3D Biodiversity and UX Implementation

Method and design concept for dense cities based on a case study in Amsterdam

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Master thesis

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This section contains the summary and introduction to the thesis. The entire report is summarized for a quick understanding of the results and conclusions. Afterwards, the full report is introduced. Here, some background information is provided on the problem in general, and how the research question is defined. There is also an explanation of the structure of the report and its planning, showing how deliverables are organized.

Start of the Thesis

Thesis summary

This thesis researches the implications of 3D biodiversity UX design, and its potential considering multifunctionality. The resulting research consisted of three different topics, namely a user research, a design method, and a design proposal for a case study. The general conclusion is that 3D biodiversity offers many benefits, however in order to maximize its potential, some fundamental aspects of how public greenery is designed and managed should change. Future research should look into the technical side of 3D biodiversity implementation, creating a small scale pilot, and involve the local users more directly.

User research

The user research was done with the help of literature, surveys, interviews, and observations. The literature results show that allowing users to interact with nature provides some benefits, however field research showed that the majority prefers indirect or soft interaction. Accessibility and space for interaction between users are also important. For the case study, local residents showed interest in communal gardening and public facilitations for cultural activities.

Design method

The design method makes use of an existing integral design method for public space created by the municipality of Amsterdam. This method uses different categories to list measures for the public space on a tactical level, in order to connect goals with practical implementations. With the results from the prior research, this method is expanded to include measures focused on restoring biodiversity and user functionality.

Design proposal

The design proposal is based on a case study of the Amsterdamse Poort, a shopping mall with social housing in the centre of Amsterdam Zuidoost. The proposal showcases how the design method can be used to create a rooftop park that restores biodiversity and at the same time involves users. The design proposal focuses on the potential multifunctionality of a rooftop park, but less on the technical implementations. Therefore, future research should look into the construction of an elevated rooftop park, material use, and required budget.

1. Introduction

Start of the thesis

1.1 Background

The urban area of the Netherlands has increased about 10 times its size in one century, from less than 2% around 1900 to 20% nowadays. At the same time, the amount of terrestrial nature decreased from 28% to 15%, while the agricultural occupation remained more or less the same (CBS, 2018). Therefore, the urbanization in the Netherlands is almost completely at the cost of nature. The importance of biodiversity for the ecosystem means that cities need to encompass effective and healthy ecological networks, connecting nature inside and outside the city. However, due to the already densely populated neighbourhoods and an ever increasing demand for new homes (Eerenbeemt, 2021), available ground should be used as efficient as possible. This requires solutions alternative to a traditional 2D biodiversity networks on the ground.

One of those solutions considers the walls and roofs of buildings as potential foundation for ecological networks. This concept of 3D biodiversity can tackle other environmental problems common in city areas as well, such as urban heat stress or failing water management during heavy rainfall or droughts.. Next to that, it opens up new opportunities for recreation for the city residents, by incorporating pathways and other recreational facilities. Small scale implementations such as the green roofs on bus stops in Utrecht,

Figure 1.1: Small investments like green roofs on bus stops already prove some of the potential of 3D biodiversity (Huisman, 2019)

depicted in figure 1.1, already show major improvement (Huisman, 2019). All in all, large scale 3D biodiversity in city centres has a huge potential, and the concept deserves to be researched and designed extensively.

1.2 Problem definition

The implementation of 3D biodiversity brings many aspects along with it. There are aspects related to creating an effective and essential ecological network, and at the same time, it needs to stay feasible and cost-effective. Next to these, the people living inside and around 3D biodiversity are directly affected as well. Snails and mosquitoes may be beneficial to the local environment, but a worry for many residents. In other words, there are many stakeholders involved, and each should be considered carefully.

1.2.1 The 4 focus points

A total of 4 aspects were defined at the start of the research to focus the scope of the project, structure the research, and categorize its results.

- Environment
- Society
- Residents
- Time

The first aspect is determined to be the **environment**, which is an umbrella term covering everything from climate to biodiversity, and from micro-organisms to small wildlife. This category will focus on the ecological implications of the research and its resulting design.

The second aspect is **society**, which is again a broad term that focusses on the economic and technical implications of the design. It will look at how 3D biodiversity can add value to society, and how it can be effectively combined with other aspects and stakeholders related to dense cities.

The local **residents** are defined as the third aspect since they especially are directly involved with the process of 3D biodiversity implementation. How will it affect their way of living, and how can they be part of the overall solution?

