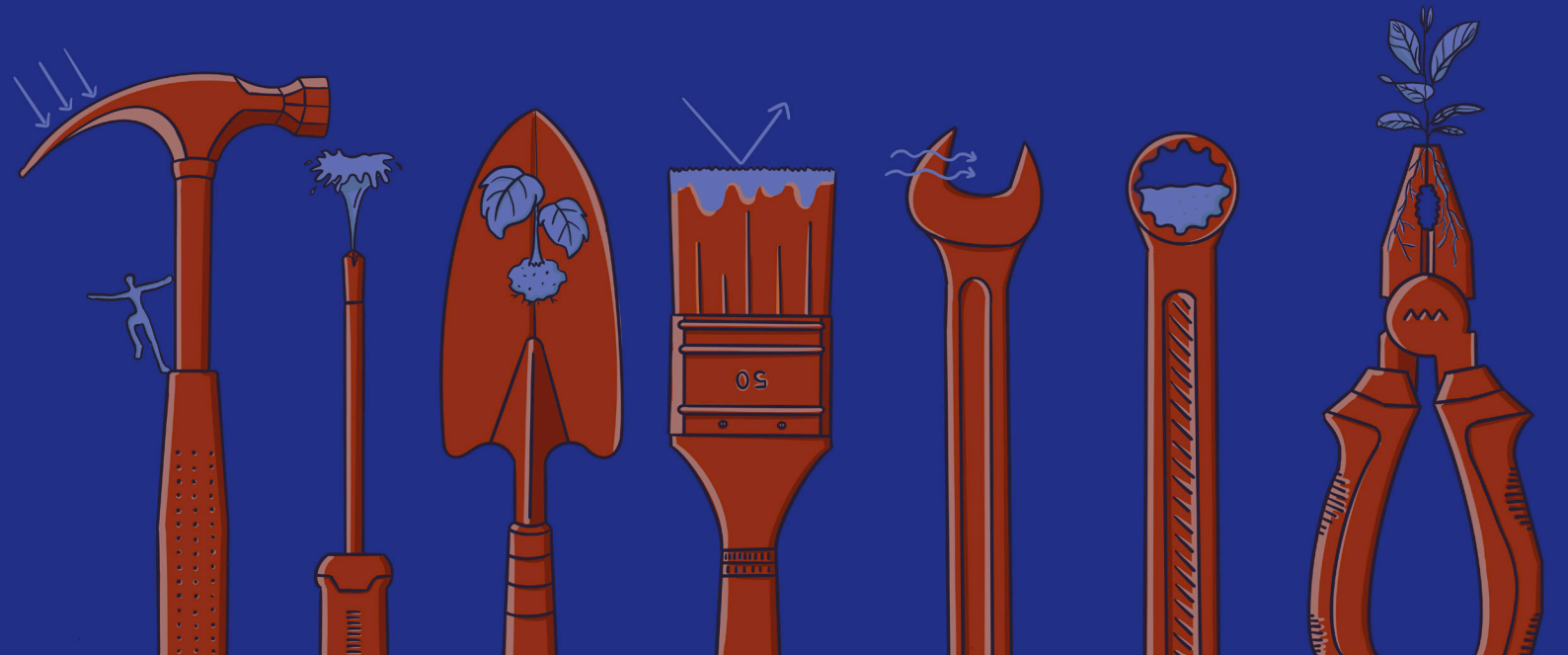
TOOLBOX

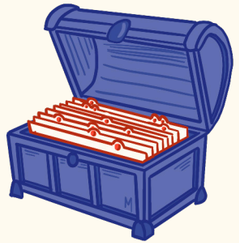
Which climate intervention will shape your street?



A BOX FULL OF POSSIBILITIES

What is this toolbox?

As the title suggest, a box full of possibilities presents a collection of design interventions that municipalities, artists, residents can use to gain knowledge and awareness of climate-resilient solutions and use in redeveloping urban space. The analysed interventions are visible above-ground to capture attention to the human eye. This box serves as a tool to initiate the development of the climate-aware streets, where climate challenges and awareness mechanisms act as the foundation for art in public space.



THE BASE OF THE CANVAS

Why do we need the toolbox?

In the context of the increasing climate challenges, strengthening climate resilience requires more than redesigning public space, it demands climate awareness, understanding and engagement. Current climate interventions often remain invisible, limiting their educational value and societal impact. By intergrating art, this toolbox offers accessible ways to communicate challenges and solutions, create awareness to humans and engage humans in contributing to climate resilience. It provides municipalities, artists and residents with a structured set of possibilities to initiate climate-aware streets, create communtiy dialogue, and building collective responsibility for climate resilience.

SHARING THE BOX

Who would use the toolbox?

The toolbox is designed for a broad group of stakeholders who would like to get involved in climate matters. For each stakeholder it could have a different aim. Municipalities can use it to inspire and educate residents while redesigning climate-aware streets and to engage them in the decision process. Artists may use the toolbox to integrate climate resilience and awareness in their art installations. Residents can use it to understanding the challenges and solutions and to participate actively in reshaping their streets.The toolbox supports collaboration across different layers of stakeholders.

EXPLORING THE INTERVENTIONS

How to use the toolbox?

How the toolbox is used depends on the users objective. If the aim is to explore, educate or inspire themselves than just play around and learn. However, when adressing a specific location that requires climate-resilient improvement, the use becomes more targeted. In such cases, users should define the criteria of the site they would like to tackle, such as tartgeting specific microclimatic processes, selecting a spatial scale or prioritizing a particular awareness mechanism (all options can be seen in the template on the next page).
The toolbox than guides users to a set of choices, filtering the proposed interventions according to these preferences. The remaining interventions are the most suitable options for the context-specific criteria given and could support in the decision-making.

TEMPLATE

What to explore?

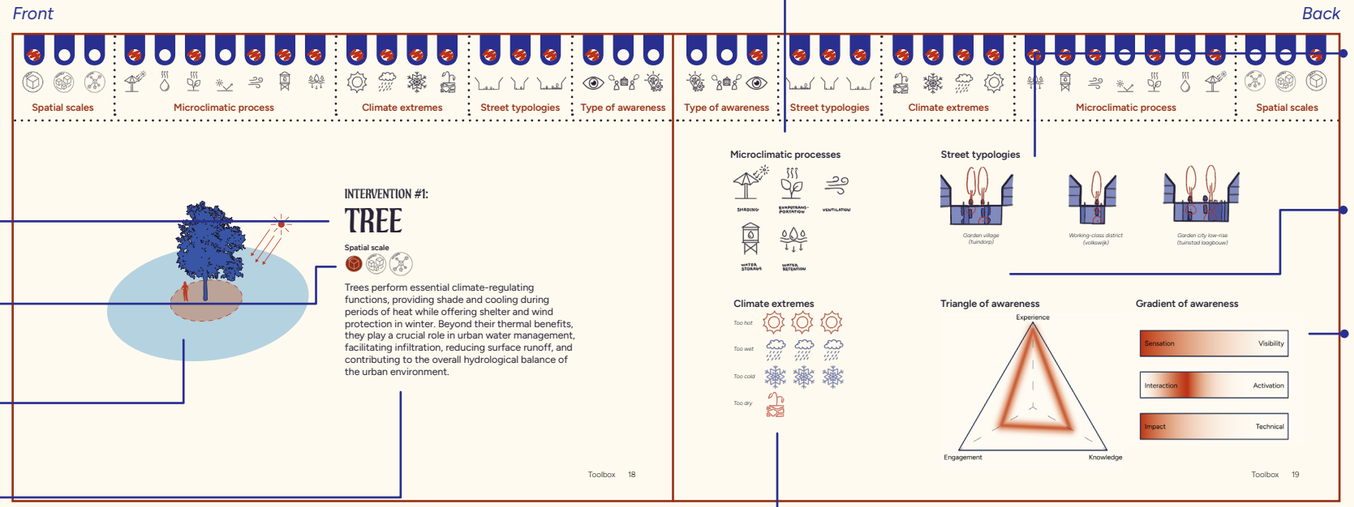
Checkbox
Summary of all the topics that are discussed about the intervention. This is a fast way to see which boxes it ticks. for instance, if users search for a micro intervention that contributes to the reduction of flooding it would be easier to see which interventions can be used

Title
Name of intervention

Scale
Size of the intervention in relation to a street: object (micro), ensemble (meso), network (macro)

Visualisation
Tool visualised in a simplified drawing

Introduction
Short information about the intervention



Microclimatic processes
Which climate processes does the intervention tackle. The analysed processes are: shading, evaporation, evapotransportation, ventilation, reflection, water storage, water retention

Street typologies
Spatial opportunity of the intervention in the 3 following street typologies: garden village (tuindorp), working-class district (volkswijk), garden city low-rise (tuinstad laagbouw).

Triangle of Awareness
This triangle visualises which awareness mechanisms it uses the most. this could be experience, engagement, or knowledge.

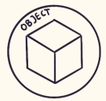
Gradient of Awareness
Each awareness mechanism operate alon its own spectrum, where a gradient visualises the specific way in which awareness is created. For experience these are: sensation and visibility; engagement: interaction and activation; and knowledge: impact and technical

Climate extremes
This evaluates how each intervantion influences future climate extremes; too hot, too wet, too cold, and too dry; either positively or negatively looking at the extremes. It is assesed on a four-point scale; 1 minor effect; 2 substantial effect; 3 large effect; - negative

SPATIAL SCALES

From micro-macro climate interventions

Art installations can be designed at multiple scales. This thesis categorizes them in the following scales: object (micro), ensemble (meso) and network (macro)

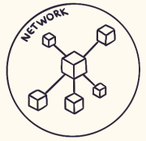


Object

Objects refer to micro-scale art installations 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 fountain, highlighting a localized aspect of climate resilience. They operate indepently from other art installations.

Ensemble

Ensembles represent to meso-scale art installations 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 socials dynamics in the urban environment.



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.

CLIMATE EXTREMES

Future weather scenario's if we don't take action (temperature and precipitation)

This thesis analyses the extremes of temperature (hot, cold) and amount of precipitation (wet, dry) and visualises their relation in a graph that represents the different scenario's

Too hot

Cities are becoming more dense, paved and industrialised. This results in warmer temperatures in urban environments which has signifigant impact on the spatial quality and health of humans (Kleerekoper et al., 2024). Interventions that incorporate shading, evaporation, evapotrans-portation, ventilation and reflection could cool down the urban environment

Too wet

According to KNMI (2023), short extreme rainfall are expected to occur with increasing frequency in the future Cities, however, are not designed to store, retain and drain such large volumes of water. Implementing interventions that focus on retention and storing water can help prevent the flooding of streets and reduce pressure on urban drainage systems

Too cold

The opposite of the too hot extreme is the too cold extreme. With the potential weakening of the AMOC, the major ocean circultion, could lead to regional cooling in the Netherlands (KNMI, 2023). Interventions should consider the colder temperatures and wind to the working of the intervention

Too dry

The opposite extreme of too wet is too dry. With the increasing temperatures, soil will become more dry which would have an impact on the efficiency of plants (KNMI, 2023)

MICROCLIMATIC PROCESSES

How to go against too hot and too wet extremes?

