowing comparison between art. The gradient further specifies the type of climate awareness created, ranging from sensation to visibility, interaction to activation, and impact to technical understanding.

climate resilience, but its primary contribution lies in activation, inviting citizens to participate in the street's transformation. These differences illustrate the value of combining the triangle and the gradient. Together, they clarify not only how much awareness is generated, but what kind of awareness each art supports.

For example, Portraits of Overwhelm scores high on experience by visually depicting submerged car roofs, while also encouraging interaction through its spatial layout. In contrast, the cool community Pacoima also leans toward experience, as it highlights streets redesigned for



Figure 5.3: Gradient of awareness applied on the 15 art installations (author, 2025)

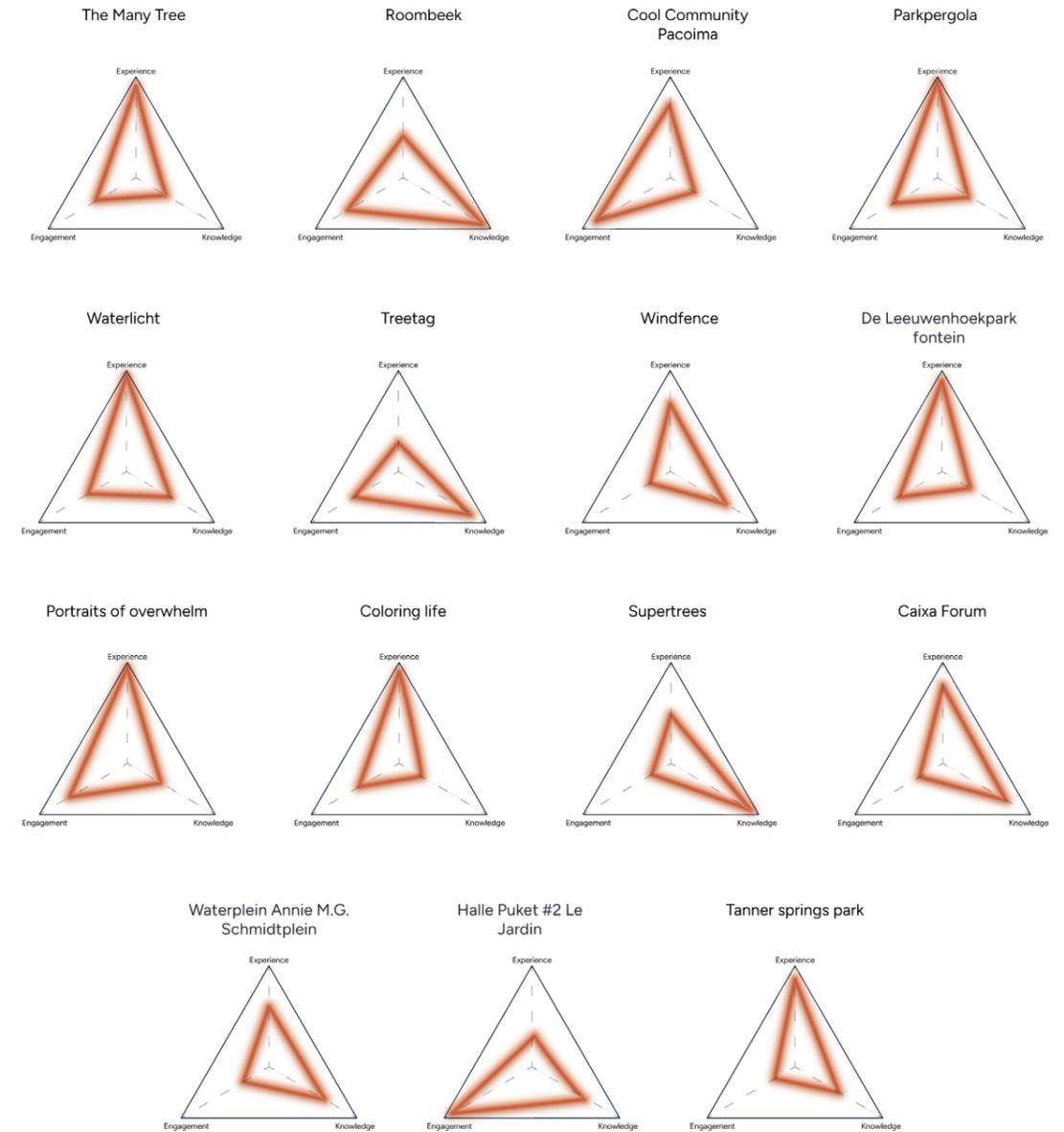


Figure 5.4: Triangle of awareness applied on the 15 art installations (author, 2025)



CHAPTER 6

THE CONCEPT

The canvas

THE CONCEPT

The climate aware street

Integrating the three components, climate interventions, awareness mechanisms and art in public space, forms the basis of the climate-aware street concept. The concept is visualised in a street sheet. The lay-out of the street is based on the garden city (tuinstad) typology, because it is spatially organised and offers sufficient space for the implementation of climate resilient interventions. However, the street sheet illustrates the possibilities and opportunities of urban streets in general. It does not imply that all streets should follow the exact same design. Instead, users are encouraged to select elements that suit for their own context. Each component contributes to their own layer in the street and simultaneously form the achieved sheet.

The climate interventions are illustrated in the axonometric drawing that divides the general street in functional zones: social, recreation, playground, and green-blue infrastructure zones. Mobility connects the zones and maintains continuity along the street (figure 6.1).

The art component is abstracted to site-specific locations where social and climate interventions functions gather. The climate interventions can be seen as forms of the art.

The relationship between individuals and these interventions highlights the role of art in public space, demonstrating how interaction and engagement have arisen.

The awareness mechanisms provide the textual layer on the street sheet. The text consists of design considerations, such as implementing artificial lighting or creating shade, which support the development of awareness. Each consideration is linked to one or more of the awareness mechanisms.

Since the street sheet only presents a single street, it raises questions about how such streets would connect within a wider urban network. The diagram as shown in figure 6.2 therefore illustrates the broader network, showing how climate-aware streets can be embedded within larger ecological, social and mobility infrastructures.

Finally, zooming in on street level, eye level perspectives clarify how the awareness mechanisms manifest spatially. The gradient of each mechanism is integrated in this perspective to show the opportunities for experience, engagement, and knowledge.

THE NETWORK

How to connect the systems?

The climate-aware street forms a network of attractive, cool, informative, and interactive routes and places to stay. The network reveals the different layers of the awareness mechanisms experience, engagement and knowledge, which form the foundation of the network

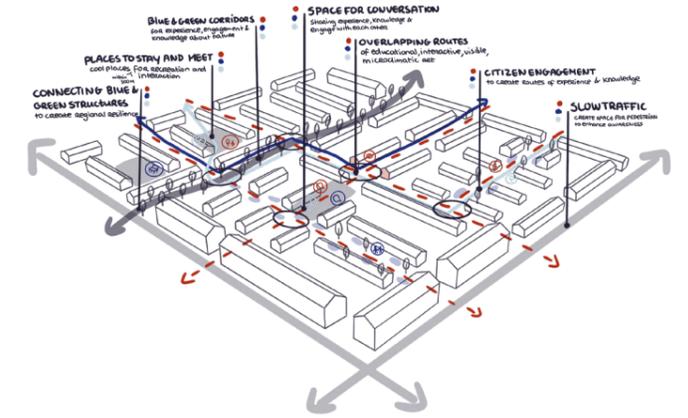


Figure 6.2: United axonometric view of the networks across the climate awareness mechanisms: experience, engagement, and knowledge (author, 2025)

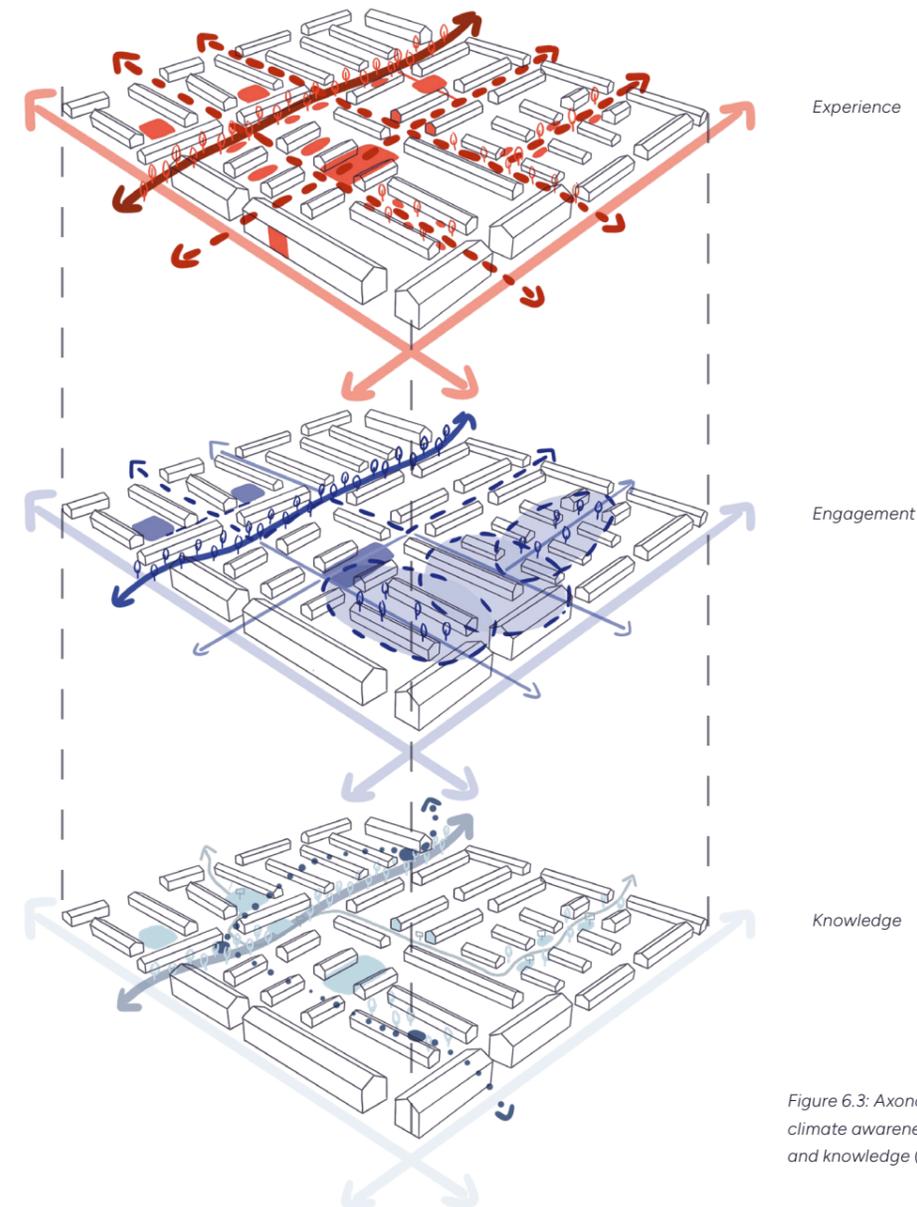


Figure 6.3: Axonometric view of the networks across the climate awareness mechanisms: experience, engagement, and knowledge (author, 2025)

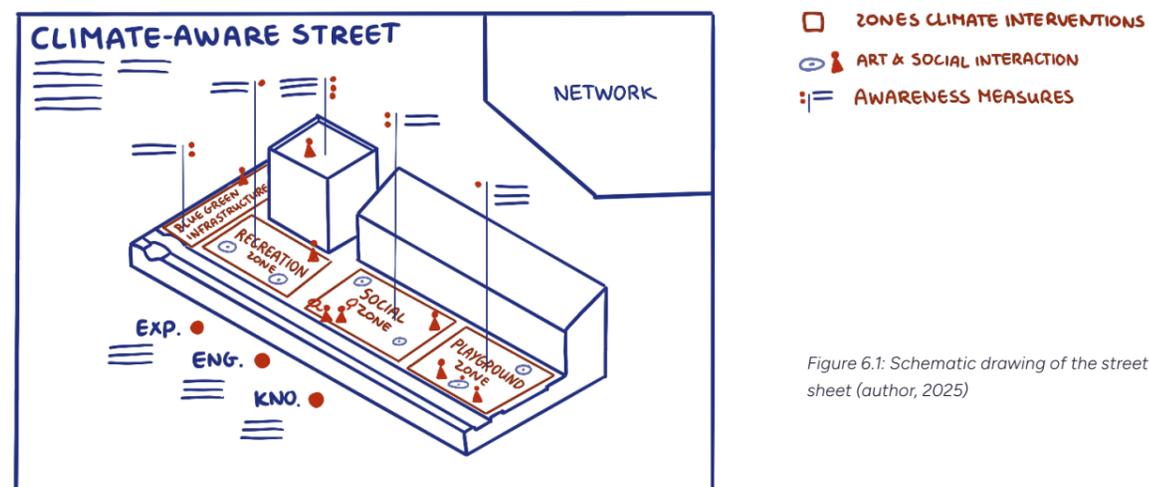
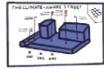