These first three aspects could be considered as different levels of the world that are connected to each other. A visualization of this can be seen in figure 1.2.

Finally, there is also the element of **time** involved. Sustainable measures that establish a robust ecological and social network need to be built to last. What that entails and how it can be achieved is to be researched as well. However, due to the fact it does not represent a stakeholder, this element will mostly be discussed in relation to the three other aspects instead of individually.

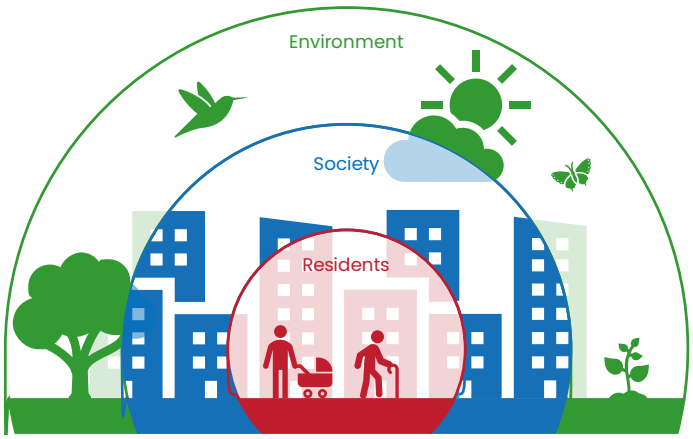


Figure 1.2: The three levels of the research question and how they relate to each other

1.2.2 Design question

This master thesis assignment will look into the potential of 3D biodiversity, its challenging aspects, and how this can be put together into a feasible design solution. It aims to answer the following research question:

How can 3D biodiversity in dense cities be realized to benefit the environment, society, and local residents, now and in the future?

1.3 Involved parties

The assignment was done in cooperation with two different parties, namely Naturalis and the municipality of Amsterdam. They provided both opportunities for the design process and valuable expertise on different views surrounding the topic. Their role and influence on the thesis are discussed here.

1.3.1 Naturalis

The original assignment came from Naturalis, a research centre in Leiden focusing on biodiversity and other ecological processes. Their idea was to bring people closer to nature through design, combining effective ecological measures to restore biodiversity with user experience. This multifunctional approach should make investments in biodiversity restoration more attractive.

Working together with Naturalis meant that there was an emphasis on effective measures for biodiversity, which are distinctively different to landscape designs currently regarded as the norm. Their expertise resulted in a better understanding of what actual natural greenery looked like, and how that can be practically implemented in a 3D manner.

1.3.2 Municipality of Amsterdam

With the help of Naturalis, the thesis was picked up by the municipality of Amsterdam after a few months of desk research. The city shows interest in effective ecological design measures and their potential regarding multifunctionality, so they were willing to help with the assignment.

The municipality provided many insights on the design of public spaces, including their own integral design method that showcased multifunctional solutions for the public space. Next to this, they provided access to a development project for the area of Amsterdamse Poort. Both of these opportunities acted as a framework in which the assignment could be completed.

The municipality also was the main hub of expertise in many different fields, including landscape design, architecture, urban planning, and pioneering pilots. The experts and their experiences surrounding urban biodiversity implementation shaped the final design considerably.

1.4 Overview

This report consists of 5 different sections. Each section contains multiple chapters that fit that part of the research process. The categories and corresponding chapters are colour coded as follows:

- i. Start of the thesis
- ii. Exploratory research
- iii. Approach
- iv. Results & conclusions
- v. References & appendices

With the help of the defined research question, an exploratory research is done, looking at the context surrounding the topic. After that, the research question is interpreted as a design question that is to be answered in two ways. First, the method looks at how this can be done in a categorical manner. Second, the design proposal shows what this looks like when applied in practice, with the help of a case study. These design answers are part of the larger general solution of the research question, and they are put together in the final conclusion of this report (Findeli, 2010).

1.4.1 Method expansion

The thesis focuses in part on the use of a design method. There already exists an integral design method within the municipality of Amsterdam, which can be used to design public spaces on multiple levels, in accordance with different aspects combined. The design method is analysed, and new findings of this research are incorporated in this specific method.

1.4.2 Case study & design proposal

Another part of this thesis considers designing an actual rooftop park, making use of the expanded method. This design proposal will answer the research question practically and is based on a case study. This case study is done based on the current situation of the Amsterdamse Poort, a city mall in the centre of Amsterdam Zuidoost. The case study is supposed to show how the expanded design method can be used in a specific setting, and how that will look like on a conceptual level.