This thesis focuses on microclimatic processes of the scenario 'too hot-too wet' (right corner). The used processes are as follows:

Shading
Blocking of solar radiation, which results in reduction of heat that reaches the surface (Klok et al., 2019)

Evaporation
Transforming liquid into vapor which cools down the urban environment and reduces the air temperature (Kluck et al., 2020).

Evapotransportation
Evaporation from the soil and plant transpiration, which cools the urban environment during the day and night (Kleerekoper et al., 2024).

Reflection
Reflection refers to the proportion of the incoming solar radiation on surfaces (Albedo). A low absorption of radiation creates a reduction in temperature in urban environments (Oke et al., 2017).

Ventilation
Removing warm air and replacing it with cooler air masses, which reduces the heat stress in cities and improves the human thermal comfort (Kluck et al., 2020).

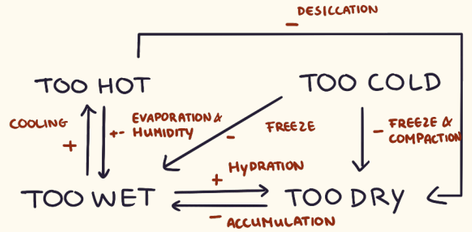
Water storage
Capturing and temporarily retaining rainfall during extreme precipitation.

Water retention
The capacity of interventions to hold rainfall where it falls, delaying runoff and drain the water to spaces where it could infiltrate in the soil or drainage systems (Kleerekoper et al., 2024)

INTERRELATIONS

Between extremes and processes

Certain extremes can influence one another, producing both positive and negative effects. These interactions could affect the processes that are examined in this thesis. For instance, cold weather and stagnant water can lead to freezing. Reflection of paved areas reduces heat absorption. However, these surfaces do not contribute to infiltration and soil hydratation. This highlights the complex balance between processes and environmental limitations.



	SHADING	EVAPORATION	EVAPOTRAN-SPIRATION	REFLECTION	VENTILATION	WATER STORAGE	WATER RETENTION
Too hot	+	+	+	+	+		
Too wet				−**		+	+
Too cold	+	−*			−***	−*	−*
Too dry			+	−**		+	+

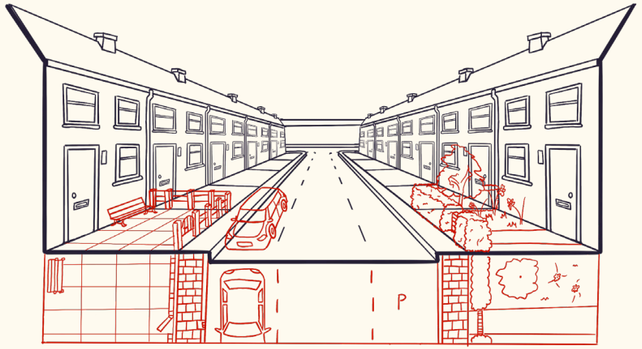
Legend
+ Positive effect
− Negative effect

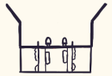
* Stagant water can freeze; **Permeable pavement absorbs sun radiation; ***Cold air further decreases the perceived air temperature

STREET TYPOLOGIES

Can it find its place on the street?

Every street typology has their own spatial opportunities. Kleerekoper (2016) classified 14 neighbourhood typologies, each defined by distinct spatial characteristics. Building on this classification, a group of students from the Amsterdam University of Applied Sciences developed a map visualising the 14 types with their climate characteristics for heat strees, flood risk, and percentage of green space. Within the scope of this thesis, three typologies are selected based on their importance in climate-related challenges and their presence in Amersfoort. The typologies selected are garden village (tuindorp), working-class district (volkswijk), and garden city low-rise (tuinstad laagbouw).

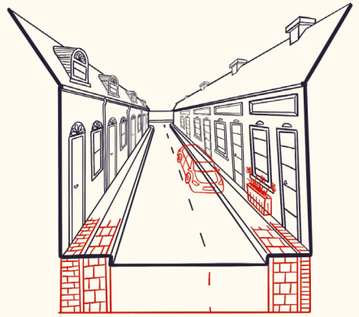




Garden village
(tuindorp)
Schematic profile (width: ~22m)

Characteristics (Kleerekoper, 2016):
Garden: Spacious front and back garden (private)
Building height: 2-3 floors
Parking: Lots of parallel parking
Available public green: Limited communal greenery
Street trees: Often no street trees

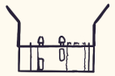
Spatial opportunity
Parking spaces (one or both sides), one way traffic (if it is not already), private gardens



Working-class district
(volkswijk)
Schematic profile (width: ~12m)

Characteristics (Kleerekoper, 2016):
Garden: No front yard
Building height: 2-3 floors
Parking: One sided parallel parking
Available public green: Little communal greenery

Spatial opportunity
Parking spaces, (private) facades



Garden city low-rise
(tuinstad laagbouw)
Schematic profile (width: ~24m)

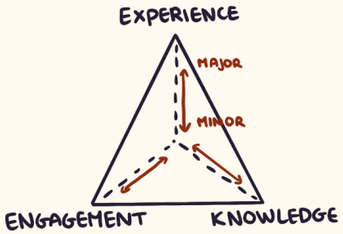
Characteristics (Kleerekoper, 2016):
Garden: Open building blocks with front and back gardens
Building height: 2-3 floors
Available public green: lots of communal greenery

Spatial opportunity
Parking spaces, one way traffic (if it is not already), communal green space, private gardens

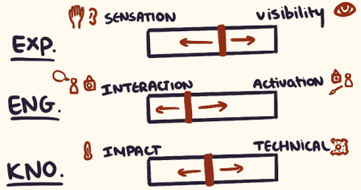
TRIANGLE OF AWARENESS & GRADIENT OF AWARENESS

Creating awareness can come in several forms

Awareness can be understood as a concept with multiple layers. This thesis uses the model developed by Iturizza et al. (2020) as the framework for understanding the awareness mechanisms (Figure x). This thesis uses the three terms experience, engagement (referring to attention) and knowledge. The shape of a places the three terms in a field, in which the most signigant role of an intervention is given. Each awareness mechanism can be positioned along its own spectrum depending on the method used to create awareness. The spection functions as a gradient, changing continuously depending on human perspective.



Triangle of Awareness



Gradient of Awareness

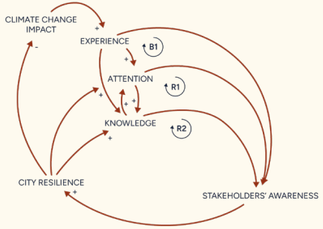
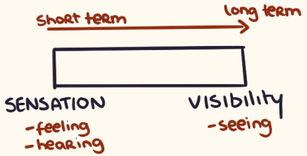


Figure 1: Awareness mechanisms in the development process (Iturizza et al., 2020)

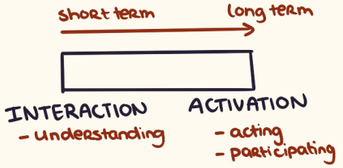
Experience

Experience relates to real life interactions with climate impacts (Iturizza et al., 2020). It involves the dimensions of perception: feeling, hearing, and seeing. For example, one could feel the intensity of heat in the street, one could have a conversation about a flood happening in the world, or one could see that a water square is filling up with rainwater.



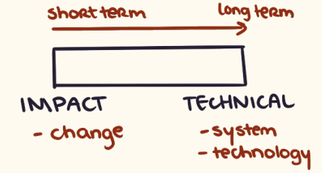
Engagement

Engagement reflects on the proactive behaviour someone acts upon (Iturizza et al., 2020). This could be about participating in activities to understand the problem and solutions or contributing in creating a more climate resilient street. For instance, creating an art installation that invites people to engage with the art or an interventions that actively engages people in involve in building resilient solutions.



Knowledge

Knowledge refers to the quantity and quality of information avaible about climate challenges and solutions (Iturizza et al., 2020). This can be about sharing information about the environmental impact a solution has as well as the technical understanding of how certain technologies function. Such as, visualising the change in temperature due to the climate intervention or educating in planting specific plant species.



LEGEND

Checkbox

Spatial scale

- Object (micro-scale)
- Ensemble (meso-scale)
- Network (macro-scale)

Climate extreme

- Too hot
- Too wet
- Too cold
- Too dry

Microclimatic Processes

- Shading
- Evaporation
- Evapotranspiration
- Reflection
- Ventilation
- Water storage
- Water retention

Street typologies

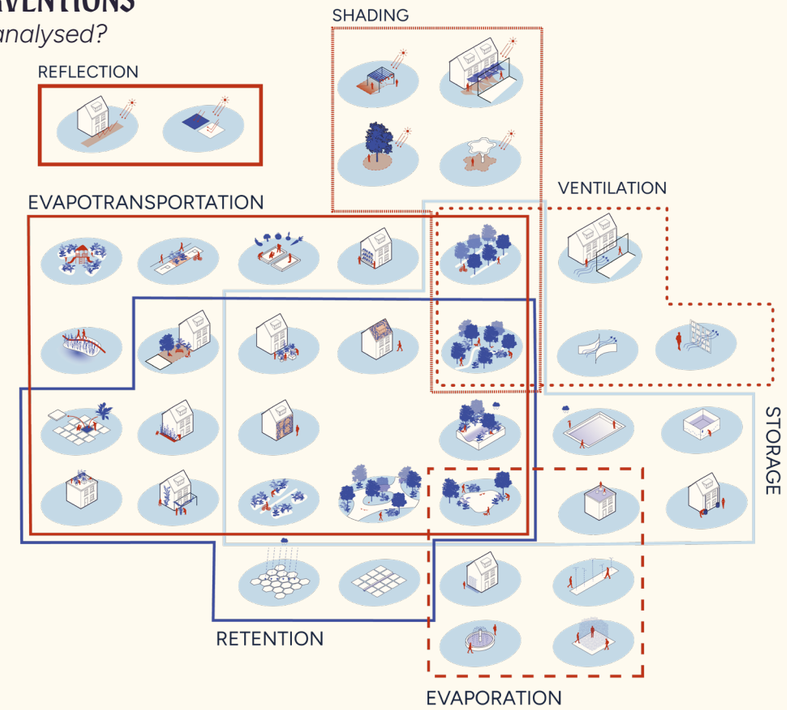
- Garden village (*tuindorp*)
- Working-class district (*volkswijk*)
- Garden city low-rise (*tuinstad laag-bouw*)

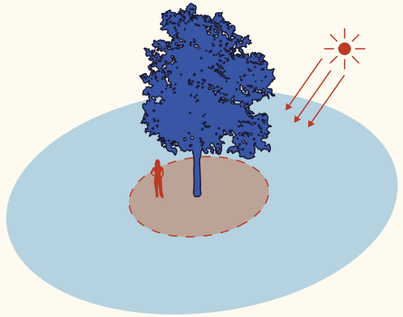
Awareness mechanism

- Experience
- Engagement
- Knowledge

CLIMATE INTERVENTIONS

Which ones are analysed?