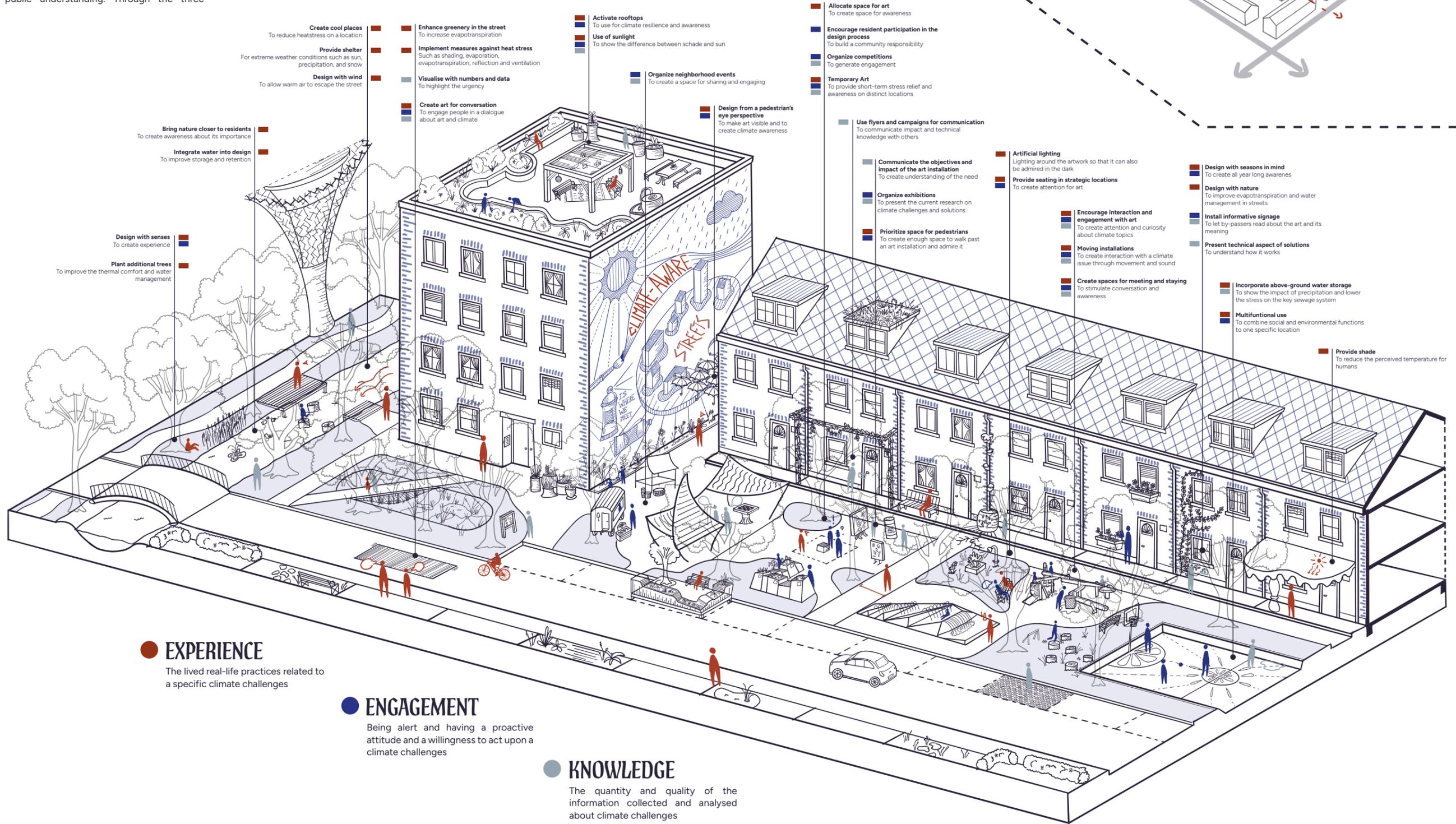
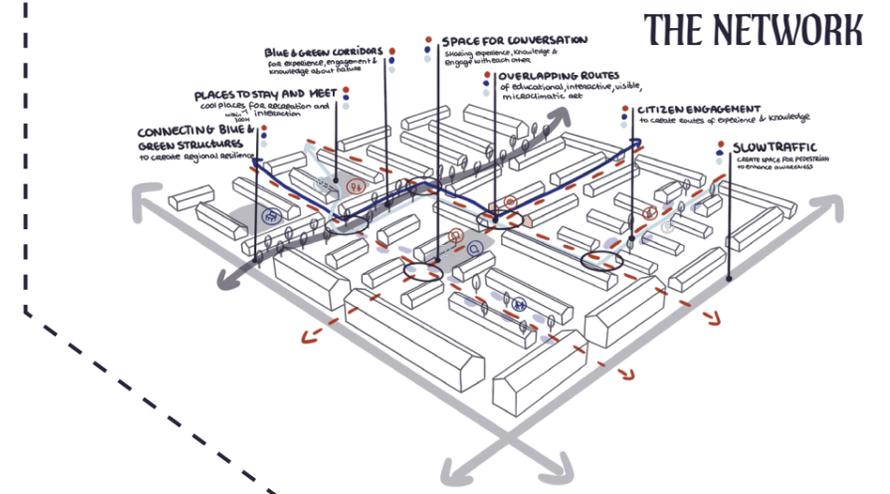
Figure 6.1: Schematic drawing of the street sheet (author, 2025)



CLIMATE-AWARE STREETS

The climate-aware street applies art in public space to create climate awareness and enhance climate resilience. By integrating art into the urban environment, the concept aims to inform users about climate-related challenges and solutions and engage them in participating in contributing to climate resilience. The primary objective is to accelerate climate resilience through deepening the public understanding. Through the three

awareness mechanisms, experience, engagement and knowledge, this objective can be achieved over time. The process starts with redesigning public space with space to create room for art and green, thereby making climatic processes more visible and tangible.



EXPERIENCE
The lived real-life practices related to a specific climate challenges

ENGAGEMENT
Being alert and having a proactive attitude and a willingness to act upon a climate challenges

KNOWLEDGE
The quantity and quality of the information collected and analysed about climate challenges

Figure 6.4: The street sheet (author, 2025)

EXPERIENCE

Make the invisible visible

Experience refers to the creation of spaces that stimulate inspiration and imagination. By integrating art into public space, individuals are able to see, hear, and feel the possibilities of climate interventions. Changes in the physical environment become perceptible, encouraging reflection and awareness. Moreover, the implementation of climate-resilient interventions

allows the effects of reduced heat, improved water management, or increased comfort to be directly experienced, reinforcing awareness through sensory perception.

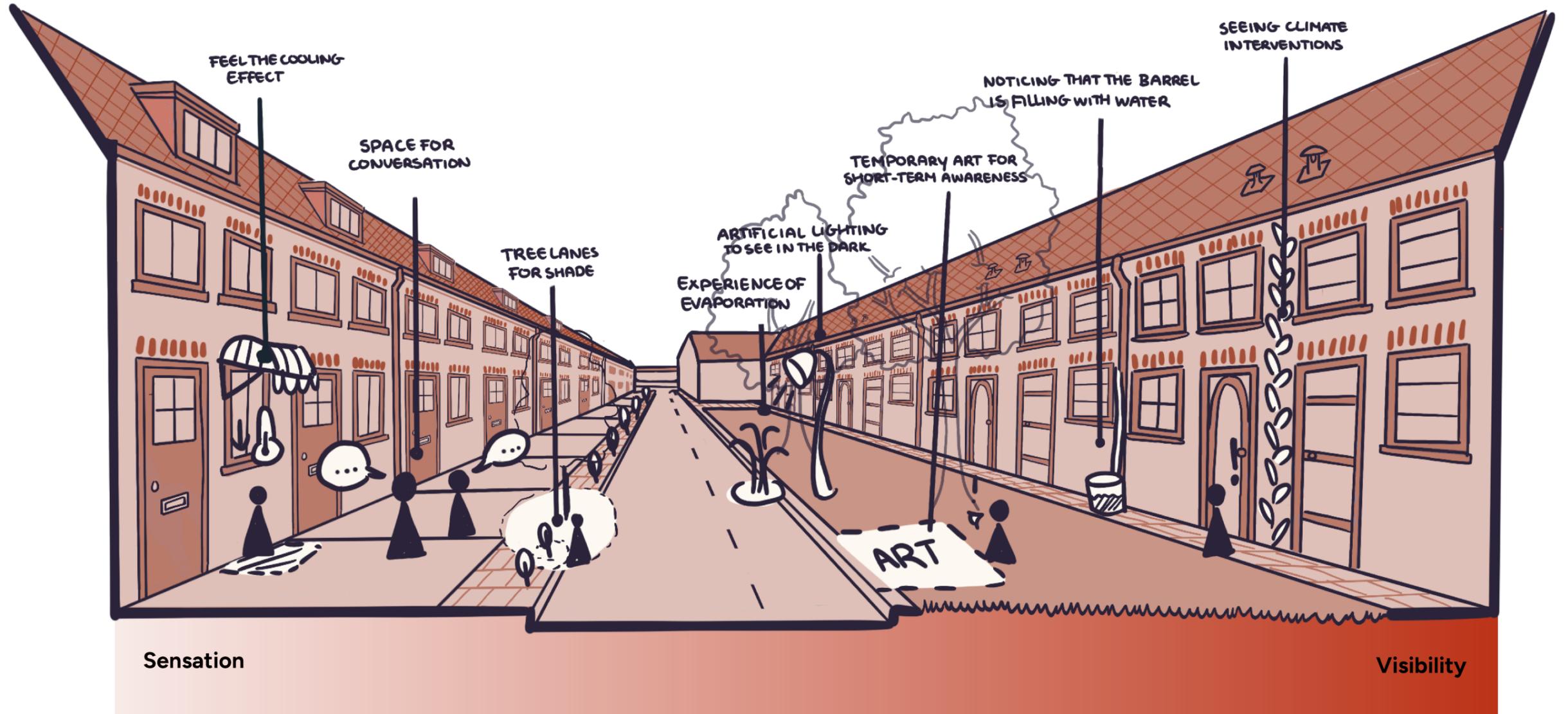
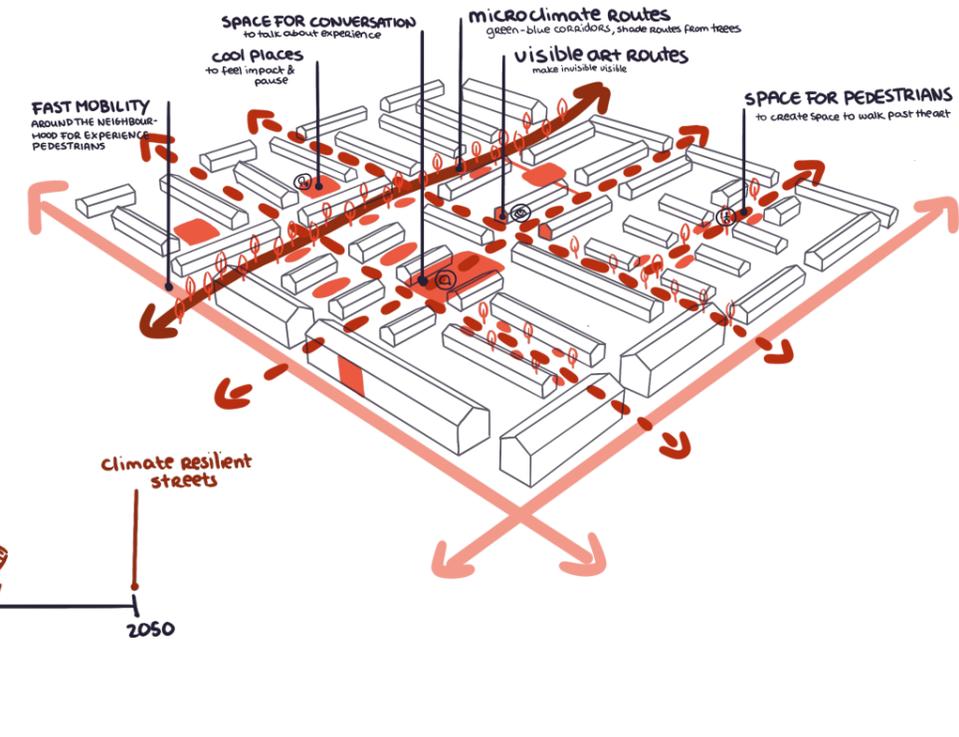


Figure 6.5: Eye perspectives elaboration on the gradient of awareness: experience (author, 2025)

Sensation

Visibility

ENGAGEMENT

Invite users to participate

Engagement functions as a mediator for accelerating the transition toward climate-resilient cities. Through interaction and active participation, citizens can contribute meaningfully to achieving resilience goals for 2050. Art that invites interaction or inspires involvement helps to translate abstract climate interventions into understandable actions,

ultimately supporting the activation of citizens and encouraging them to take part in climate resilient efforts.