1.4.3 Timeline

The timeline shows the chronological set up of this research. It consists of multiple phases that work towards answering the design question. The phases were defined as follows:

1. Exploration
2. User research
3. Ideation
4. Conceptualization
5. Finalization

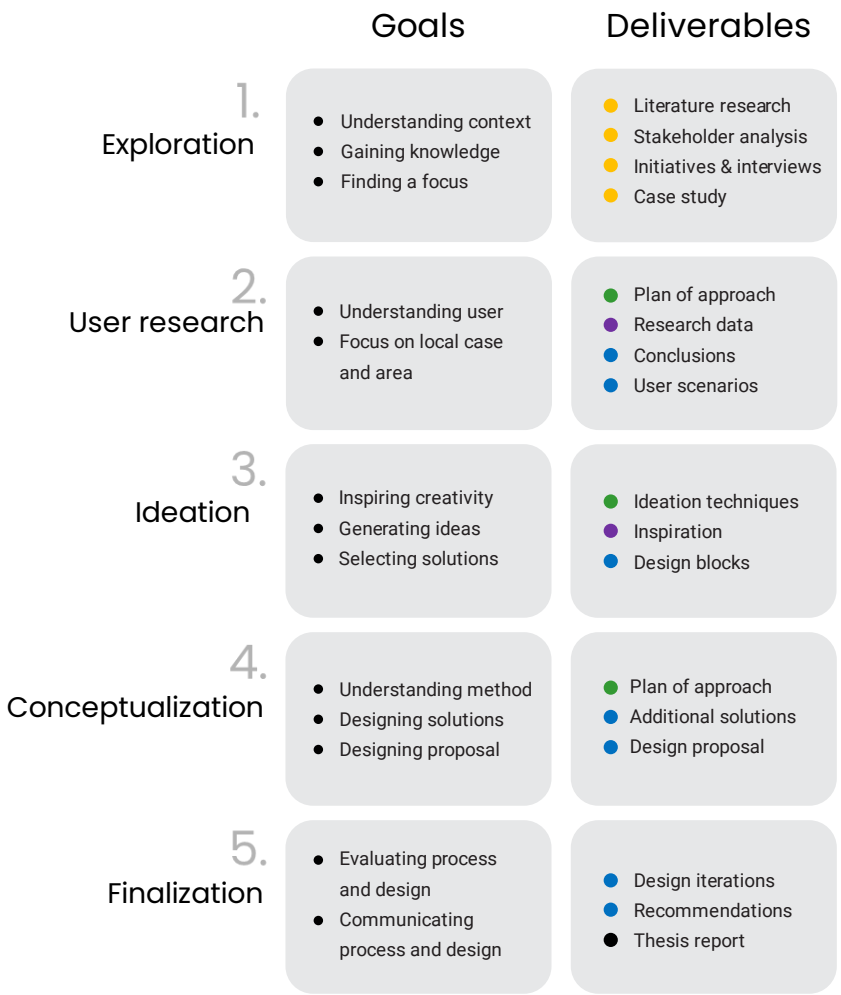


Figure 1.3: Overview of the thesis timeline with phases, goals, and deliverables

The first phase is about exploring the issue of 3D biodiversity implementation. What are the relevant benefits, as well as its challenges? Who is involved in the process, and how do they relate to each other? These questions are to be answered with an extensive literature research and available expertise. The explorative phase also focuses on the case study at hand. Research on the Amsterdamse Poort is done, looking at its location, history, demographic, and future. This will give insight on the current condition and experience of the area and show what aspects may be necessary to incorporate in a design for it.

The second phase focuses on gathering data around potential users of 3D biodiversity. This is often overlooked when green roofs are implemented, but this research emphasizes the potential of involving users in the designs. There will be surveys, interviews, and observations done in order to gain a better understanding on the perception of the user. The resulting synthesized data is used as input for the next phases.

The third phase entails the ideation process, which will take all the previous gathered data to look for potential focus points and solutions. It will use inspiration and exploration to create multiple design values and design blocks that can be part both of the extended Amsterdam method and the design concept of the Amsterdamse Poort.

The fourth phase will conceptualize first the method and then the design concept, as it showcases how they can take shape when the previously ideated solutions are incorporated. It will describe all features and potential of the designs, while also discussing important points that will require a shift in thinking by the stakeholders involved.