INTERVENTION #1:

TREE

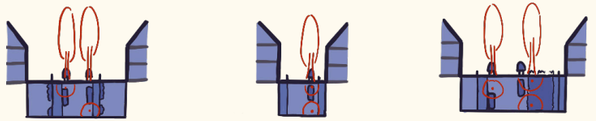
Spatial scale

Trees perform essential climate-regulating functions, providing shade and cooling during periods of heat while offering shelter and wind protection in winter. Beyond their thermal benefits, they play a crucial role in urban water management, facilitating infiltration, reducing surface runoff, and contributing to the overall hydrological balance of the urban environment.

Microclimatic processes

Climate extremes

Street typologies

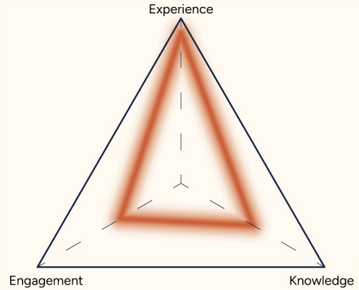


Garden village (tuindorp)

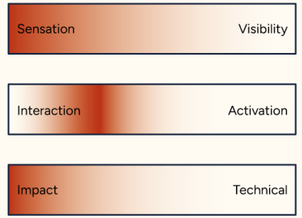
Working-class district (volkswijk)

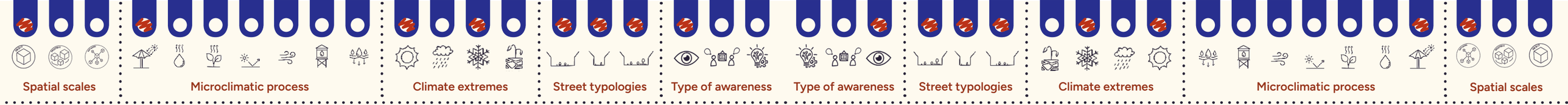
Garden city low-rise (tuinstad laagbouw)

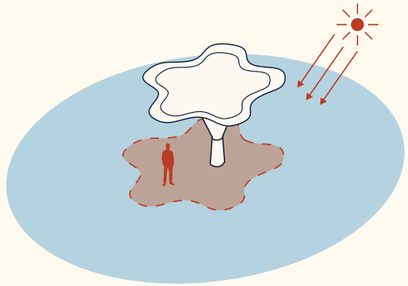
Triangle of awareness



Gradient of awareness







INTERVENTION #2:

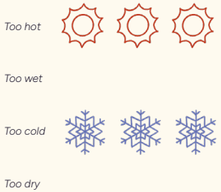
SHADOW STRUCTURES

Spatial scale

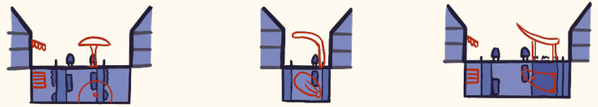
Shadow structures provide shade during periods of extreme heat creating a cool place for citizens. In addition, it offers shelter for extremer weather conditions such as precipitation and snowstorms.

Microclimatic processes

Climate extremes



Street typologies

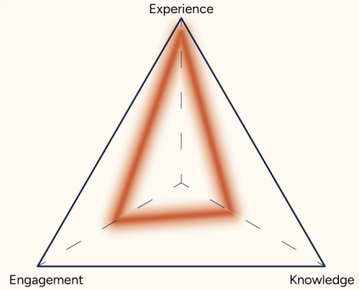


Garden village (tuindorp)

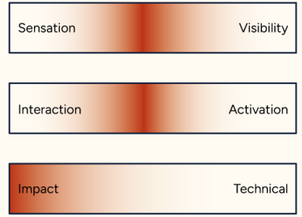
Working-class district (volkswijk)

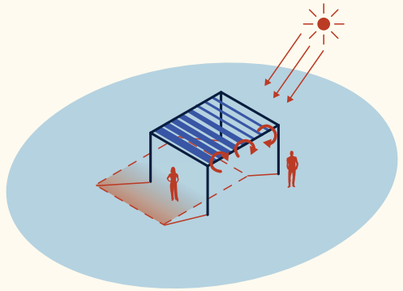
Garden city low-rise (tuinstad laagbouw)

Triangle of awareness



Gradient of awareness





INTERVENTION #3:

ADJUSTABLE SHADOW ELEMENTS

Spatial scale

Adjustable shadow elements allow users to modify the amount of solar radiation to their preferences. These elements can be opened and closed to increase sun exporsure, or block additional sunlight. In summer this could help with cooling down a space by closing the elements and in winter they would offer sunlight by opening the elements

Microclimatic processes

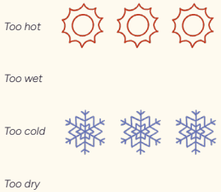
Street typologies

Garden village (tuindorp)

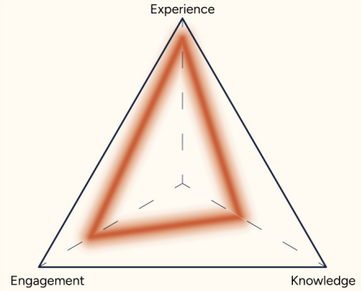
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

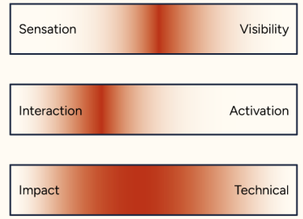
Climate extremes

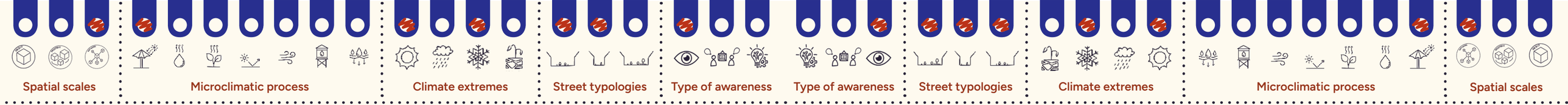


Triangle of awareness



Gradient of awareness





INTERVENTION #4:

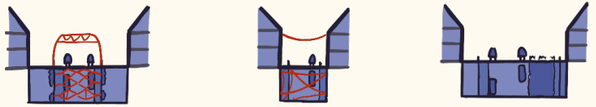
SHADED STREETS

Spatial scale

Combining different shading elements defines the intervention of shaded streets. A network of shading elements in formed to cool down a larger surface and creates a pathway of shelter through the streets for extreme weather conditions such as heatstress and precipitation.

Microclimatic processes

Street typologies

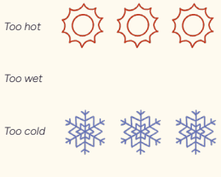


Garden village (tuindorp)

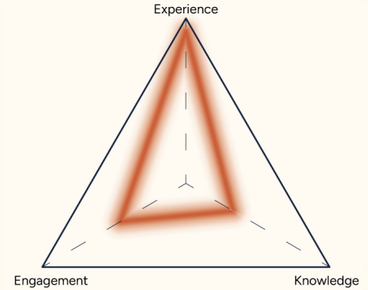
Working-class district (volkswijk)

Garden city (tuinstad laagbouw)

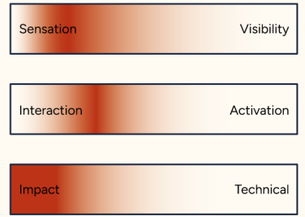
Climate extremes

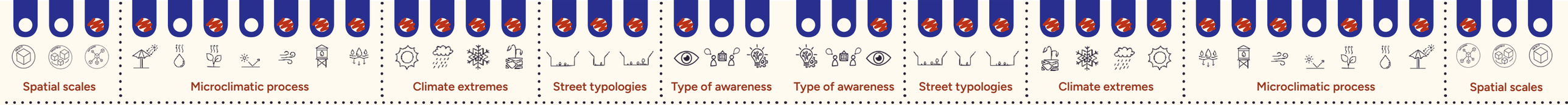


Triangle of awareness



Gradient of awareness





INTERVENTION #5:

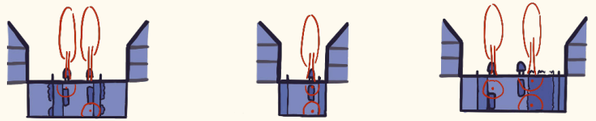
TREE LANES

Spatial scale

Combining different shading elements defines the intervention of shaded streets. A network of shading elements in formed to cool down a larger surface and creates a pathway of shelter through the streets for extreme weather conditions such as heatstress and precipitation.

Microclimatic processes

Street typologies

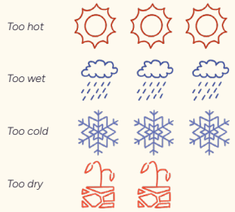


Garden village (tuindorp)

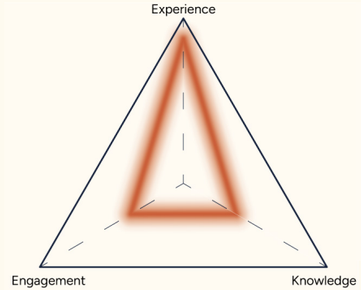
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

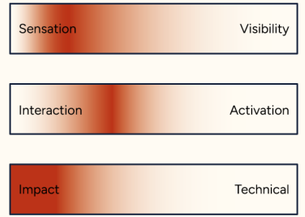
Climate extremes

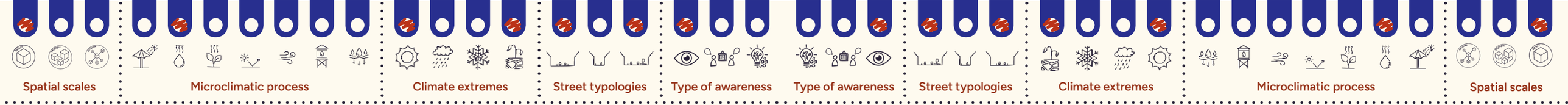


Triangle of awareness



Gradient of awareness





INTERVENTION #6:

FOUNTAINS

Spatial scale

Fountains cool the surrounding environment by through the proces of water evaporation, which reduces the air temperature and contributes to a comfortable public space. In hot periods, this creates a cooler microclimate. However in cold extremes, the combination of water and freezing temperatures leads to ice which would create an unsafe public space.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