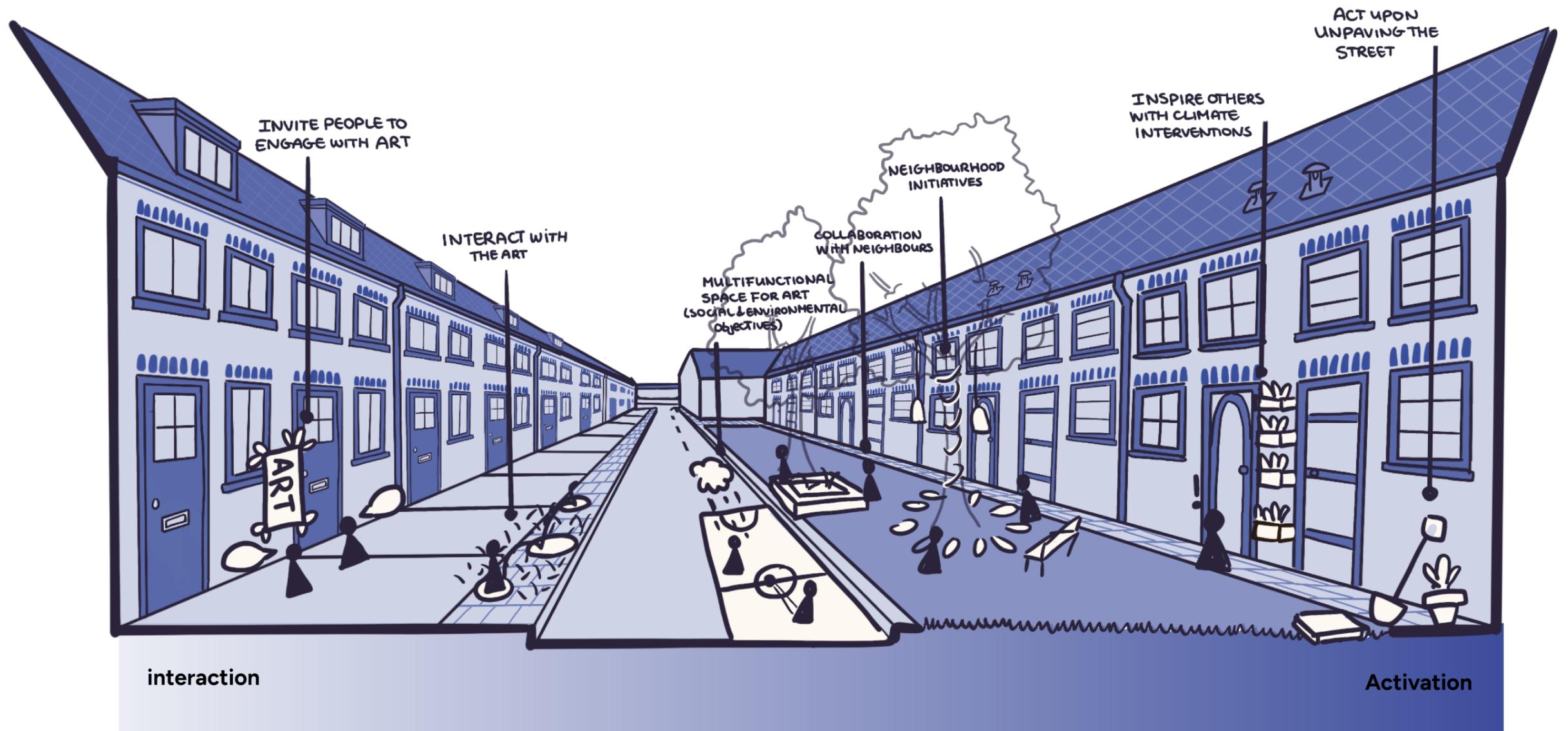
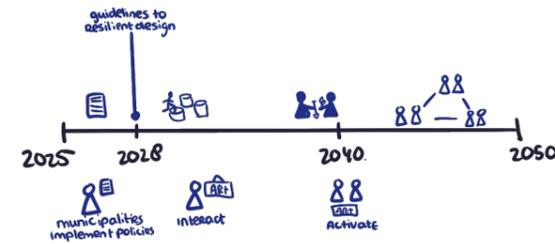
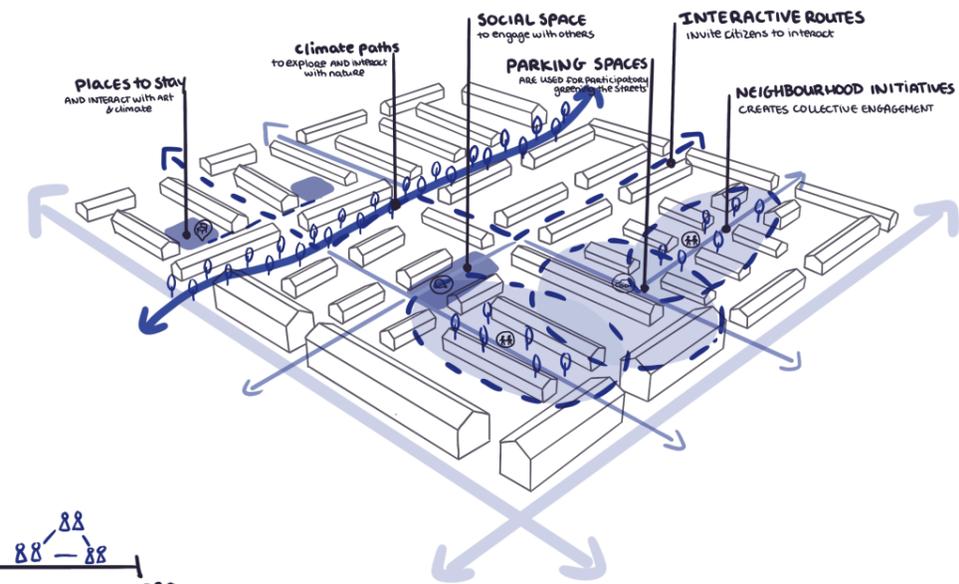


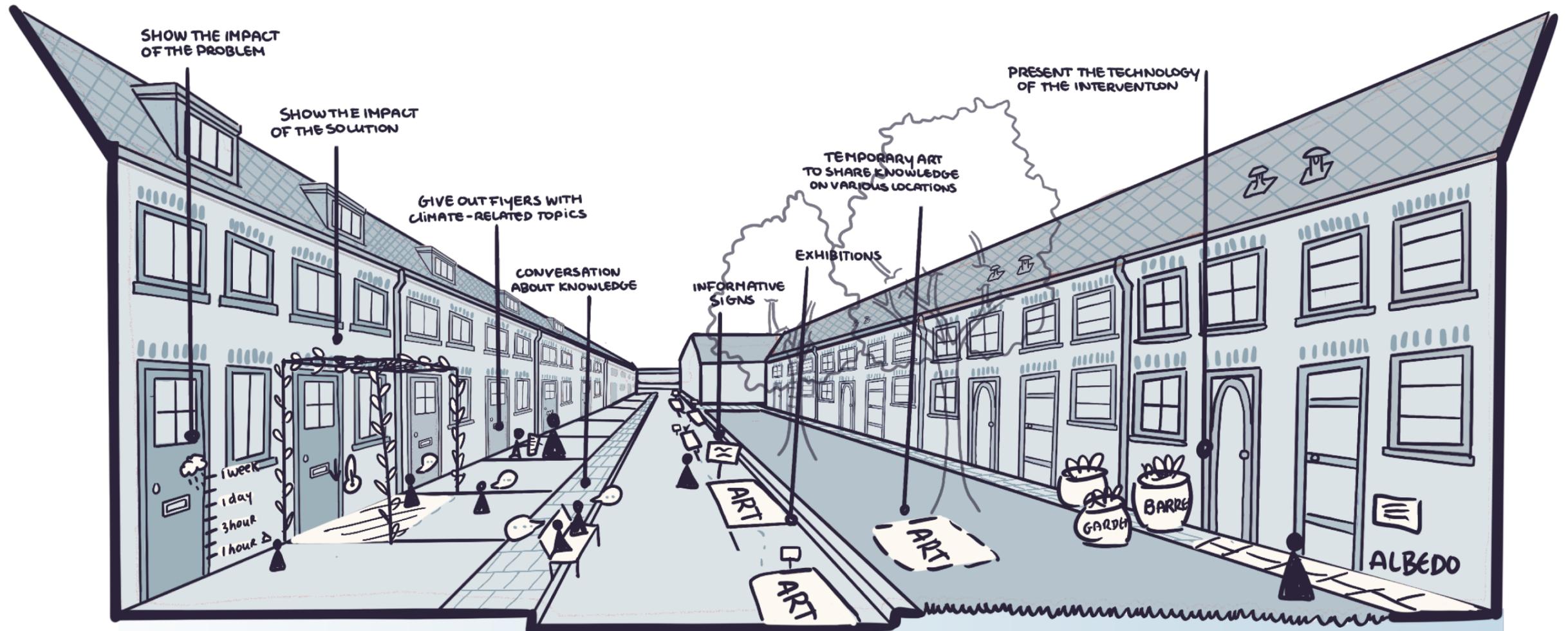
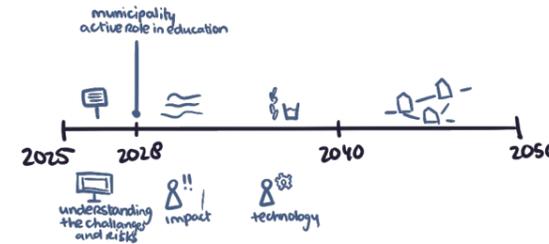
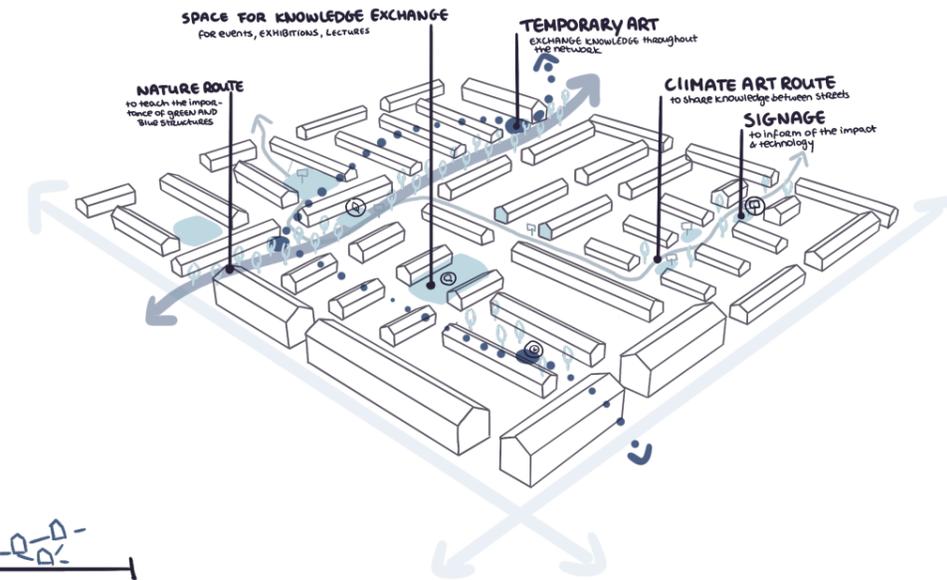
Figure 6.6: Eye perspectives elaboration on the gradient of awareness: engagement (author, 2025)

KNOWLEDGE

Educate for understanding

Knowledge is essential for explaining the function and impact of climate interventions to users. Without access to information about the technologies and processes involved, awareness remains incomplete. Visual and textual communication play a crucial role in facilitating understanding. Art can support this translation by making technical information accessible and

relatable. Additionally, designing spaces for meeting and staying promotes dialogue among individuals, further supporting the exchange of knowledge and collective learning.



Impact

Technical

Figure 6.7: Eye perspectives elaboration on the gradient of awareness: knowledge (author, 2025)

ART OVER TIME

Adapt to change, evolve over time

Figure 6.8 shows a conceptual transformation of a the street over time, highlighting the role of art in creating climate awareness and resilience.

On the left side (around 2025), the street represents an early stage of climate adaptation. Art appears mainly as temporary, small-scale, and informational interventions, such as markings, signs, and interactive elements in the street. These interventions focus on education, inspiration, and short-term engagement, helping

residents to notice climate challenges and begin understanding climate-related solutions.

Moving toward the right side (2050), the street evolves into a fully climate-aware and climate resilient environment. Art is no longer an addition but becomes embedded within green-blue infrastructure, façades, and public space. Vegetation, water flows, and artistic elements form a connected network that supports cooling, water management, biodiversity, and social

interaction. Here, art functions at a larger scale, contributing to long-term awareness, collective activation, and integration into urban systems.

Overall, the image visualises a timeline from awareness to action, showing how art can gradually shift from communication and experimentation to a permanent, systemic component of climate resilient street design.

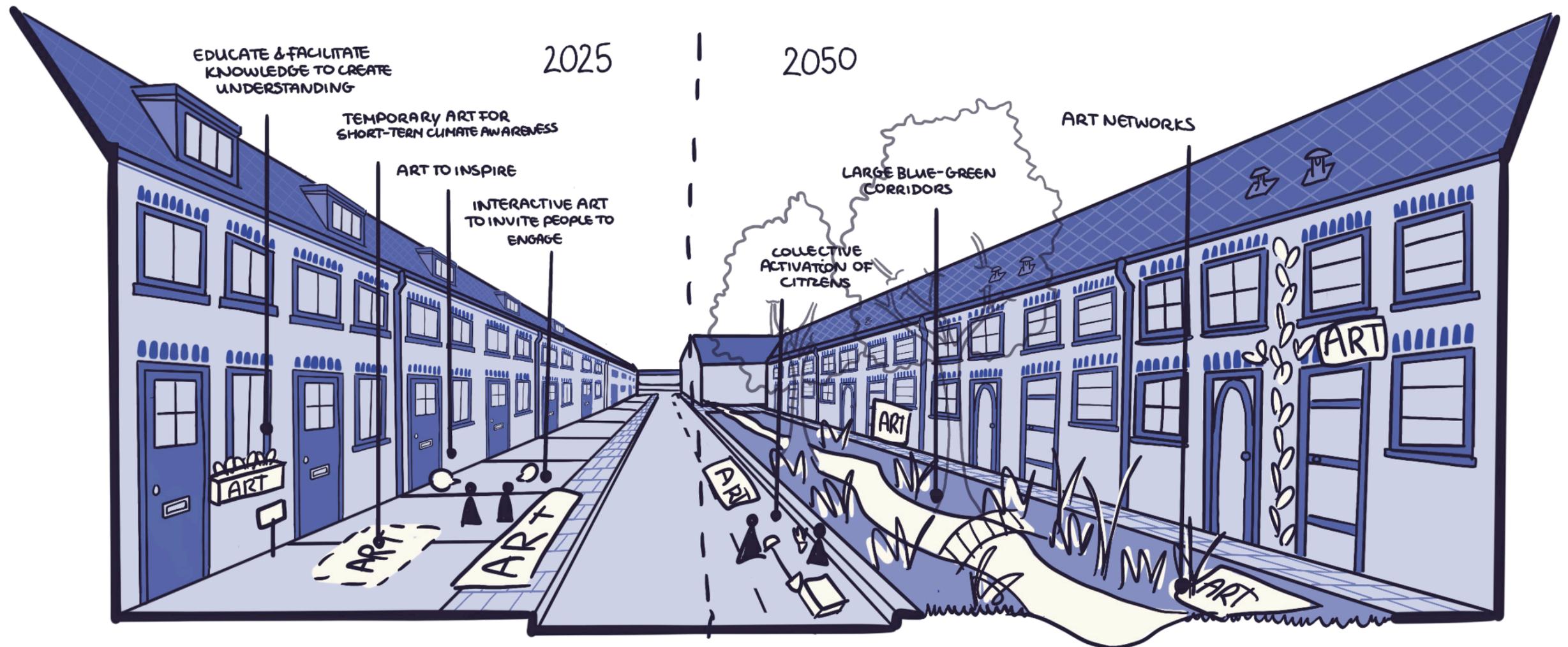


Figure 6.8: Eye perspectives elaboration on change of art over time (author, 2025)

THE USER

Who is using the concept?

Now that the concept has been presented, it is important to identify its intended users and examine how each group will make use of it. Figure 6.10 visualises a power-interest matrix that illustrates the stakeholders involved and their current position within the project. Based on this analysis, three primary stakeholders, the municipality, artist and citizens, have been selected for further exploration, focusing on the roles they play in applying the climate-aware street concept.