In the final phase, the entire process is put together into a report. The process is visualized, designs are evaluated, and any shortcomings or further recommendations are identified and discussed. All information is sorted into the relevant chapters.

The timeline is visualized in figure 1.3, with each phase listing their goals and deliverables. The deliverables are colour coded to show where they end up in the final thesis report.

This phase consists of an exploratory research. This part of the thesis provides valuable context surrounding 3D biodiversity implementation., focussing on why it is beneficial and how that can be effectively realized in practice. Already existing initiatives are analysed, as well as the relevant stakeholders identified. Lastly, the case study on which the design proposal will focus is analyzed in more detail. An overview of what can be found per chapter is visualized in figure ii.1.

II Exploratory Research

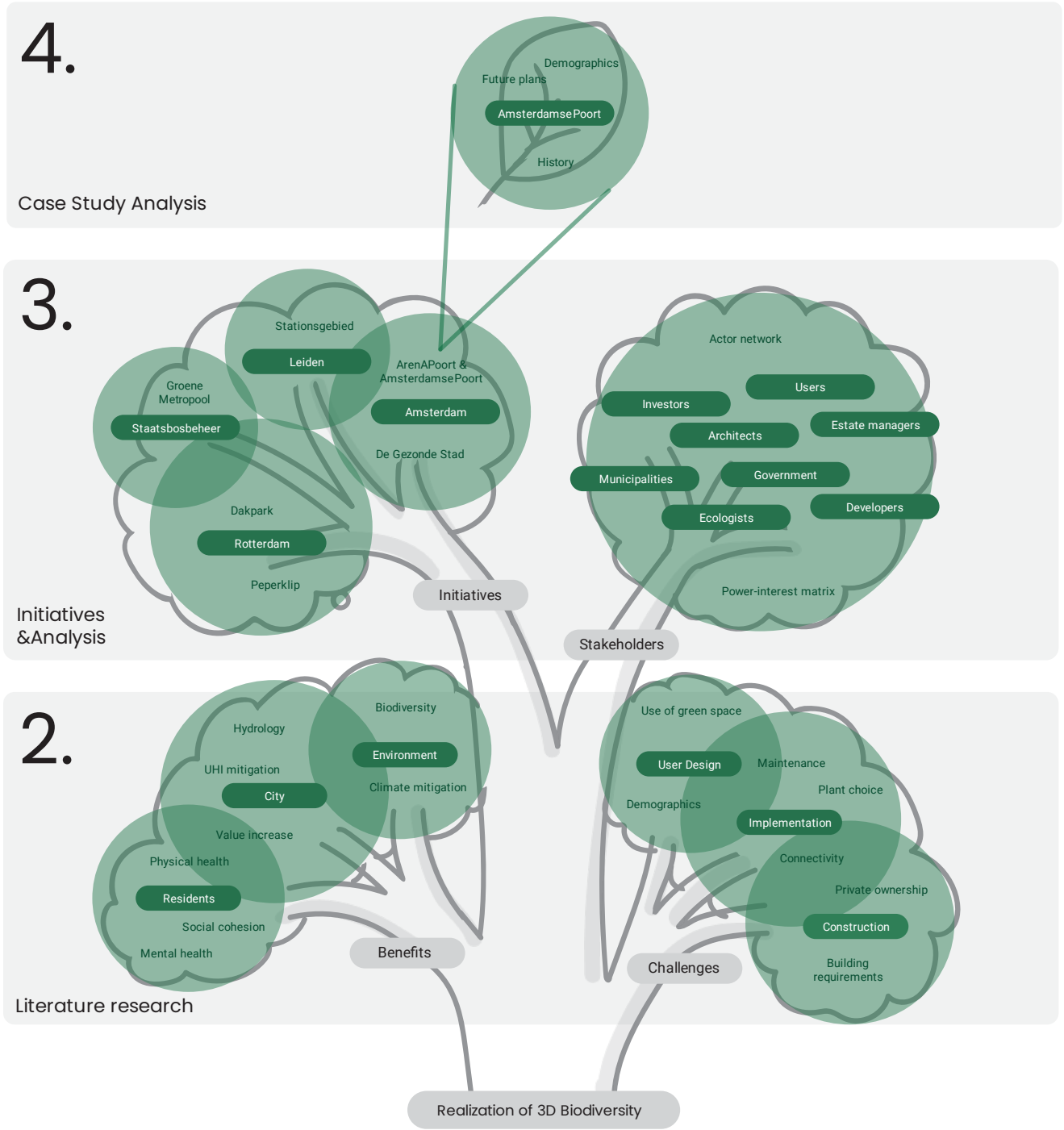


Figure ii.1: Overview of the exploration research

Exploration

2. Literature Research

2.1 Approach

The first part of the explorative phase focuses on the benefits and challenges of 3D biodiversity implementation in the broad sense. It follows from an extensive literature research. This is done in order to gain a better understanding of the context surrounding 3D biodiversity implementation, what it entails and how its effects can influence its surroundings. The benefits and challenges will give focus to the most important features that should be considered in the design process following the explorative phase.

The literature was gathered online with the help of key terms such as “green cities”, “user experience”, or “urban biodiversity”. The terms are based on the initial assignment description provided by Naturalis, which can be found in appendix A.1. Combining these terms provided some papers that listed specific benefits or considerations relevant for this thesis.

2.2 Benefits