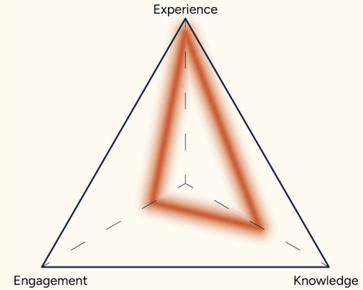
Too hot

Too wet

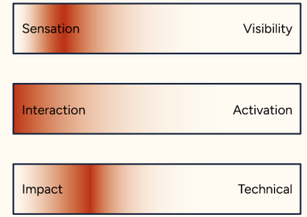
Too cold Negative effect: freezing of water

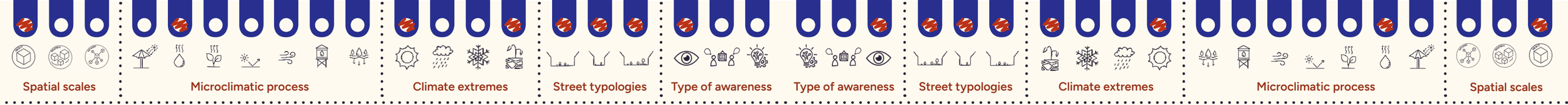
Too dry

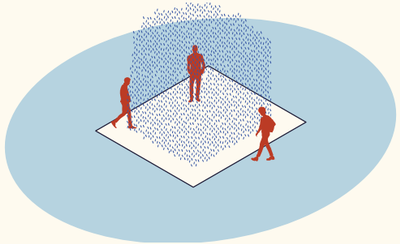
Triangle of awareness



Gradient of awareness







INTERVENTION #7:

MISTING SYSTEMS

Spatial scale

Misting systems are installations where fine water droplets disperse in the air to cool down the surrounding public space. This cooling effect is generated throught evaporation, which lowers the air temperature. Research indicates that fine misting sytems can achieve localized air temperature reductions of 0.7 to 3 degrees, which makes this intervention an effective way for reducing heatstess in streets. However in cold extremes, the combination of water and freezing temperatures leads to ice particles which creates an unsafe public space.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

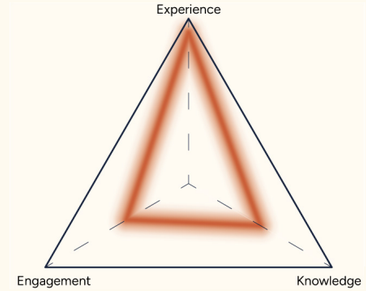
Too hot

Too wet

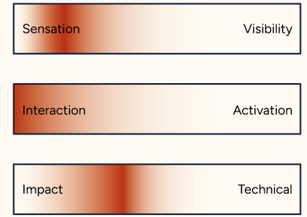
Too cold Negative effect: freezing of water

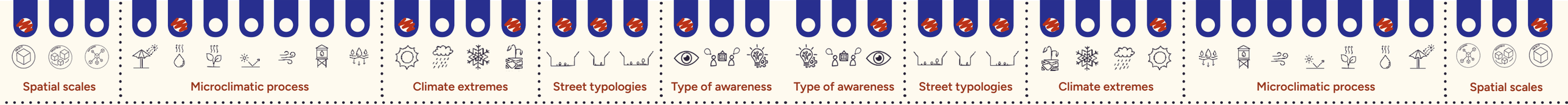
Too dry

Triangle of awareness



Gradient of awareness





INTERVENTION #8:

WATER WALLS

Spatial scale

Unlike fountains, water walls are integrated in a vertical facade. As people walk by the interventions they experience a cooling breeze generated by the evaporation of fine water droplets. Evaporation reduces the air temperature in public space. However in cold extremes, the combination of water and freezing temperatures leads to ice which would create an unsafe public space.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

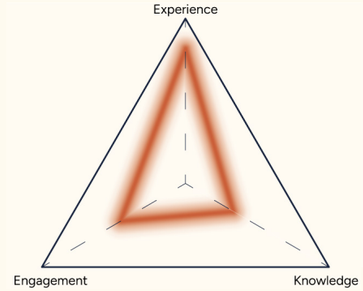
Too hot

Too wet

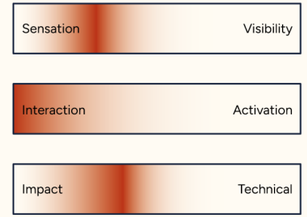
Too cold Negative effect: freezing of water

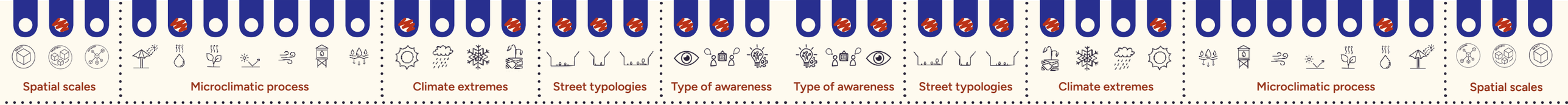
Too dry

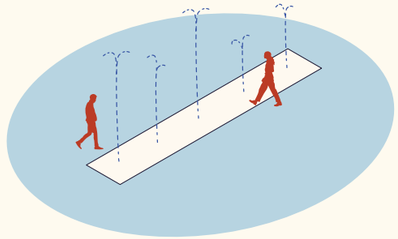
Triangle of awareness



Gradient of awareness







INTERVENTION #9:

MOVING WATER INSTALLATIONS

Spatial scale

This intervention combines the cooling system of fountains with playful elements such as sound and movement. Moving installations improve attention and engagement, encouraging users to interacte with the installation. In addition to the social aspect, the evaporating water also provides a cooling effect in the surrounding environment.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

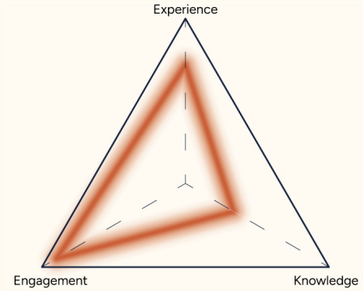
Too hot

Too wet

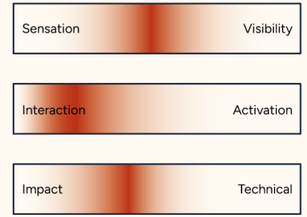
Too cold Negative effect: freezing of water

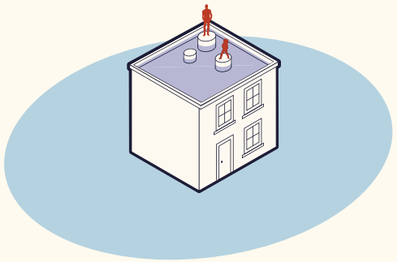
Too dry

Triangle of awareness



Gradient of awareness





INTERVENTION #10:

BLUE ROOF

Spatial scale

There are two types of blue roofs: those designed to cool the surrounding environment and those intended to store rainwater and retained in time to buffer the next precipitation. The combination of these would be ideal, as already implemented in Singapore. Cooling is achieved through slow evaporation of stored water. However, this effect is not always guaranteed, as the roof may dry out. Another drawback, in colder extremes, stagnant water may freeze, which can negatively influence their objective.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

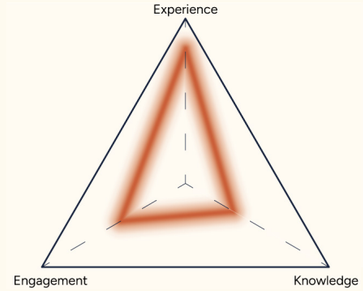
Too hot

Too wet

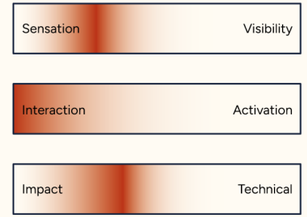
Too cold Negative effect: freezing of water

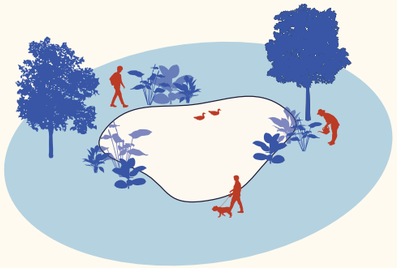
Too dry

Triangle of awareness



Gradient of awareness





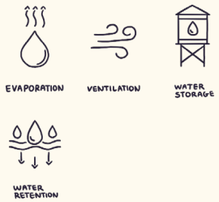
INTERVENTION #11:

PONDS

Spatial scale

Ponds capture precipitation temporarily and allow it to drain off slowly. In addition, through slow evaporation may it cool down the surrounding environment. However, ponds also absorb heat during the day and release it at night, which lead to higher nighttime temperature and reduced thermal comfort.

Microclimatic processes



Climate extremes

Too hot

Too wet

Too cold Negative effect: freezing of water

Too dry

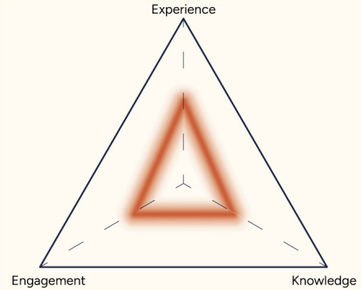
Street typologies

Garden village (tuindorp)

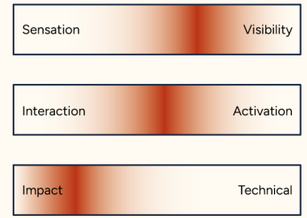
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Triangle of awareness



Gradient of awareness



INTERVENTION #12:

PLANTERS

Spatial scale

Planters are micro-scale interventions that consist of containers with soil in which vegetation can grow. The advantage in urban environment is that the roots of the plants are restricted to the dimensions of the planter, preventing interference with underground utilities such as pipelines or cables. Planters contribute to cooling the public space by evaportranspiration. In addition, they store and retain small amounts of precipitation.

Microclimatic processes

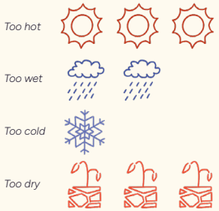
Street typologies

Garden village (tuindorp)

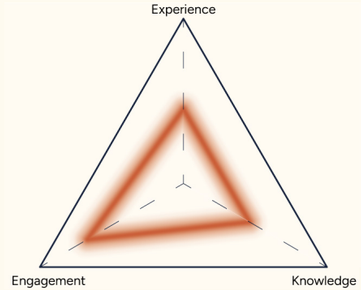
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

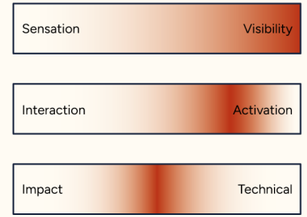
Climate extremes



Triangle of awareness



Gradient of awareness



INTERVENTION #13:

VERTICAL FACADE GARDEN

Spatial scale

Vertical facade gardens contain stacked planters mounted onto a wall or vertical element, allowing a high density of vegetation on a small surface. The vertical facade gardens contribute to cooling the public space by evaportranspiration. In addition, they store and retain small amounts of precipitation.