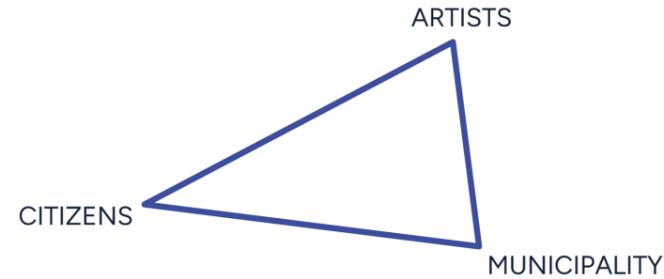


Figure 6.9: Triangle of key users (author, 2025)

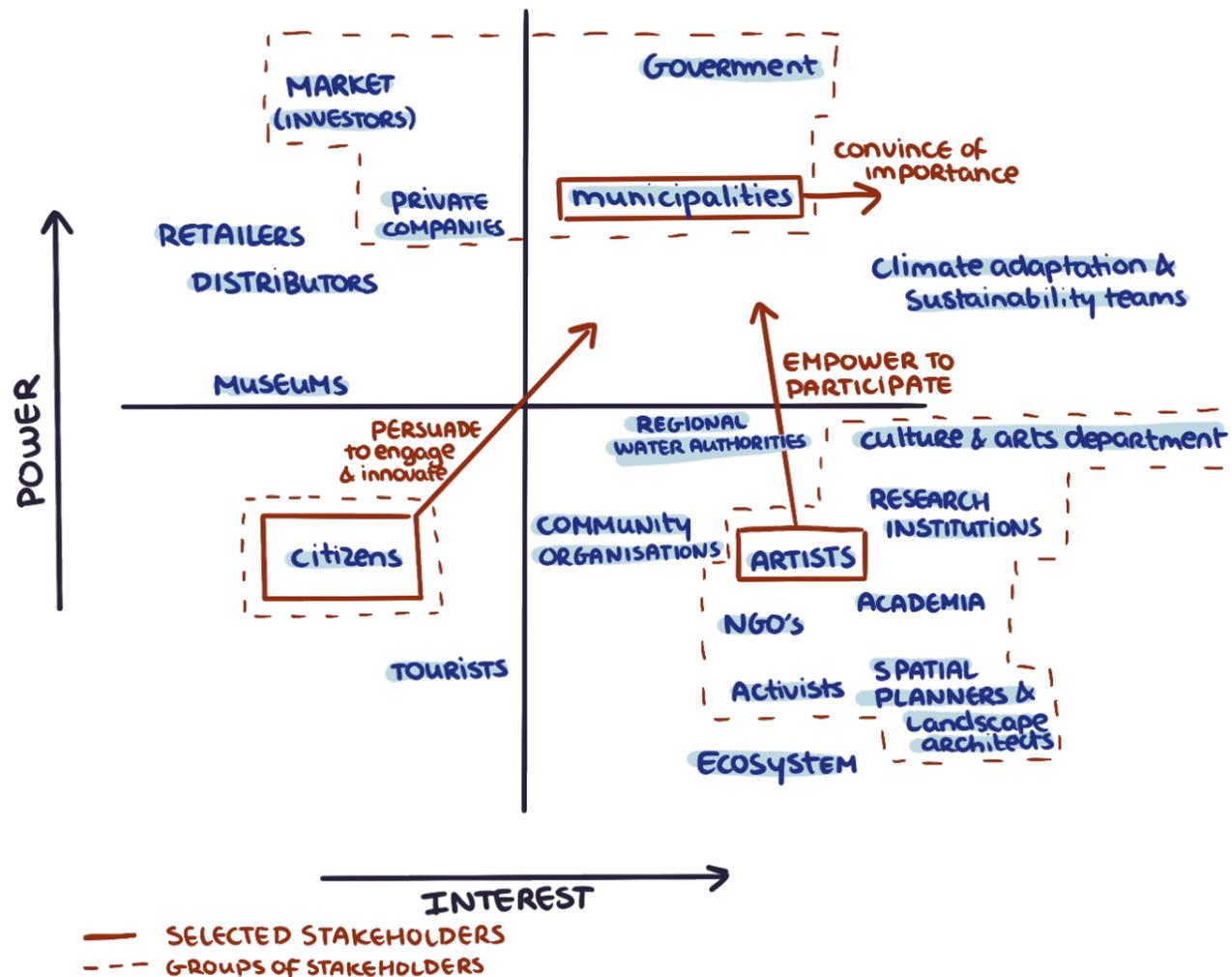


Figure 6.10: Power-interest matrix of the project (author, 2025)

Figure 6.11 shows the relationship between the outcomes of the concept (top) and the relationship between the users (bottom). The section in between elaborates on the interrelationships between outcomes and users. The following paragraphs explain how each user group engages with the outcomes.

Municipality

The municipality is the stakeholder that will make the most use of the concept. As the primary facilitator and initiator for redesigning public space, it has a responsibility for integrating art, supporting climate aware activities and communicate information for climate challenges and resilience. Municipalities also assign artists to create art that align with their objectives. The outcomes therefore serve as a guidance and direction on how to redesign public space. The street sheet provides measures of awareness that municipalities can consider in policies and public space redesign. The toolbox offers an easy tool to select a suitable solution for a specific location. Only a few choices must be made, and it will give a list of interventions that check the boxes. And the example book illustrates possibilities for combining art and climate resilient interventions. This is to help municipalities recognise the broader value of art beyond aesthetics, positioning art as an engaging and translating element in public space.

Artists

Artists are central stakeholders because they create the art that is the foundation of the climate-aware street concept. The municipality creates an assignment for artists to use. They use the concept more as an inspiration framework and a source of contextual and

environmental understanding. The street sheet provides awareness measures that can be translated in the art. The same with the toolbox is a way to educate the artist on the function and processes of climatic interventions. Particularly, the interventions that must be incorporated in the art. The example book offers references on how other artists have embedded climate into art installations.

Citizens

Citizens form the final and most socially significant user group. The long-term aim of this concept is to encourage citizen to actively engage in climate-resilient behaviour. The first step in this process is raising awareness of the solutions, which could be supported by municipal communication and the presence of climate art in public space. Over time are expected to interact with the art, develop understanding of its meaning, and ultimately engage in climate action in collaboration with other citizens. The toolbox serves as the primary outcome for citizens, providing accessible knowledge on climate solutions and helping to identify the most suitable option for their own street. The street sheet and example book function as an inspirational and educational source, offering insights into the concept and the application of art in public space.

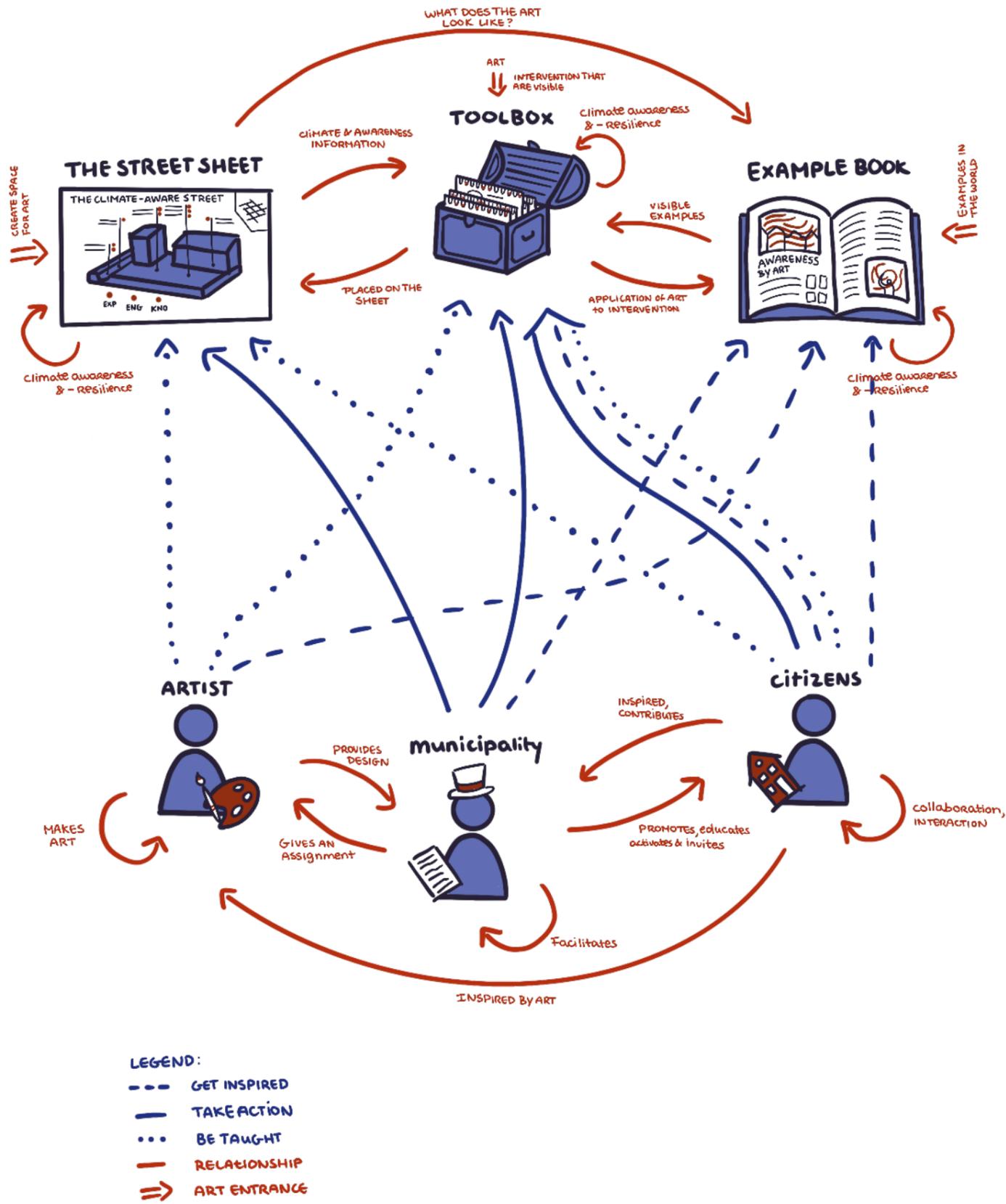
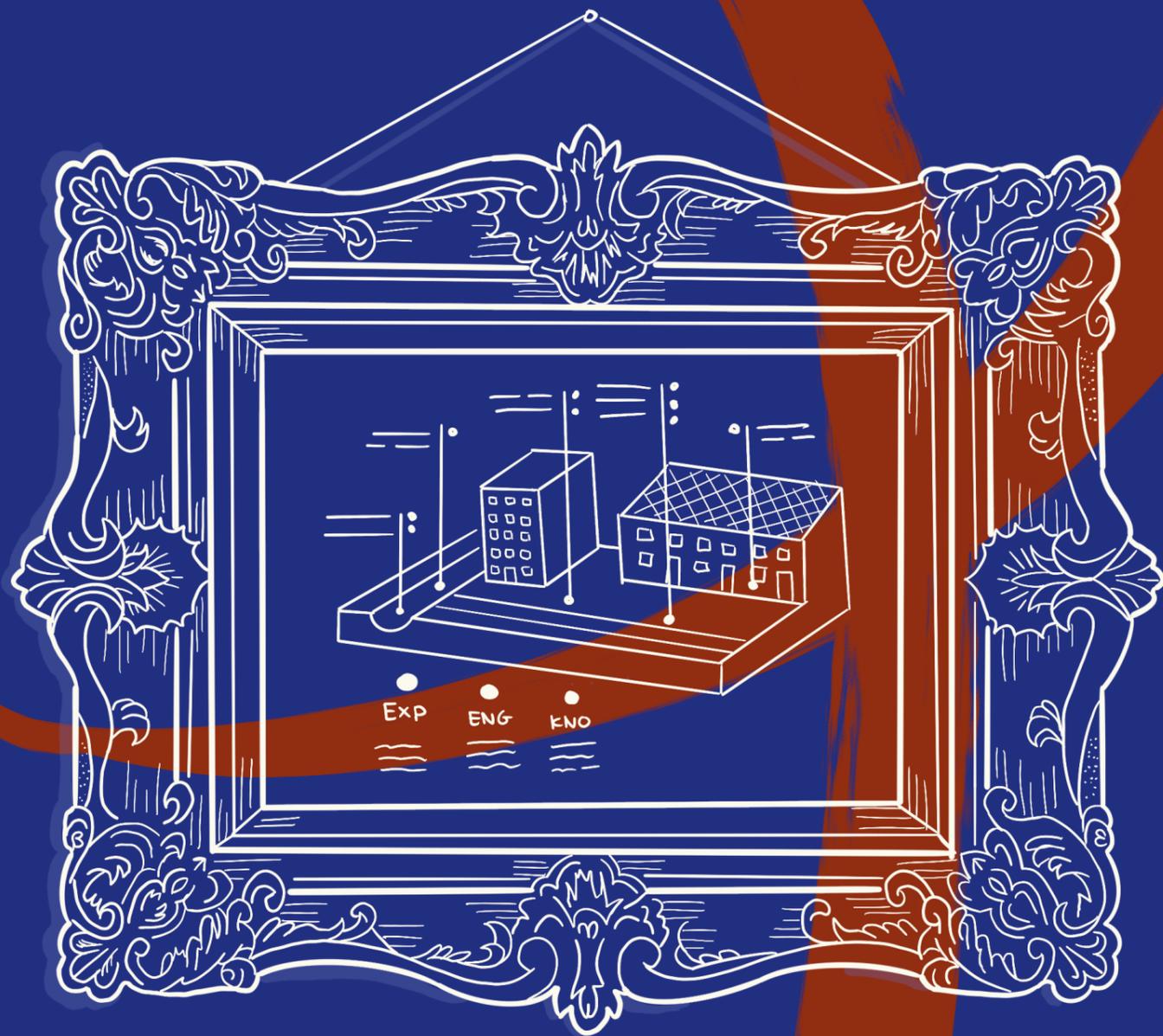


Figure 6.11: Relationship between the users and the outcome (author, 2025)



CHAPTER 7 CONCLUSION AND DISCUSSION

The frame

CONCLUSION

This thesis demonstrates that integrating art into street design offers a powerful and multidimensional approach to enhancing climate resilience and create climate awareness. The climate-aware street concept developed in this research shows that the combination of visible climate interventions, art in public space and awareness mechanisms, experience, engagement and knowledge, can transform a street into a space where climate resilience becomes tangible, perceptible and meaningful for its users. The outcomes toolbox, street sheet and awareness by art example book, create a multilayered approach to answer the following research question:

How can a street design concept integrating art in public space, enhance climate resilience and create climate awareness?

First, the research presents the importance of climate resilience in public space. Temperatures are rising, the winters become wetter, the summers drier, and more extreme weather events are expected in the future (KNMI, 2023). These climate extremes are the driven factor to find a solution.

Interventions contributing to climate resilience are already existing, however, these are mostly invisible for the human's eye which makes it difficult for individuals to understand and act upon enhancing resilience. This thesis highlights that art can bridge this gap, by translating the technology into tangible art and engage individuals through art.

A toolbox with visible climate interventions contribute to tackling the climate extremes too hot and too wet. Climatic processes such as shading, evaporation, evapotranspiration, ventilation, reflection, water retention, and water storage are integrated in the toolbox. For each intervention, information is given about which microclimatic processes it oversees; on which spatial scale it is applicable; which climate extremes it tackles; in which street typology to apply; which mechanism of climate awareness it involves and where on the gradient of awareness the intervention is located. Art has the capacity to reveal how the interventions work and why they matter. When a user of the toolbox is seeking to enhance climate resilience on a specific location it can filter the intervention on these aspects to find the most

suitable intervention for the location. In this way, the toolbox sorts out the solutions for tackling climate challenges.

The integration of the awareness mechanisms provides an understanding of how art can create awareness. The thesis uses the theory of Itturiza et al. (2020) to explain climate awareness in three mechanisms: experience, engagement and knowledge. The mechanisms are expanded with a gradient; experience from sensation to visibility; engagement from interaction to activation; and knowledge from impact to technical. Awareness is a layered process that develops over time, shifting from momentary perception to long-term behaviour change.

The street design concept, visualised through the street sheet and supported by the toolbox, demonstrates how art and climate interventions can coexist as a coherent system. The concept is based on an archetype street, which means it can be transferable to various locations and is scalable to a multiscale network of climate-aware streets. The street sheet shows the layered concept of climate resilience, climate awareness and art in public space where municipalities, artists, citizens and other users can act upon.

Art can be applied in numerous ways. This thesis designed a booklet called 'awareness by art: examples' which displays 15 art creations that combine climate challenges and resilience with the mechanisms of awareness. It aims to inspire and create understanding in how art can function as a mediator to translate climate technology and knowledge and a way to engage people in contributing to climate resilience.

This thesis demonstrates that a street design concept integrating art in public space can enhance climate resilience by embedding visible climate resilient interventions, while

simultaneously creating climate awareness through experience, engagement and knowledge mechanisms. The result presents an approach in which users would communicate, understand, engage and participate collectively. Ultimately, creating climate art in public space accelerates the changes to achieve the objective of the Netherlands to climate resilient 2050 (Ministerie van Infrastructuur en Waterstaat, 2023). The art of resilience begins in the street, where climate and art meet.

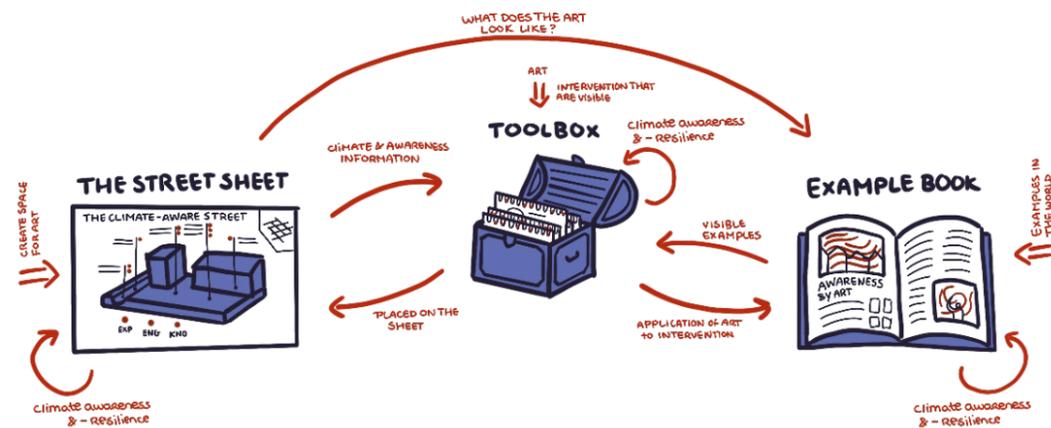


Figure 7.1: The key outcomes of this thesis and their relationship (Author, 2025)

RECOMMENDATIONS

As the primary recommendation, the key objective is to make climate resilience visible in public space. By implementing art in public space this could contribute to understanding the challenges and solutions of climate change and form a foundation for individuals to act upon it themselves or collectively. Design with the awareness mechanisms as the basis of creating the climate awareness in public space.

In addition, applying the mechanisms in the street design process would gain knowledge in how individuals would be aware of public space. Whereas most street designs would implement a certain ideal or system, it could be that users would not have the same perception on the purpose. By creating awareness in public space, make it visible through experience, invite users to participate through engagement, and share information through knowledge, individuals could become understanding of the proposed design.

Furthermore, individuals should engage more in the relations between art, technology and science. Creating art that combines these three elements not only contributes to enhancing

climate resilience but also functions as a mediator for creating public awareness through engagement and education. Municipalities, therefore, should implement public climate art in their policies about redesigning climate resilient streets to reach the climate resilience goals by 2050.

The last recommendation is to stimulate collaboration between different actors such as the municipality, artists and citizens. Only by shared responsibility and understanding the objectives of climate resilient streets can be achieved. Participation and engaging individuals in the design process and application could gain the social cohesion.

TRANSFERABILITY

This thesis has designed a street design concept through the context of an archetype street. This means that the street sheet, which explains the concept, can be seen as a template that could be applied on multiple contexts. The concept gives measures in how users can implement climate interventions and awareness mechanisms guidelines. The idea is that users consider the measures and guidelines to redesign their own specific location to create a climate-aware street. In the end, when several networks of climate awareness streets are formed, a network emerges that connects the streets and results in overlapping art and climate routes through the city.

Through the toolbox users can filter interventions that suit in their specific context. In that way is the toolbox as an extension of the street concept to create more transferability on several contexts. Users can give their preferences, and the toolbox filters the suitable interventions.

The example book on the other hand shows an inspiration and understanding on how art and climate issues are currently explored. These

are located on specific locations, however, could still be transferable to other locations. For instance, the temporary art of the Many Tree or Waterlicht changes location over time to engage a greater group of individuals. The same with green initiatives as Treetag or Halle Puget #2 Le jardin, which show the flexibility of art in public space.

In conclusion, the three outcomes, street sheet, toolbox, and example book, form a concept that is transferable to various locations. The teach, inspire and invite users to engage and participate in contributing to climate aware streets.

REFLECTION

The thesis combines the topic of climate change, climate resilience, climate awareness and art in public space to contribute to a comfortable environment for individuals living in it. This unites in the urban context of a street creating a new form of designing public spaces. In relation to the studio of metropolitan ecologies of place connection between streets results in a multiscale network of art, knowledge routes and blue green infrastructures. Beginning from a micro scale intervention to creating structures in the macro-scale.

Whereas the multiscale approach seeks the relation between the specific space and the bigger picture, this thesis achieves a multidisciplinary angle of social, climatic and artistic disciplines. Showing the scientific relevance of the project through the analysis and toolbox development of climate solutions interventions and relating them to topics as climatic processes, scale, street typologies, climate awareness mechanisms and climate awareness gradients. This shows the opportunities of climatic interventions for the purpose of public space.

Besides the scientific relevance through the climate approach, the thesis uses climate awareness to create a relationship with climate resilience. The social perspective proceeds in the understanding of climate-related matters and to engage and educate individuals to contribute to climate resilience. Taking the perspective of citizens give the insight in where scientific application is currently lacking. Municipalities on the other hand can use the outcomes to educate and implement the concept. The combination of social and scientific framework creates a complex narrative of interrelating processes.

The complex narrative of this thesis resulted in a creative process of research and design. This created a process that shifted from the original plan. Starting with the thesis the key focus was on analysing the city of Amersfoort through creating a spatial design strategy on a specific location. In this the topics of art and climate resilience were already a primary concept. However, while analyzing the topics, a spatial design became less interesting for this project. That is when a new street concept sparked my interest. Looking back at my time

during the bachelor, I now understand that my interest is mostly in the conceptualisation phase of a project. In the design courses, my interest was focused on a strong concept and narrative and realising the complete design came second. Therefore, in terms of the process of my graduation, I deviated from the original plan of designing a strategy for Amersfoort to developing an archetype street design concept that could be applied in many urban contexts. This approach worked a lot better and made working on this project a real pleasure.

Through the archetype street design concept, the research and design are deeply entangled with each other. The street concept is the design of the whole thesis, with the research of climate resilience, climate awareness and art in public space as the foundation. The research uses the methods of tool development and conceptual design to create the outcomes, toolbox, street sheet, and awareness by art: example book, which combines both environmental and social perspectives. Creating a box full of possibilities demonstrates on how municipalities, artists, and citizens can redesign their location. The street sheet gives guidelines to tackle your design with a climate awareness angle. Together these outcomes create a tool to tackle climate resilience and form both the research and the design (figure 7.2).

contexts. Likewise, the selection of climate extremes could be extended. This thesis focuses on too hot and too wet, leaving too cold and too dry outside the scope; incorporating these conditions would strengthen the applicability of the concept.

Second, future research could explore the financial implications of integrating art into public space. In an interview Marieke Sikkens, person who is in charge of art at the municipality of Amersfoort, explained that costs could differ around 40.000-200.000 euros depending on the size of the project. The cost can therefore be very high. However, it may also yield financial benefits through funding streams from various cultural, environmental and municipal sources, for example funding from het Mondriaanfonds. Understanding how public space design, art, and climate resilience can be jointly financed would offer valuable insights. Additionally, maintenance remains a recurring challenge in art project. In combination with increased vegetation or interactive installations may require substantial upkeep, which entails costs. Therefore, would costs, through financial implications, funding and maintenance be an interesting expansion on the thesis.

Finally, the behavioural change of individuals could have an influence on the climate awareness. Awareness is a subjective phenomenon and varies across individuals, shaped by factors such as culture, political orientation, financial circumstances, and life stage. Since awareness evolves over time, the concepts proposed in this thesis should be periodically reevaluated to ensure they continue to resonate with changing perceptions and behaviours.

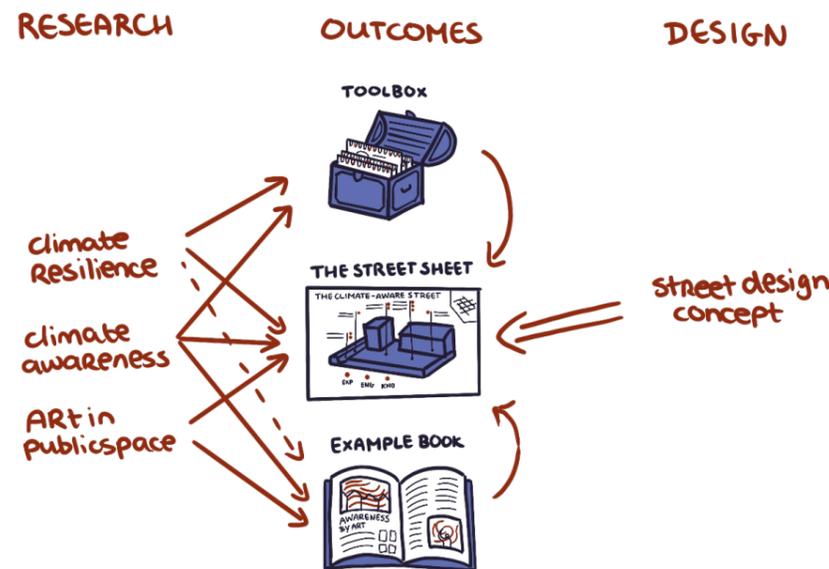


Figure 7.2: The relation with the outcomes, research and design (Author, 2025)

Research limitations

For future research, several directions can be proposed. First, the scope of the toolbox could be expanded. This thesis evaluates only three of the fourteen street typologies identified by Kleerekoper (2016), namely garden village, working class district, and garden city low-rise. A broader analysis, incorporating all typologies, could provide a more comprehensive understanding of how the climate-aware street concept performs across different urban