Microclimatic processes

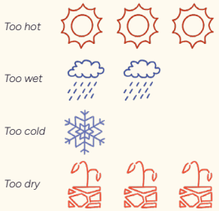
Street typologies

Garden village (tuindorp)

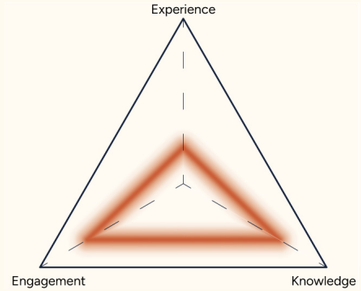
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

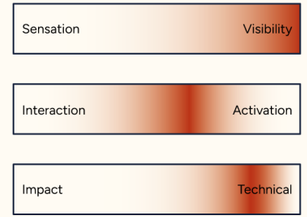
Climate extremes



Triangle of awareness



Gradient of awareness



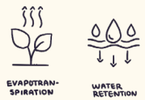
INTERVENTION #14:

HORIZONTAL FACADE GARDEN

Spatial scale

Horizontal facade gardens refer to gardens planted directly along the facade of a building. This intervention is particularly effective in areas with limited space between the buildings. The horizontal facade gardens contribute to cooling the public space by evaportranspiration. Furthermore, it helps with unpaving of the public environment which enhances the possibility of retaining rainwater during extreme precipitation events.

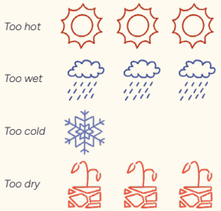
Microclimatic processes



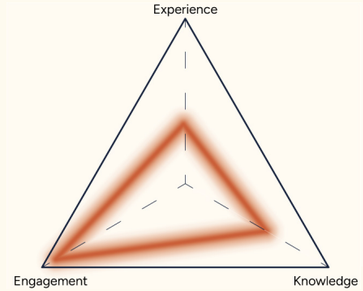
Street typologies

Garden village (tuindorp) | *Working-class district (volkswijk)* | *Garden city low-rise (tuinstad laagbouw)*

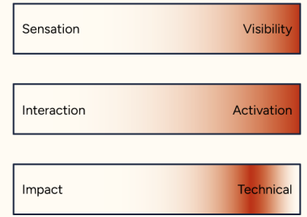
Climate extremes

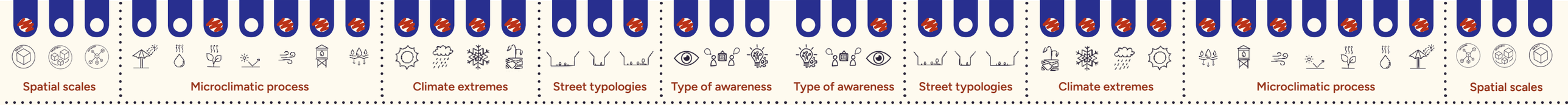


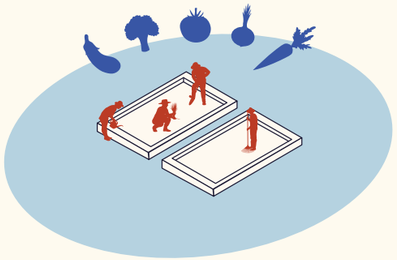
Triangle of awareness



Gradient of awareness







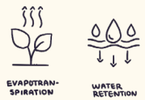
INTERVENTION #15:

URBAN FARMING

Spatial scale

Urban farms offer an opportunity to create multifunctional green spaces. They contribute to climate resilience extremes ‘too hot’ and ‘too wet’, while simultaneously provide a social space for interaction and shered responsibility. Greening the area cool the urban environment through evatranspiration and enhance the capacity to retain precipitation during heavy rainfall events.

Microclimatic processes



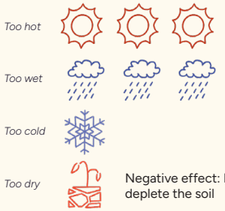
Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

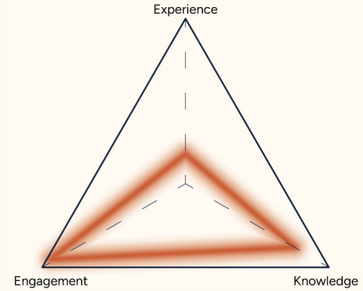
Garden city low-rise (tuinstad laagbouw)

Climate extremes

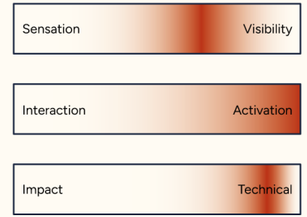


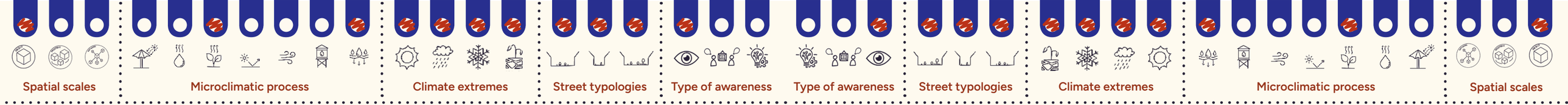
Negative effect: Intense farming can deplete the soil

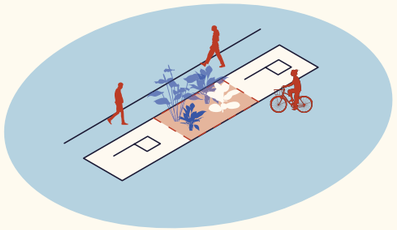
Triangle of awareness



Gradient of awareness







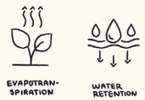
INTERVENTION #16:

GREEN PARKING SPACES

Spatial scale

A significant portion of street space is occupied by parked cars. By transforming a small number of these parking spaces, they could serve as cool islands in the public environment. The intervention reduces the local air temperature through vegetation, while also increasing the capacity of soil to retain and slowly absorb precipitation.

Microclimatic processes



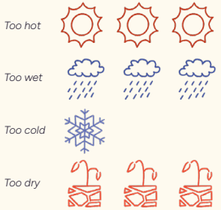
Street typologies

Garden village (tuindorp)

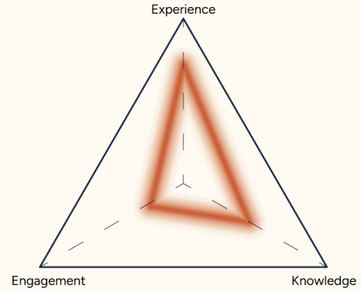
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

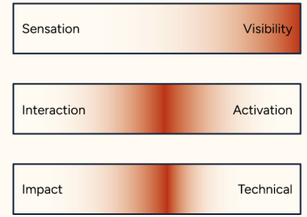
Climate extremes

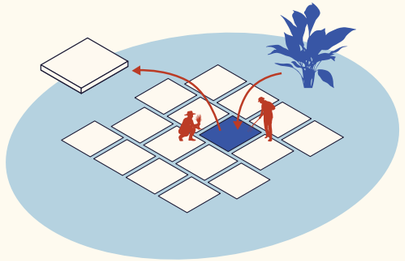


Triangle of awareness



Gradient of awareness





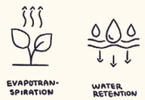
INTERVENTION #17:

UNPAVING OF STREETS

Spatial scale

An overarching strategy, unpaving of streets is an effective approach for cooling the urban environment and increasing the soil's capacity to retain precipitation. The Dutch initiative NK tegelwippen shows an example of a competition, in which municipalities count the amount of replaced tiles to vegetated surfaces. By removing hard surfaces and repurposing it to greenery, unpaving the streets contributes to improved thermal comfort through increased evatranspiration and enhance the urban water management.

Microclimatic processes



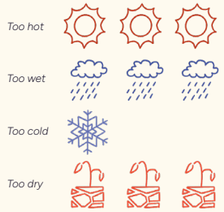
Street typologies

Garden village (tuindorp)

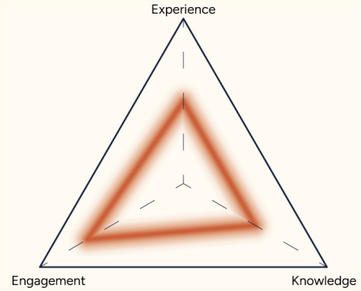
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

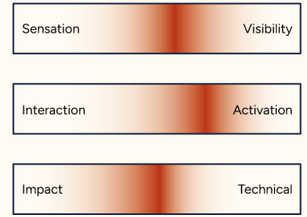
Climate extremes



Triangle of awareness



Gradient of awareness



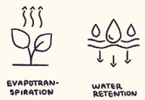
INTERVENTION #18:

IVY PLANTS

Spatial scale

Ivy plants are self-climbing plants that attach to surfaces using tendrils. They function as protection against direct solar radiation, reducing the building and surface temperature and contribute to cooling through ecapotranspiration . In colder periods, ivy also acts as an insulating layer, protecting facades from cooling space even more. This results in a comfortable microclimate in hot and cold extremes.

Microclimatic processes



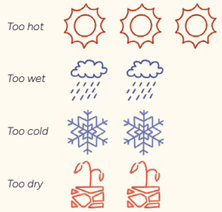
Street typologies

Garden village (tuindorp)

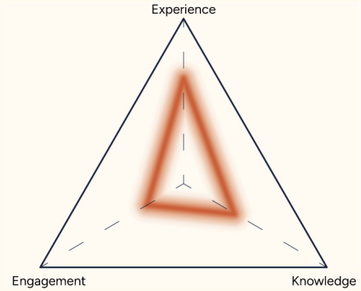
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

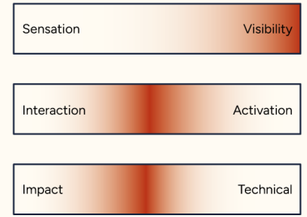
Climate extremes

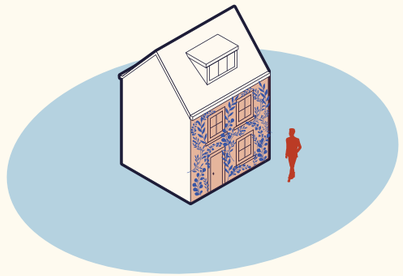


Triangle of awareness



Gradient of awareness





INTERVENTION #19:

GREEN FACADE

Spatial scale

Green facades use a construction in front of a wall that gives space for plants to grow and climb. They function as protection against direct solar radiation, reducing the building and surface temperature and contribute to cooling through ecapotranspiration . In colder periods, ivy also acts as an insulating layer, protecting facades from cooling space even more. This results in a comfortable microclimate in hot and cold extremes.