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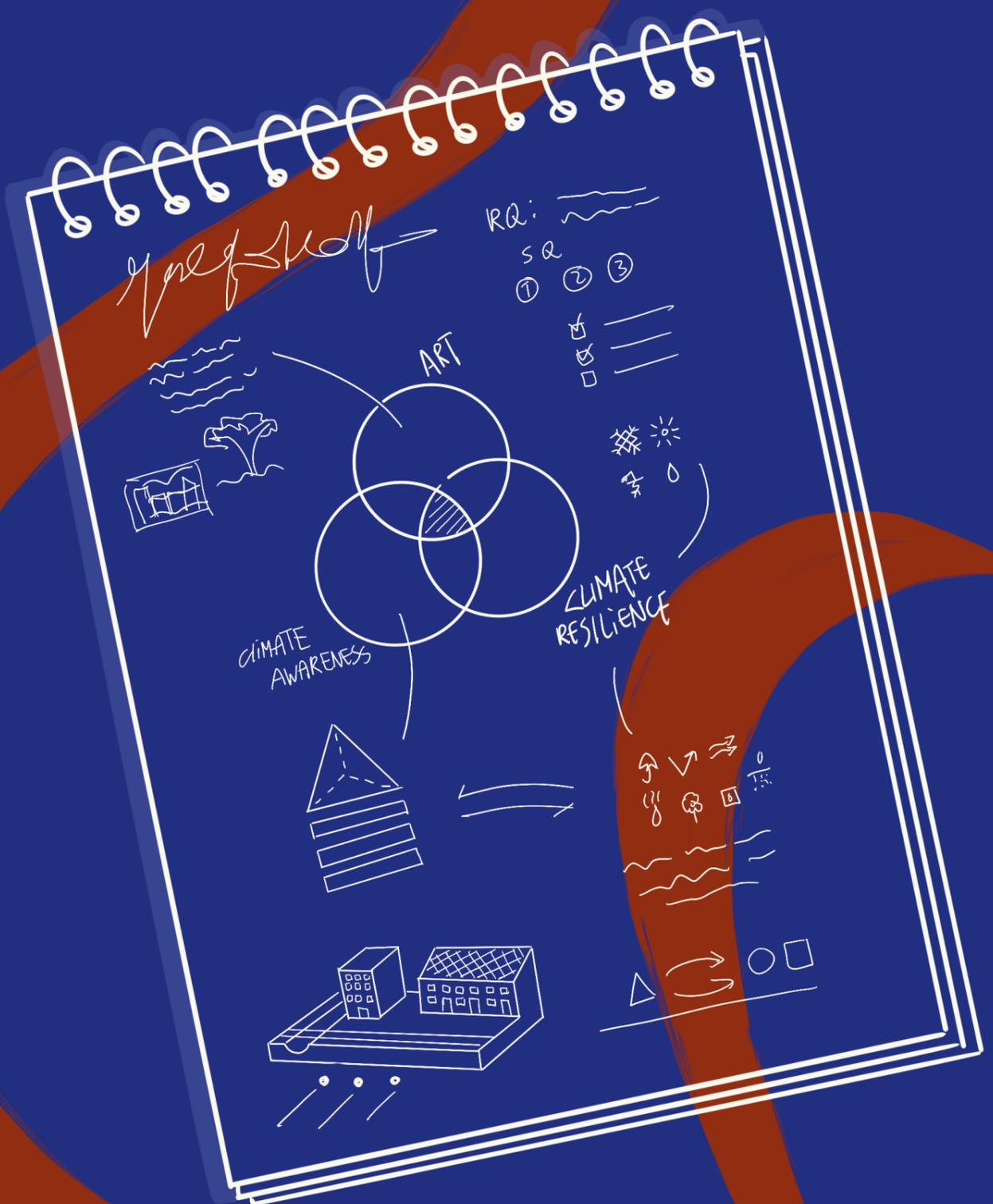
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Appendix

- A. Dutch tables and figures
- B. Casestudy Amersfoort: Analysis and synthesis
- C. Process art commission
- D. Assignment letter

A. Dutch tables and figure

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Tabel met kenmerken wijktypologieën op basis van Kleerekoper (2016)

Wijktypologie	Bouwperiode	Kenmerken
Stedelijk bouwblok	voor 1930	geen voortuin of groenstrook, 4-5 lagen
Vooroorlogs bouwblok	1900-1940	niet altijd voortuin, 3-4 lagen, bredere straten dan stedelijk bouwblok en soms groenstrook
Tuindorp	1910-1930	ruime voor- en achtertuinen, 2-3 lagen, veel langsparkeren, jaren 30-bouwstijl, beperkt gemeentelijk groen, vaak geen straatbomen
Volkswijk*	1930-1940	geen voortuin, weinig gemeentelijk groen, 2-3 lagen, eengezinswoningen
Naoorlogse tuinstad laagbouw	1945-1955	open bouwblokken met veel groen, 2-3 lagen, eengezinswoningen
Naoorlogse tuinstad hoogbouw	1950-1960	open bouwblokken met veel groen, 4-6 lagen, appartementen, berging op begane grond
Naoorlogse woonwijk	1940-1990	voor- en achtertuin, 2-3 lagen, eengezinswoningen in rij, twee onder een kap of vrijstaand
Bloemkoolwijk	1975-1980	eengezinswoningen met voor- en achtertuin, kronkelende stratenpatronen, hofjes, brede groenstrook rondom de wijk
Hoogbouw stadscentrum*	1960-heden	meer dan 10 lagen, gebouwen in grid
Sub-urbane uitbreiding - Vinex	1990-2005	eengezinswoningen in rij, twee onder een kap, vrijstaand, appartementen

* Voor de typologieën Volkswijk en Hoogbouw stadscentrum zijn geen praktijkvoorbeelden opgenomen in dit voorbeeldenboek.

Figure A.1: Characteristics street typologies based on Kleerekoper (2016)

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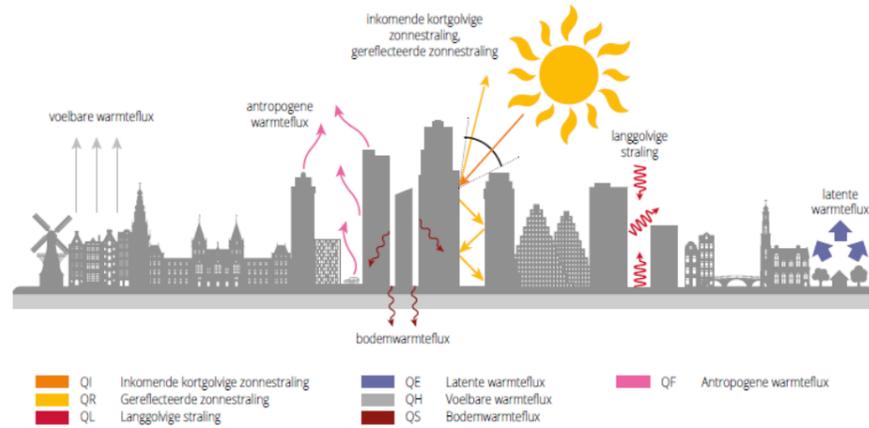


Figure A.2: Energybalance of the Urban Environment (in Dutch) (Kluck et al., 2020)

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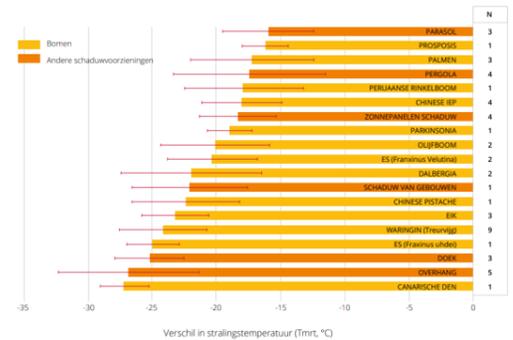


Figure A.3: The difference between different shading elements - trees in yellow and other shading facilities in orange - expressed in radiant temperature (Tmrt). The right column shows the amount of measurements done in Phoenix, Arizona. (in Dutch)(Schneider et al., 2019)

B. Casestudy: Amersfoort

Amersfoort serves as the case study for this thesis. The city is centrally located in the Netherlands, in the province of Utrecht, with a population of approximately 160,000 inhabitants, making it the fifteenth-largest Dutch city (Gemeente Amersfoort, 2023). Its centrality in the Dutch urban network, positioned between the Randstad and the northern and eastern provinces, makes Amersfoort an important regional connector, supported by railway and highway infrastructures (Metz & Van Essen, 2021) (figure B.1). The cityscape is characterized by diverse landscapes: the Utrechtse Heuvelrug forests, the Gelderse Vallei agricultural lands, and the peat landscapes of Eemland (figure B.2).

Amersfoort has recently been recognized for its quality of life and innovative planning, receiving the “City of the Year 2023” award from the Academy of Urbanism (2023). At the same time, however, climate assessments reveal structural vulnerabilities. The municipality’s omgevingsvisie (environmental vision) and omgevingsrapportage indicate that Amersfoort scores low on climate adaptation, particularly in heat-resistant public space, water storage, and drought resilience (Lindeboom et al., 2022). The city already faces extreme heat, drought, and heavy rainfall, and projections show these challenges will intensify in the coming decades (KNMI, 2023).

Amersfoort has formulated ambitions for 2030–2040, focusing on sustainability, resilience, and social cohesion (B.3). Yet the gap between technical adaptation and public awareness remains significant. This creates an urgent need to explore how interventions in public space can simultaneously strengthen climate resilience and create citizen awareness. This thesis therefore proposes Amersfoort as a testing ground for strategies that integrate art, design, and climate adaptation, to demonstrate how visible and engaging interventions can bridge this gap.

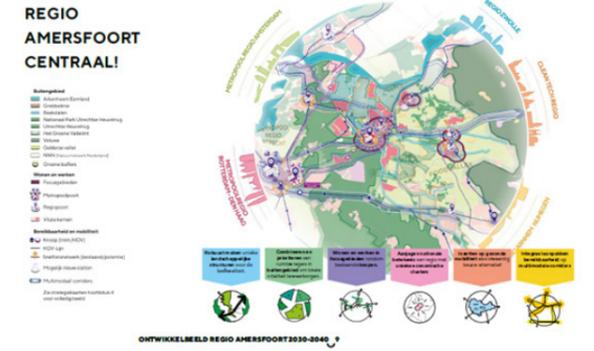


Figure B.1: Regional connection of Amersfoort (Metz & Van Essen, 2021)



Figure B.2: Amersfoort landscape and rivers (Gemeente Amersfoort, 2023)

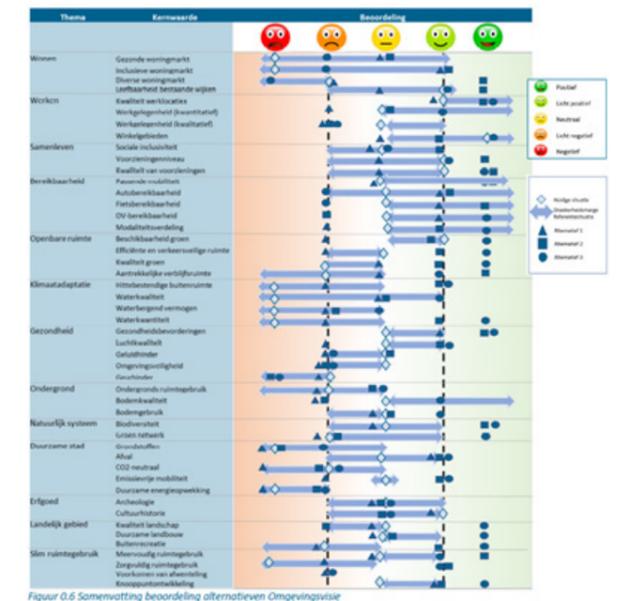


Figure B.3: Assessment Amersfoort on the ‘Omgevingsvisie’ (Lindeboom et al., 2023; Gemeente Amersfoort, 2023)

B. Analysis of Amersfoort - facilities

This map shows the presence of facilities such as education, shopping, religion & culture, sport, care, parks, business and public toilets, throughout the city of Amersfoort. They visualize the places for people to stay and meet and the most common routes of transportation that link these various places. Concluding from this map the different areas have several facilities throughout the neighbourhood. With two primary business areas on the east and west side of Amersfoort and 3 train stops creates an entrance into the city.

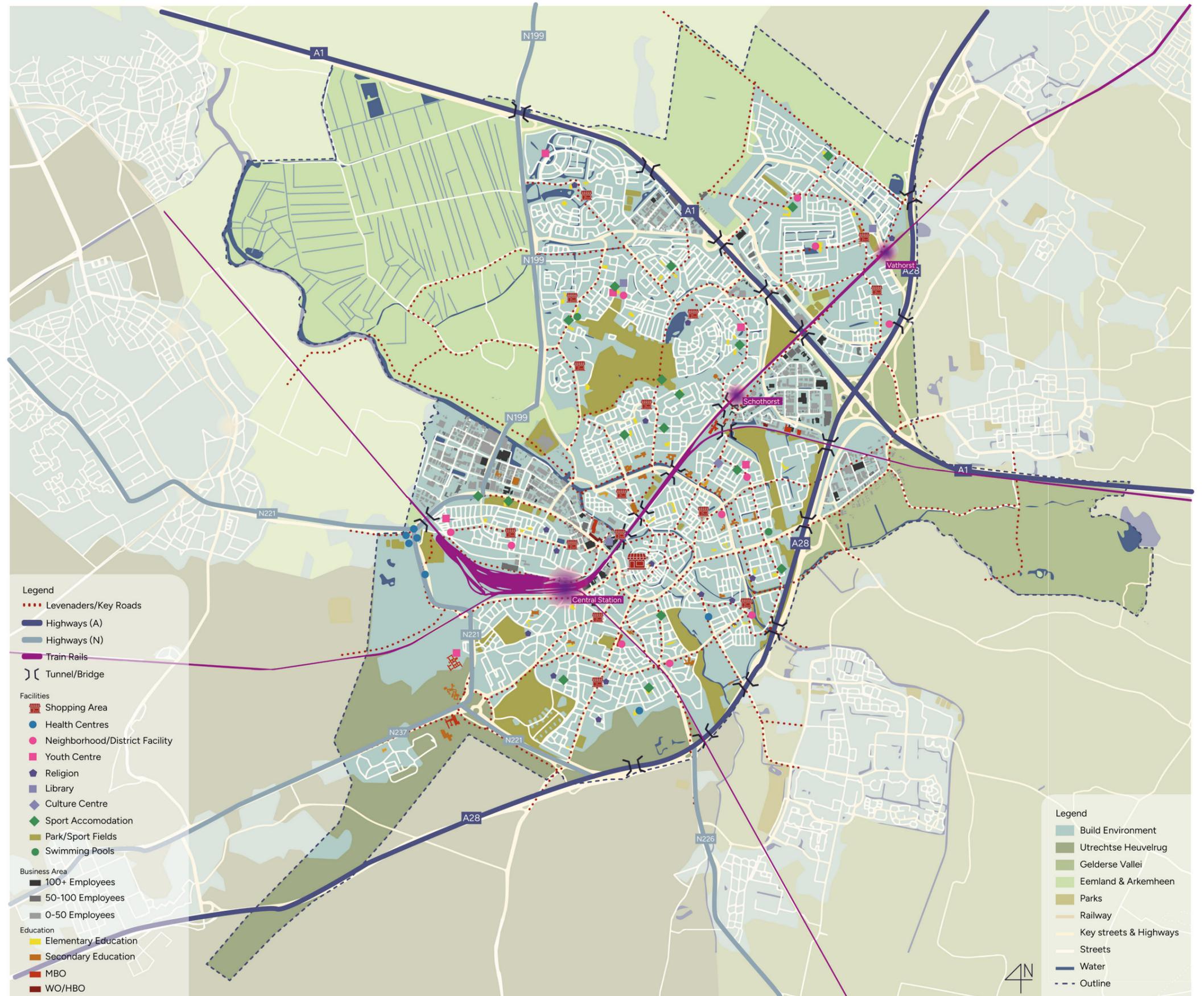


Figure B.4: facilities analysis Amersfoort (author, 2

B. Analysis of Amersfoort - Climate extremes

The map of climate extremes combines the analysis of climate research on water nuisance, perceived temperature, heat island effect, distance from cool spaces and water storage ability. The extremes of these are visualised and overlap with each other. This should help understand the areas of attention and challenges that public space is going to deal with. In terms of heat and flooding the areas in and around the old city centre are most vulnerable to heat problems.