Microclimatic processes

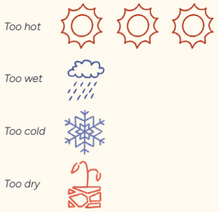
Street typologies

Garden village (tuindorp)

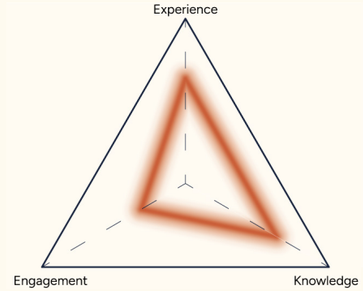
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

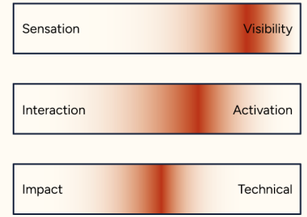
Climate extremes



Triangle of awareness



Gradient of awareness



INTERVENTION #20:

GREEN ROOF

Spatial scale

Most buildings have unused rooftop space, and transforming these surfaces into green roofs offers multiple microclimatic benefits. They have a high capacity for retaining precipitation, and when combined with additional systems they temporary can store the precipitation. In addition, the vegetated surface absorbs les heat contributing to a cooling effect in the surrounding public space. Moreover, green roofs provide valuable habitat for diverse flora and fauna, enhancing biodiversity.

Microclimatic processes

Street typologies

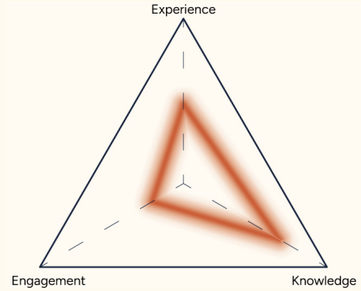
Garden village (tuindorp)

Working-class district (volkswijk)

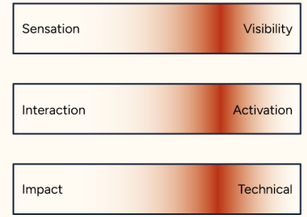
Garden city low-rise (tuinstad laagbouw)

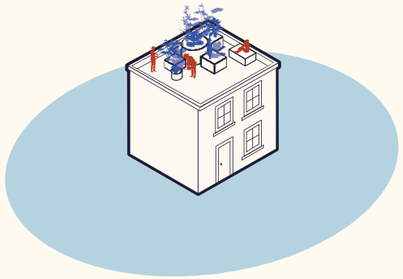
Climate extremes

Triangle of awareness



Gradient of awareness





INTERVENTION #21:

ROOF GARDEN

Spatial scale

Most flat roofs are unused, overlooking their potetial to serve as a multifuntional space for social and climate needs. Redesigning flat roofs to roof gardens contributes this multifunctional potential. Roof gardens enhance the thermal comfort under both hot and cold extremes through the process of shelter and evapotranspiration from vegetation. Moreover, roof gardens provide for an improves water management by increasing the capacity to retain precipitation within the vegetation.

Microclimatic processes

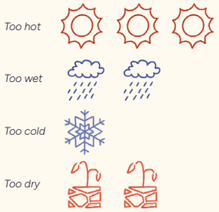
Street typologies

Garden village (tuindorp)

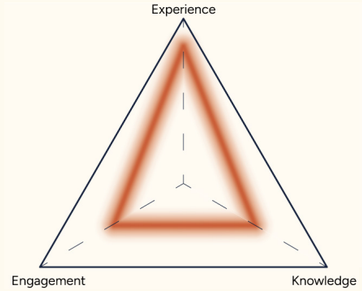
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

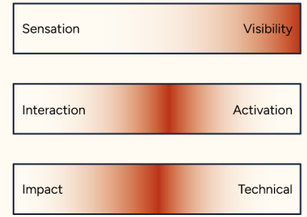
Climate extremes



Triangle of awareness



Gradient of awareness



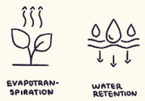
INTERVENTION #22:

GREEN SQUARES AND PLAYGROUNDS

Spatial scale

Transforming squares and playground into greener spaces contributes to mitigating the impacts of climatic extremes, thereby creating a more comfortable environment. Vegetation provides for cooler conditions for recreation through evapotranspiration, while during periods of intense rainfall, these green spaces function as a buffer for infiltrating and retaining the precipitation.

Microclimatic processes



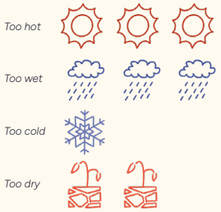
Street typologies

Garden village (tuindorp)

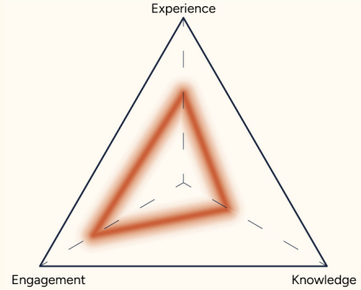
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

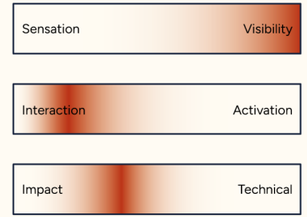
Climate extremes



Triangle of awareness



Gradient of awareness



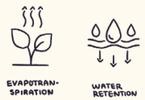
INTERVENTION #23:

POCKET PARKS

Spatial scale

Pocket parks are small green spaces embedded within urban areas that funtion as a cooling space in public space. They reduce the temperature of the surrounding space and encourage interaction and recreation. Additionally, these park can function as a retention area during wet extremes, contributing to improved water management. Depending on the urgency, pocket parks can be designed as temporary or permanent structures to adress immediate spatial and climatic challenges.

Microclimatic processes



Street typologies

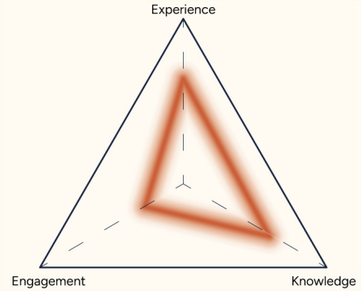
Garden village (tuindorp)

Working-class district (volkswijk)

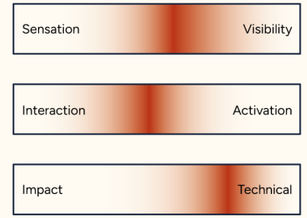
Garden city low-rise (tuinstad laagbouw)

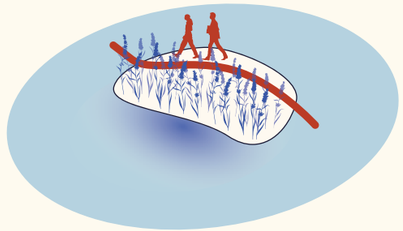
Climate extremes

Triangle of awareness



Gradient of awareness





INTERVENTION #24:

HELOPHYTE FILTERS

Spatial scale

Helophyte filters consists of a system of sand filters planted with reed. Besides their function of filtering and purifying the wastewater through bacterial activity around the roots, they also contribute to stabilization of the local microclimate. During hot periods, helophyte filters reduce the temperature through evapotranspiration, while in cold periods they provide shelter. In addition, helophyte filters are capable of storing rainwater and reuse it when needed in drier periods.

Microclimatic processes

Street typologies

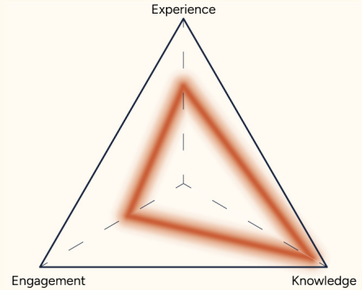
Garden village (tuindorp)

Working-class district (volkswijk)

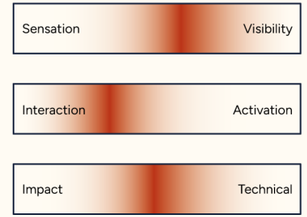
Garden city low-rise (tuinstad laagbouw)

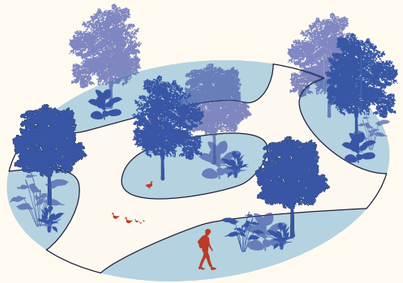
Climate extremes

Triangle of awareness



Gradient of awareness





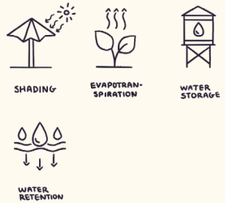
INTERVENTION #25:

WETLANDS

Spatial scale

Wetlands refer to natural areas characterized by the presence of interconnected blue structures. Wetlands are natural spaces for macro-scale waterbuffering and retention. However, many existing wetlands have been altered or dried up due to urban development, resulting in a negative impact on the capacity to store rainwater. Restoring or integrating wetlands within urban environment is therefore of great importance for enhancing climate resilience and improving urban microclimate under both hydrological and thermal extremes.

Microclimatic processes



Climate extremes

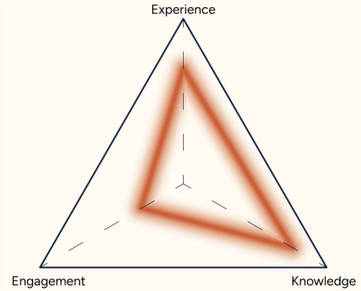
Street typologies

Garden village (tuindorp)

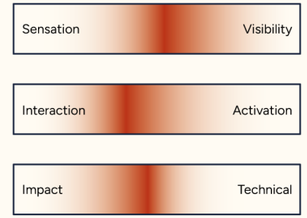
Working-class district (volkswijk)

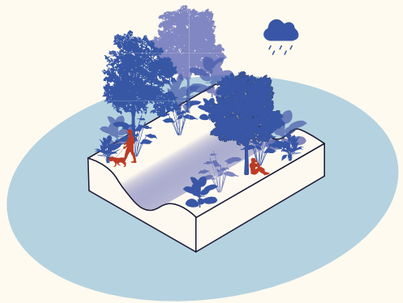
Garden city low-rise (tuinstad laagbouw)

Triangle of awareness



Gradient of awareness





INTERVENTION #26:

BIOSWALES

Spatial scale

The sewage system alone is often under significant pressure due to the increasing volumes of stormwater. Bioswales, therefore could function as an above-ground infrastructure for buffering and infiltrating precipitation, thereby reducing the press on the sewage network. Furthermore, bioswales enhance biodiversity and connect the network of green infrastructure in public space.

Microclimatic processes

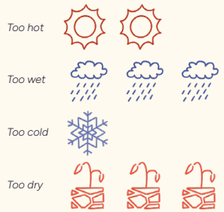
Street typologies

Garden village (tuindorp)

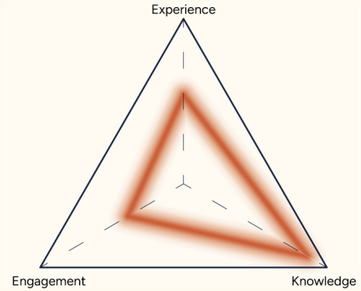
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

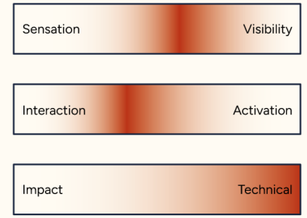
Climate extremes

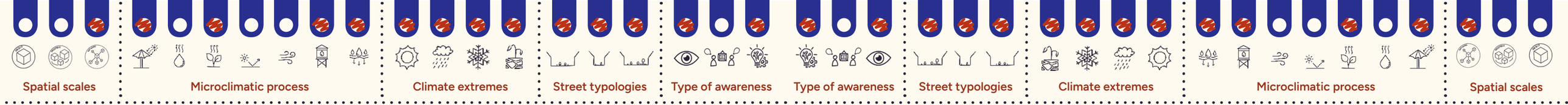


Triangle of awareness



Gradient of awareness





INTERVENTION #27:

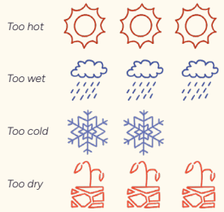
URBAN FOREST

Spatial scale

Urban forests refer to dense spaces of trees and green infrastructure within urban environments. While they serve as a recreational and ecological function, they also play a crucial role in regulating the urban microclimate. Forests mitigate heat stress by providing shade and are open for urban ventilation. Moreover, their dense vegetation enhances the infiltration and buffering of precipitation contributing to the overall climate resilience.

Microclimatic processes

Climate extremes



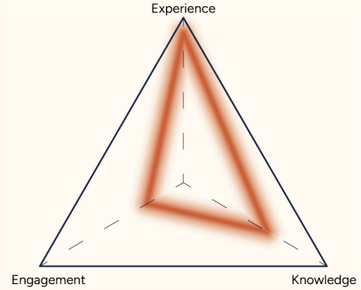
Street typologies

Garden village (tuindorp)

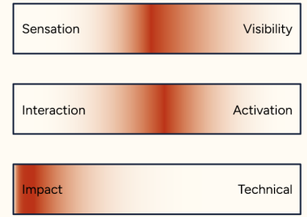
Working-class district (volkswijk)

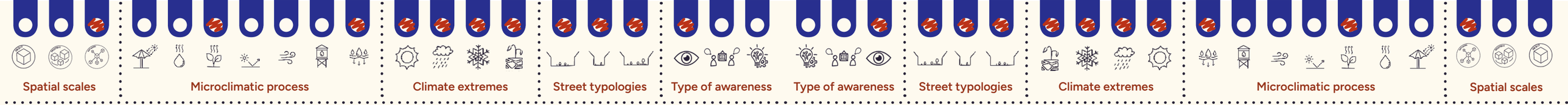
Garden city low-rise (tuinstad laagbouw)

Triangle of awareness



Gradient of awareness





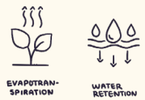
INTERVENTION #28:

GREEN STROKES

Spatial scale

Green strokes are meso-scale intervention that function as a installation for heat reduction and water buffering. They consist of several structures interconnected within a broader spatial network. Green strokes are effective densely built environment with limited space through their flexible composition.

Microclimatic processes



Street typologies

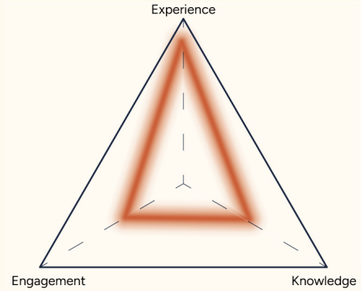
Garden village (tuindorp)

Working-class district (volkswijk)

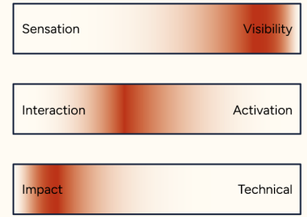
Garden city low-rise (tuinstad laagbouw)

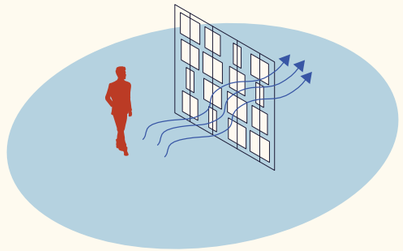
Climate extremes

Triangle of awareness



Gradient of awareness





INTERVENTION #29:

VISUALISE WINDFLOW

Spatial scale

Wind is an intangable climatic element, which contributes to cooling down public spaces. In many urban environments, warm air tends to accumulate due to insufficient natural ventilaion. Therefore, integrating wind flows into spatial design is important for improving thermal comfort. On a micro-scale, this begins with understanding the behaviour of wind flows.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

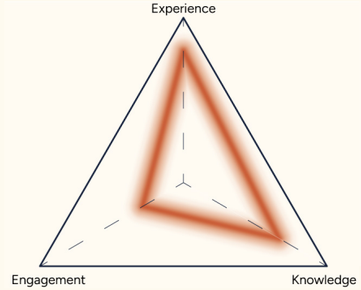
Too hot

Too wet

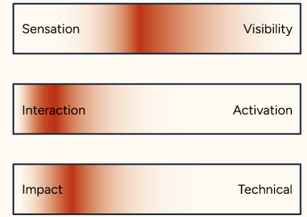
Too cold Negative: cold air further decreases the perceived air temperature

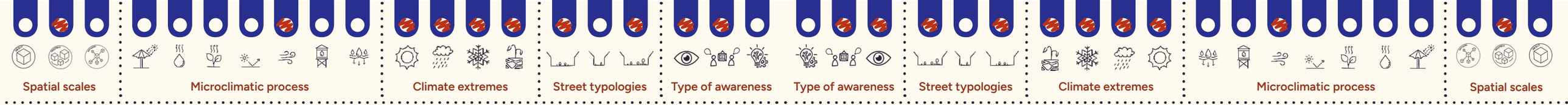
Too dry

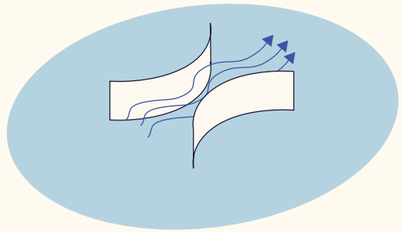
Triangle of awareness



Gradient of awareness







INTERVENTION #30:

CREATE SMALL PATHWAYS

Spatial scale

Wind is an intangable climatic element, which contributes to cooling down public spaces. In many urban environments, warm air tends to accumulate due to insufficient natural ventilaion. Therefore, integrating wind flows into spatial design is important for improving thermal comfort. On a meso-scale, designers can shape public spaces that creates pathways for windflows, enabling warm air to be exchanged by cooler air. Such interventions can significantly reduce the perceived air temperature.

Microclimatic processes

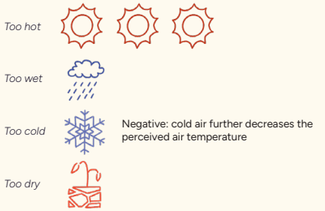
Street typologies

Garden village (tuindorp)

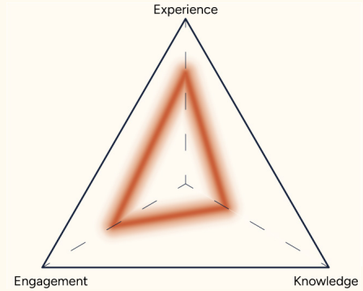
Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

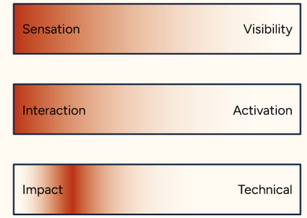
Climate extremes



Triangle of awareness



Gradient of awareness



INTERVENTION #31:

CREATE URBAN PATHWAYS

Spatial scale

Wind is an intangable climatic element, which contributes to cooling down public spaces. In many urban environments, warm air tends to accumulate due to insufficient natural ventilaion. Therefore, integrating wind flows into spatial design is important for improving thermal comfort. On a macro-scale, establishing urban ventilation corridors through open and green infrastructures contributes to reducing the heat stress in urban environments through air exchange. Semi-open landscapes and loosely arranged trees are particularly effective in facilitating these windflows.

Microclimatic processes

VENTILATION

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

Too hot

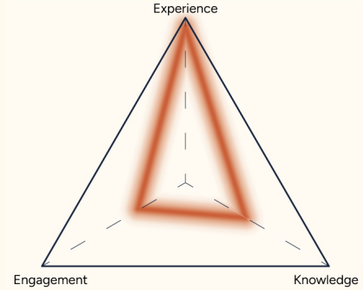
Too wet

Too cold

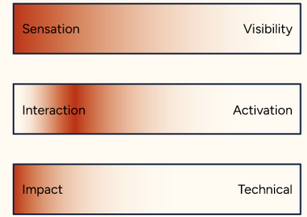
Too dry

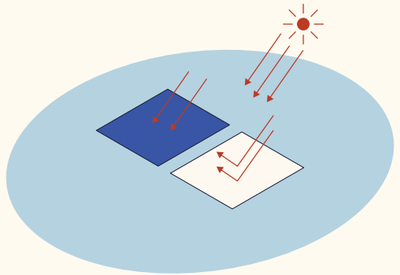
Negative: cold air further decreases the perceived air temperature

Triangle of awareness



Gradient of awareness





INTERVENTION #32:

VISUALISE ALBEDO EFFECT

Spatial scale

Every surface possesses a specific reflection factor, known as albedo. A higher albedo indicates a greater capacity to reflect radiation, thereby reducing the heat absorption. As a result, materials with a high albedo warm up less, leading to lower surface and ambient temperature in a public spaces. Engaging with this technical principle, forms the foundation for understanding reflective materials.