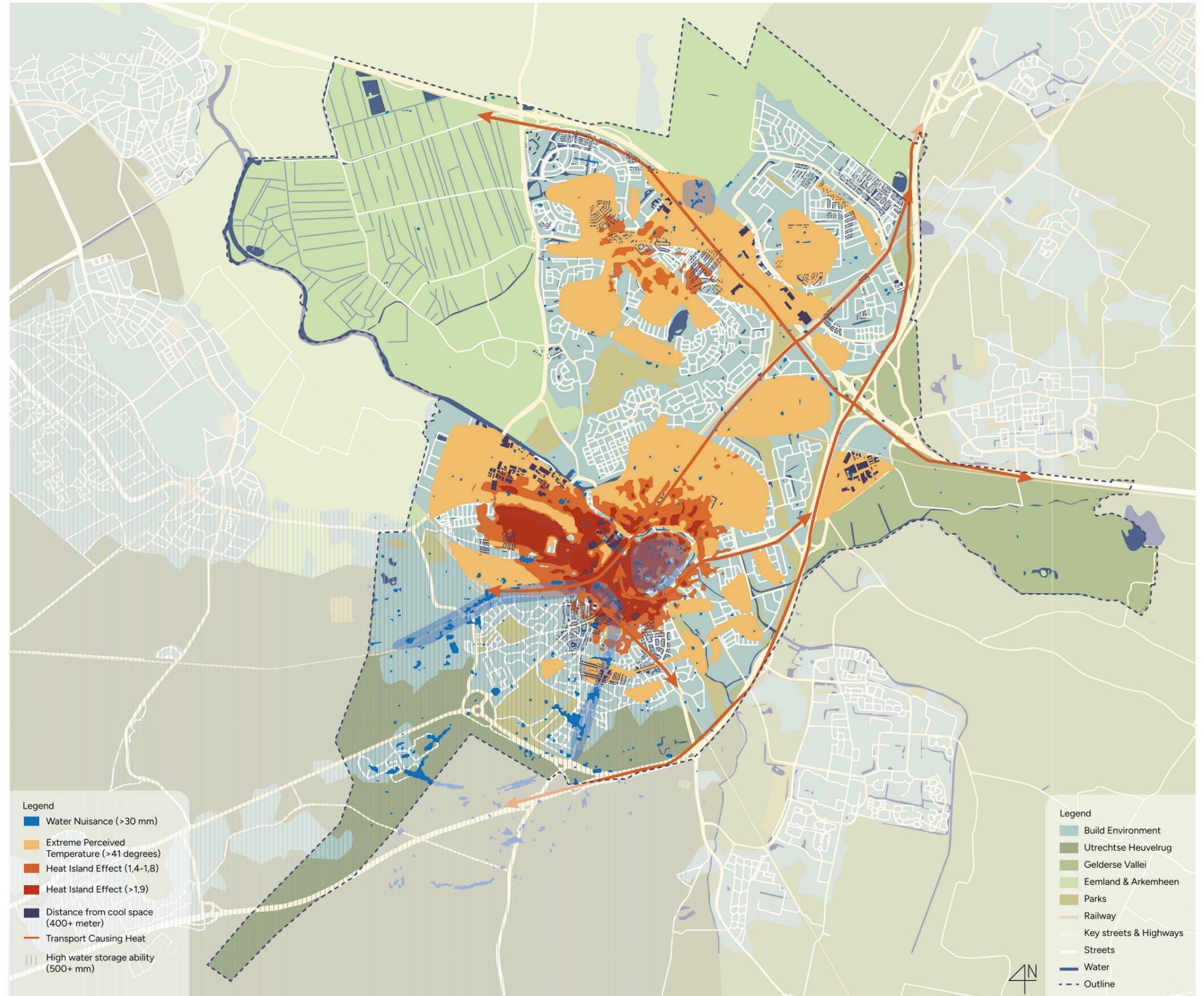


Figure B.5: Climate challenges analysis Amersfoort (author,

B. Analysis of Amersfoort - Art

Amersfoort already has a distinct collection of around 200 artworks throughout the city. This analysis represents where these art installations are placed and in which way they are visible by the human eye. There is a clustering of artworks in the old city centre which concludes that the city centre is quite full.

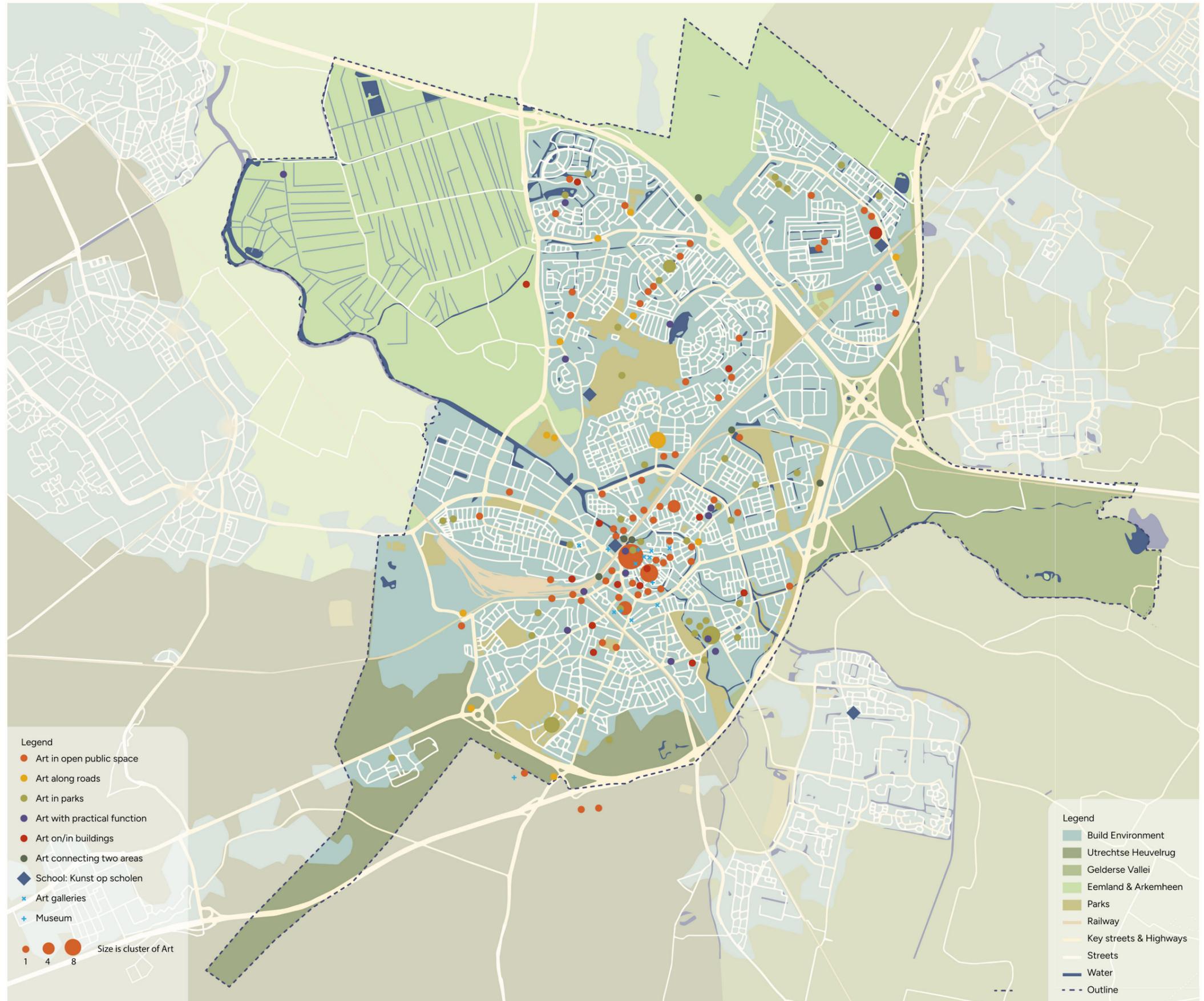


Figure B.6: Art analysis Amersfoort (author, 2

B. Analysis of Amersfoort - street typologies

The last analysis displays the different street typologies in Amersfoort. It divides the building periods of Amersfoort in clusters. Simultaneously with the climate extremes the different typologies that have a significant impact on public space form the foundation on which street typologies should be analysed.

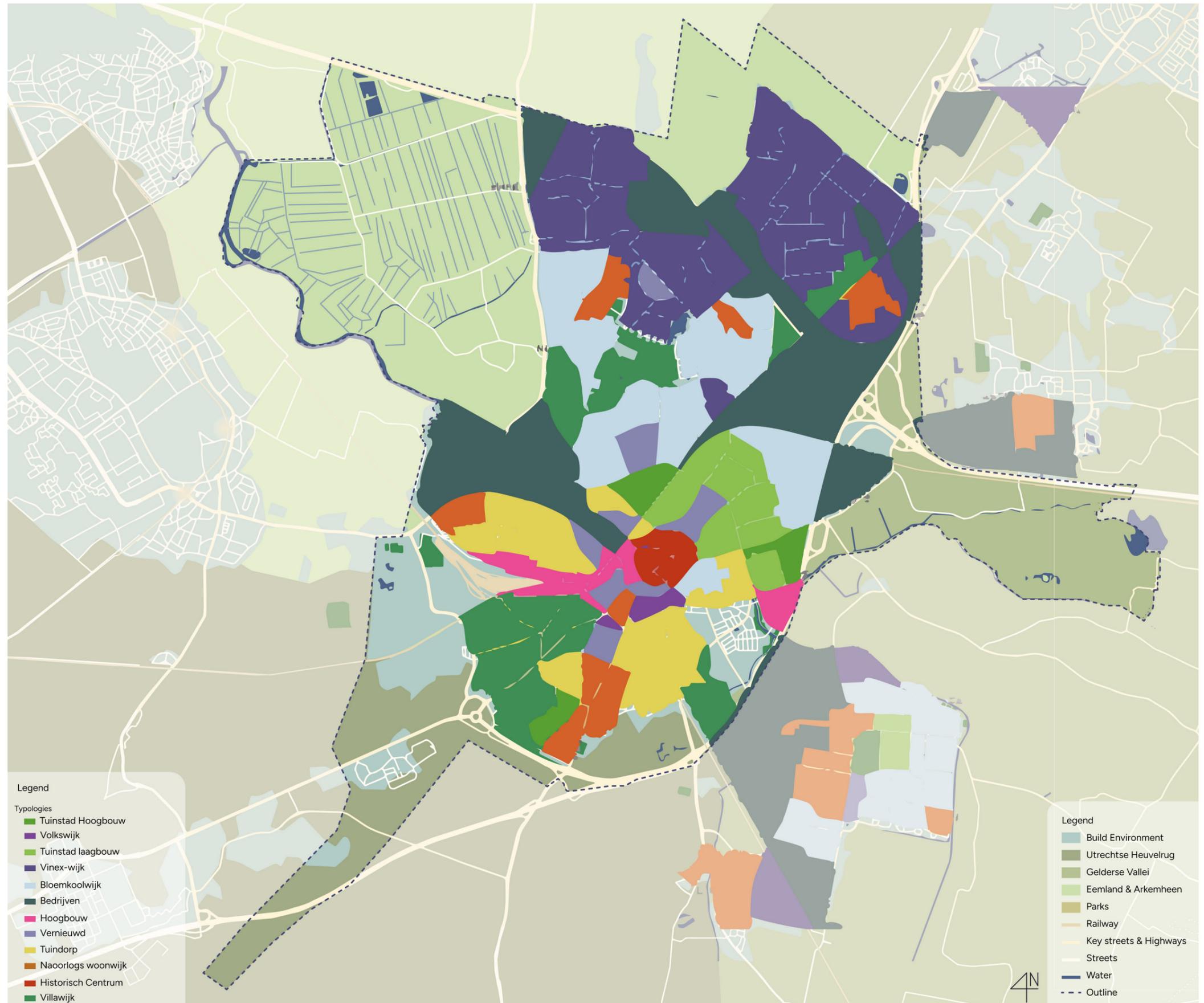


Figure B.7: Street typology analysis Amersfoort (author, 2025)

B. Synthesis of Amersfoort

Overlapping the 4 different maps creates this finalised map in which the extremes are made visible. From this map three typologies have been chosen that have a high climate extreme challenge and form a cluster of different facilities. The typologies are garden village (tuindorp), working-class district (volkswijk) and garden city low rise (tuinstad laagbouw).