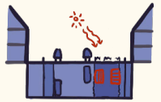
Microclimatic processes

REFLECTION

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)



Garden city low-rise (tuinstad laagbouw)

Climate extremes

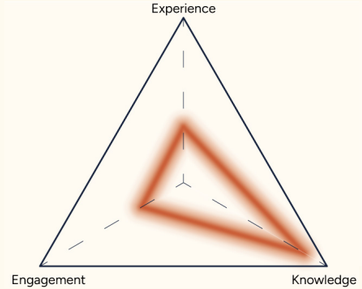
Too hot

Too wet

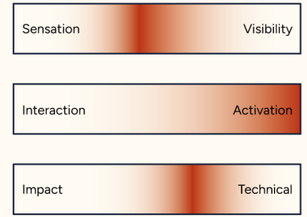
Too cold Negative: reflection of heat radiation

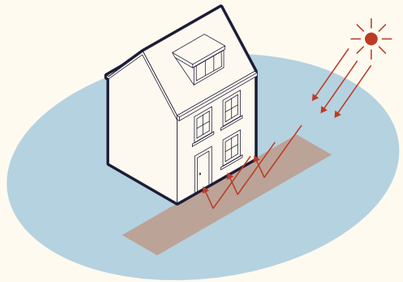
Too dry Negative: impermeable pavement

Triangle of awareness



Gradient of awareness





INTERVENTION #33:

REFLECTIVE MATERIALS

Spatial scale

Every surface possesses a specific reflection factor, known as albedo. A higher albedo indicates a greater capacity to reflect radiation, thereby reducing the heat absorption. As a result, materials with a high albedo warm up less, leading to lower surface and ambient temperature in a public spaces. By incorporating such reflective materials, the intensity of heat radiation within streets can decrease, contributing to improved thermal comfort in the surrounding urban environment.

Microclimatic processes

REFLECTION

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

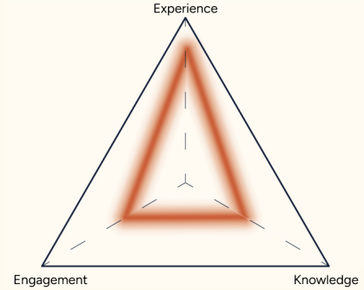
Too hot

Too wet

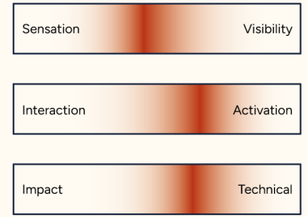
Too cold Negative: reflection of heat radiation

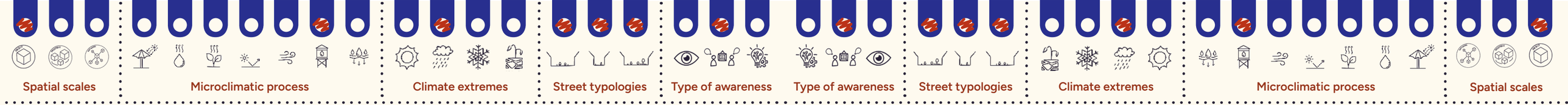
Too dry Negative: impermeable pavement

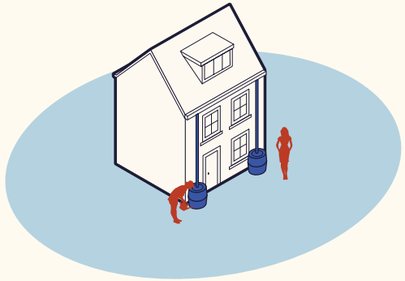
Triangle of awareness



Gradient of awareness







INTERVENTION #34:

RAIN BARRELS

Spatial scale

A rain barrel is an easily installed intervention designed to collect and store stormwater. Although the capacity is relatively small, it can accomodate for local source of water for sprinkling and watering of vegetation.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

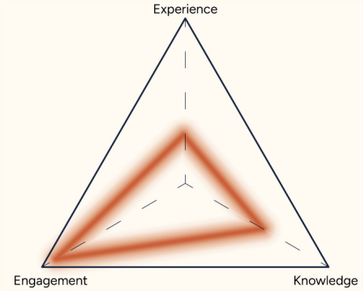
Too hot

Too wet

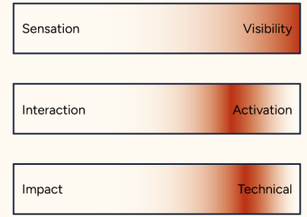
Too cold Negative effect: freezing of water

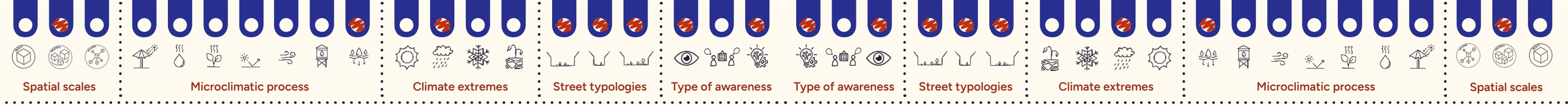
Too dry

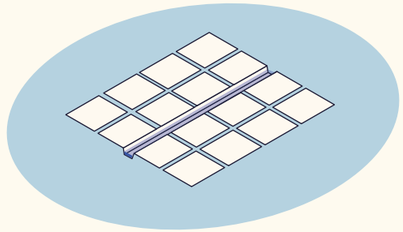
Triangle of awareness



Gradient of awareness







INTERVENTION #35:

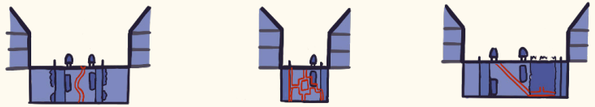
ABOVE-GROUND DRAINAGE

Spatial scale

Instead of focusing on retaining and infiltrating water, above-ground drainage can raise awareness of the volume of precipitation that surfaces must accomodate. Moreover, by making water flows visible, such systems facilitate precipitation to locations better suited for retention or infiltration.

Microclimatic processes

Street typologies



Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

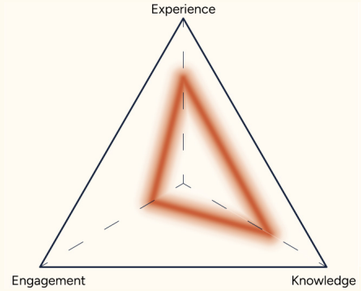
Too hot

Too wet

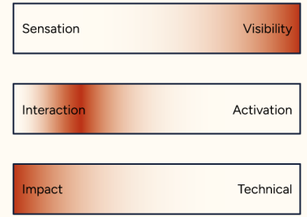
Too cold Negative effect: freezing of water

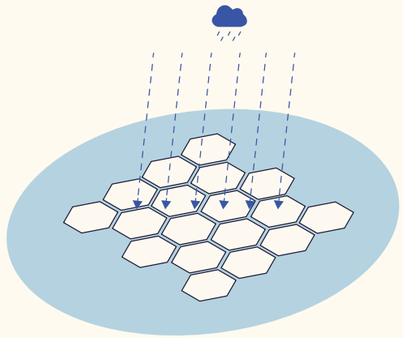
Too dry Negative: impermeable pavement

Triangle of awareness



Gradient of awareness





INTERVENTION #36:

PERMEABLE PAVEMENT

Spatial scale

Permeable has the capacity to infiltrate and retain precipitation, allowing water to percolate through the surface into the underlying soil. In many cases, permeable pavement incorporate space for vegetation. The intervention serves as an effective solution for locations with limited public space.

Microclimatic processes

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

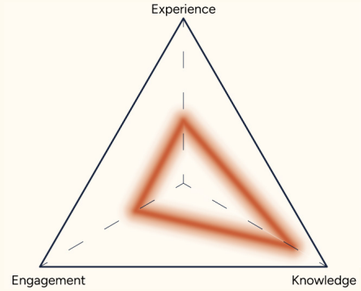
Too hot

Too wet

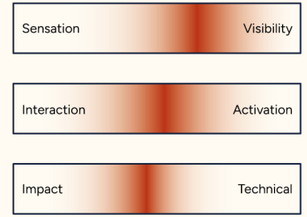
Too cold

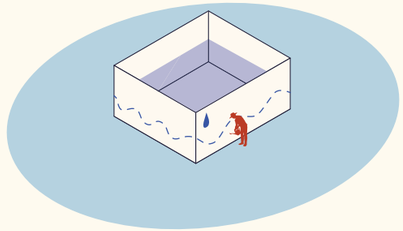
Too dry

Triangle of awareness



Gradient of awareness





INTERVENTION #37:

SEASONAL STORAGE

Spatial scale

Seasonal storage systems collect and buffer precipitation during wetter periods, and use it during times of drought. This intervention captures large volumes of water in the winter, and can be released for vegetation irrigation or lost through evapotranspiration in summer. Thereby, contributing to a balanced an resilient urban water cycle.

Microclimatic processes

WATER STORAGE

Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

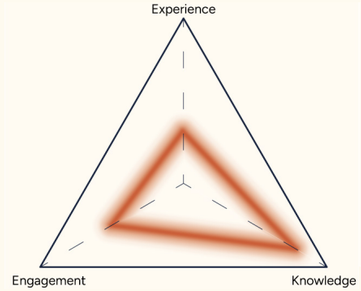
Too hot

Too wet

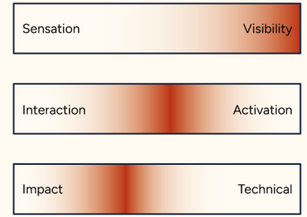
Too cold Negative effect: freezing of water

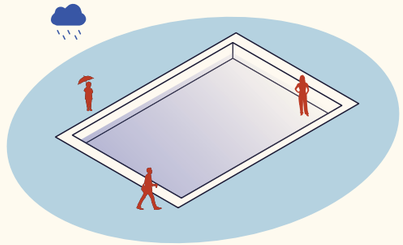
Too dry

Triangle of awareness



Gradient of awareness





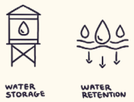
INTERVENTION #38:

WATER SQUARE

Spatial scale

Water squares represent urban design interventions that integrate climatic funtions, such as infiltration and storage, and recreational uses, such as play and social interaction. During periods of intense precipitation, the square temporarily serves as a water buffer. The rest of the time, the square is occupied by other human activities, making it a multifunctional and adaptive element within urban environments.

Microclimatic processes



Street typologies

Garden village (tuindorp)

Working-class district (volkswijk)

Garden city low-rise (tuinstad laagbouw)

Climate extremes

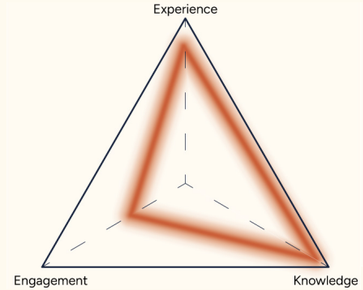
Too hot

Too wet

Too cold Negative effect: freezing of water

Too dry

Triangle of awareness



Gradient of awareness