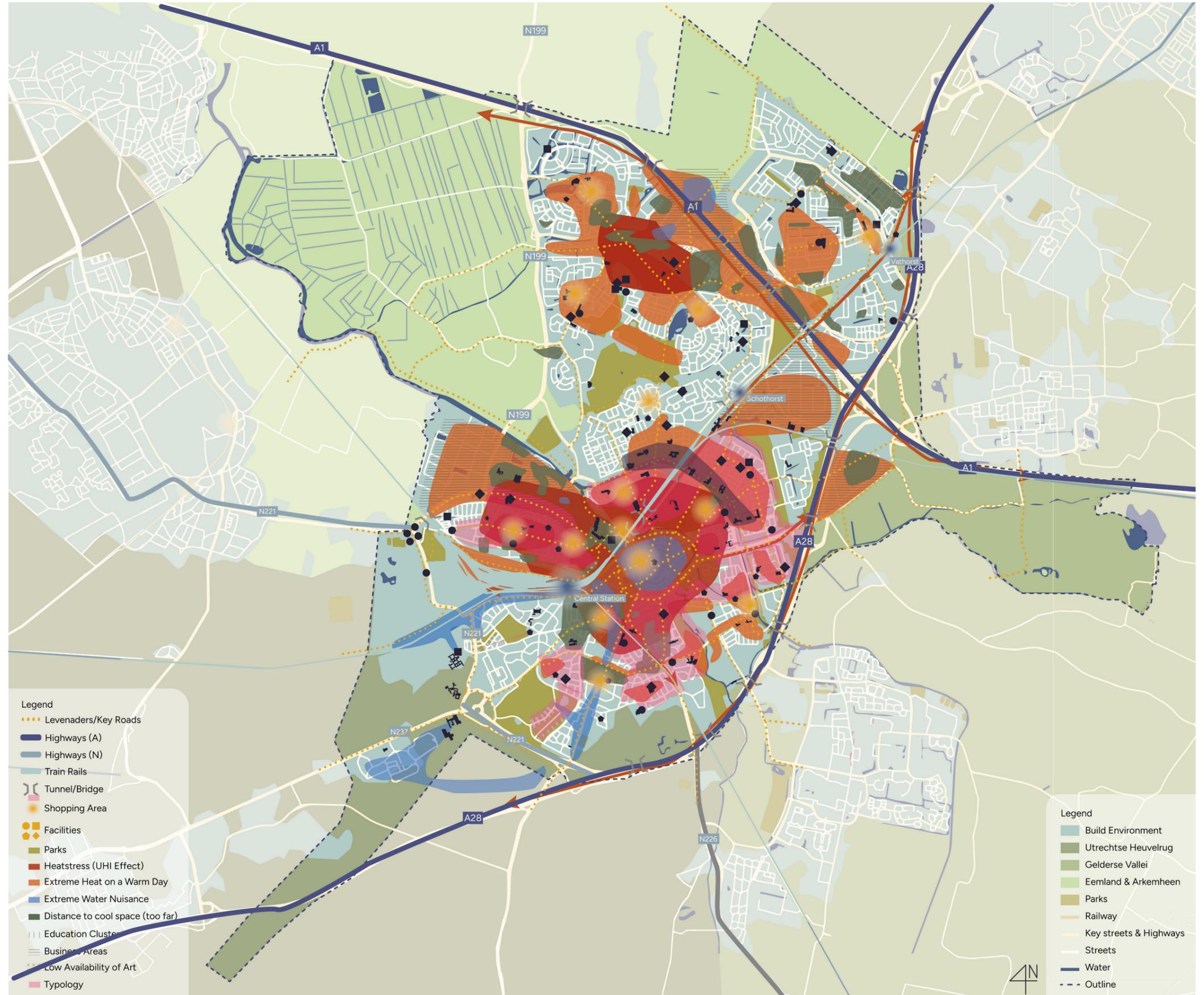


Figure B.8: synthesis map Amersfoort (author, 2025)

C. Process art commission

This diagram outlines the structured process of developing, commissioning, and implementing a public art project, from initial assignment to final realisation. The process emphasizes interdisciplinary collaboration, stakeholder involvement, and contextual integration throughout all phases.

The process begins with the definition of the assignment, often initiated by a client such as a municipality, educational institution, or housing corporation. The location typically functions as a strategic entry point within the urban fabric, such as a city hall, school, or public square. At this stage, the objectives of the art project are established, including its societal relevance, spatial context, and thematic focus.

Subsequently, a project team is assembled, consisting of an architect, project leader, client representatives, potential end users, and urban or spatial designers. Together, they assess the spatial and social conditions of the site, define constraints, and identify opportunities. Expert consultations are incorporated to ensure the artistic concept aligns with technical, spatial, and societal requirements.

The next phase involves the selection of artists, often through an open or invited call. Artists are chosen based on criteria such as artistic quality, contextual sensitivity, and relevance to the project goals. Around three shortlisted artists develop preliminary concepts, which are reviewed by a selected committee. This committee evaluates the proposals in relation to feasibility, budget, spatial integration, and conceptual strength.

Following selection, the chosen artist enters a design development phase, refining the concept in collaboration with stakeholders and experts. This phase includes technical elaboration, material selection, cost estimation, and spatial detailing. Public engagement and participatory

methods may be employed to incorporate local knowledge and foster community ownership.

The process then moves into the execution and realisation phase, during which the artwork is produced and installed. This stage requires coordination with contractors, engineers, and municipal departments to ensure safe and sustainable implementation. Budget control, planning, and quality assurance are critical components of this phase.

Finally, the process concludes with placement, delivery, and maintenance planning. Ownership and responsibility for long-term maintenance are formally assigned, often to the municipality or client. In some cases, additional funding is secured through cultural grants or external funds. The completed artwork contributes to the public realm by enhancing spatial quality, social engagement, and cultural meaning.

Overall, the diagram presents public art commissioning as a collaborative, iterative, and context-driven process, in which artistic expression, spatial design, and societal values are closely intertwined.

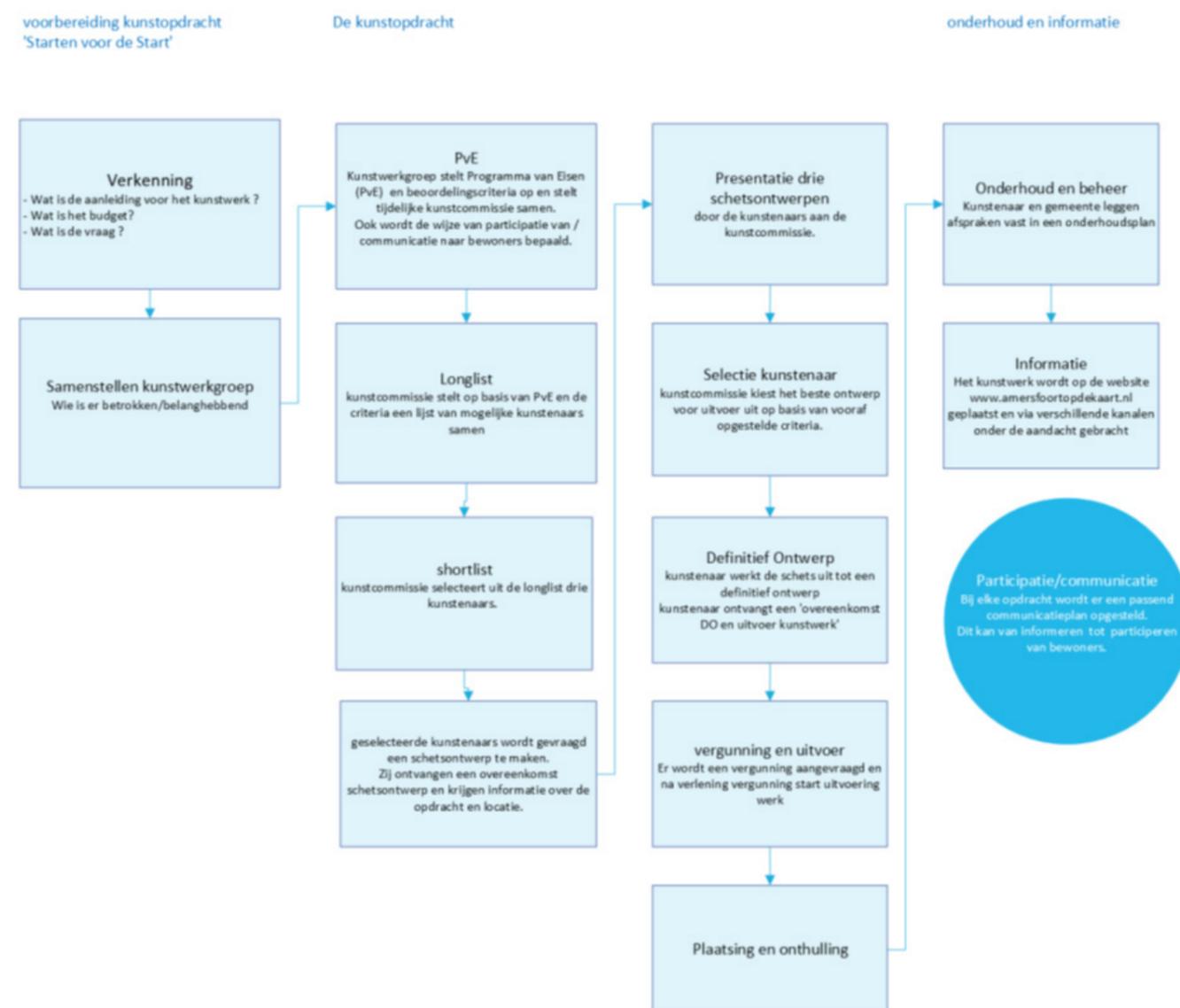


Figure C.1: Process of an art commission in Amersfoort [Dutch text] (Gemeente Amersfoort, z.d.)

D. Assignment letter

The process describes the distinct phases in which actors can play a role. For municipalities, the assignment specifics form the basis for building climate resilient art in public space (figure x). It defines the expectations and framework for a public art project and is structured around both substantive and practical considerations. On a content-related level, the brief outlines the project's underlying motivation, identifying the initiating parties and situating the commission within its institutional, social, and spatial context. A thorough analysis of the site is required, focusing on urban design characteristics and explaining why an artistic intervention is necessary at this specific location and what meaning it may generate within the urban environment.

The brief establishes an artistic and conceptual direction, indicating the general type or nature of the artwork in order to guide and limit the selection of artists. At the same time, artistic interpretation remains open: artists are granted freedom to respond creatively to the commission, while only practical and contextual conditions are fixed. Clear project objectives are formulated, allowing for qualitative and/or quantitative evaluation of the artwork's outcomes.

On a practical level, the commission specifies the desired final result and outlines a structured planning process. This includes the formulation of the assignment and objectives, the design and development phase, financing, permits, public support, procurement procedures, and execution. Documentation of the entire process is required to ensure transparency and accountability.

Financial aspects are addressed comprehensively. The budget is recognized as variable and dependent on factors such as project scope, duration, artistic medium,

material choices, innovation, involvement of third parties, and the artist's level of experience. The artist's fee is determined in relation to the total art budget and follows established professional guidelines, such as the percentage-based fee regulations for visual artists. In addition, the brief accounts for supplementary costs, taxation, and identifies potential funding sources. These may include internal municipal resources, such as cultural budgets, percentage-for-art schemes, construction budgets, or communication funds, as well as external financing through sponsorships, cultural funds, or crowdfunding initiatives.

Combining these elements in a letter, creates an example on how municipalities could tackle public space through art. Figure x gives an example of the content and practical information needed on the letter. Here the introduction of climate resilient and climate awareness measurements can be implemented in the letter to incorporate these in the final design.

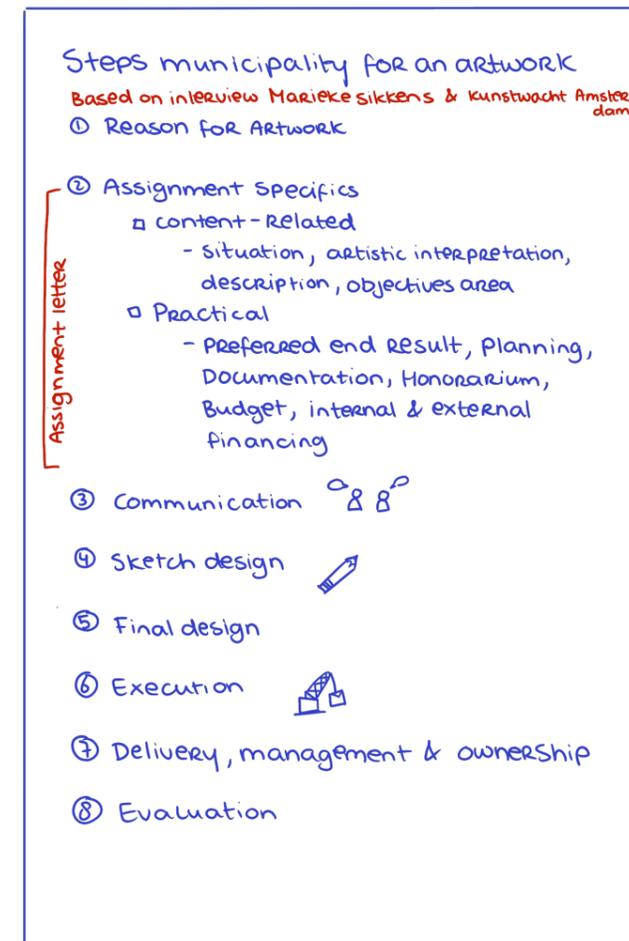


Figure D.1: Phases of the creation of an artwork used by municipalities (author, 2025)

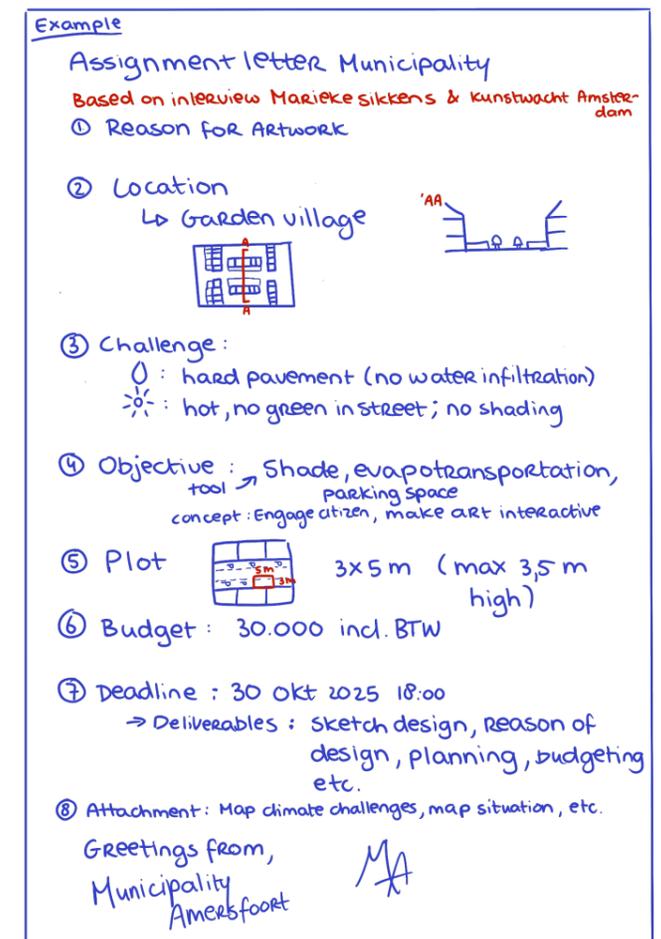


Figure D.2: Assignment letter elements example (author, 2025)