The first part of the preliminary research concerns the benefits of 3D green space implementation in general. It provides insight in the broad scale of impact that increased biodiversity in cities can have. Based on the findings, the benefits of 3D biodiversity implementation can be divided into three different levels of impact, as shown previously in figure 1.2. Each level will be listed here individually, but they are very much connected. When residents benefit from a green space, society will flourish too, and benefits for the environment are essential for the survival of everyone in the long run.

2.2.1 Benefits for the residents

Residents can benefit from green spaces in urban areas in three different ways. First of all, there is evidence showing that direct contact with nature improves general mental wellbeing. There is a direct link between time spent in nature and increased wellbeing, and it has been advised to spend at least 2 hours in nature every week (White et al., 2019). This highlights the need for urban green spaces to make nature more accessible for residents inside city centres as well. 3D biodiversity on roofs and walls are an effective solution to this as they can incorporate nature in densely populated areas and improve mental health there.

The same goes for the physical health of residents. One study has shown a substantial increase in recovery speed for hospitalized patients when their window overlooked greenery, as compared to a view of brick walls (Ulrich, 1984). There are also some indirect benefits when it comes to physical health. Green spaces both facilitate and promote going outdoors, and they have proven to increase physical activity by providing residents with the space needed for a walk, run, or work out (Wolch, Byrne & Newell, 2014).

Another major advantage is the social cohesion that comes with most green spaces. Parks have been a meeting place for friends in any city, and the host of social activities and events as well (Jennings &

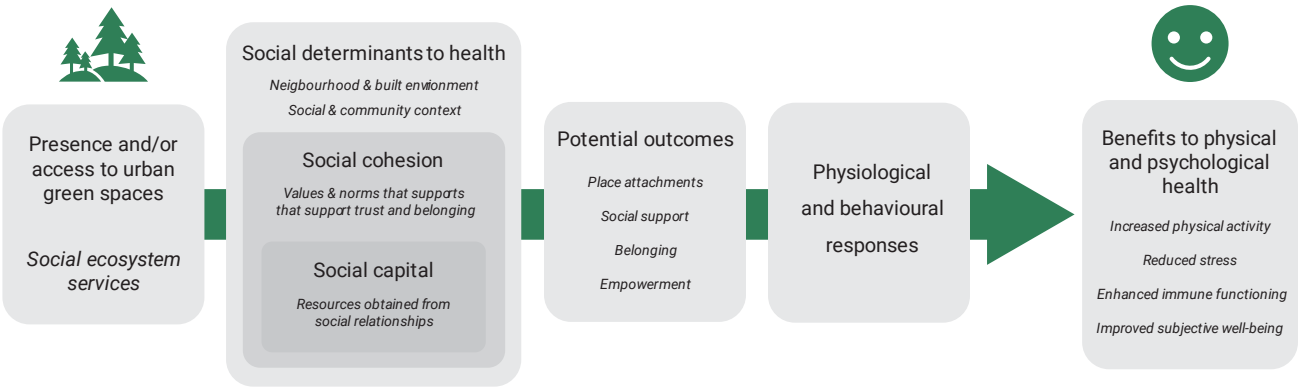


Figure 2.1: Schematic overview of how urban green spaces contribute to mental and physical health (Jennings & Bamkole, 2019).

O'Brien, 2019). It also gives the opportunity for meaningful voluntary work, such as maintaining the greenery or harvesting fruits. The social cohesion links back to the two previously mentioned benefits, as a stronger community feeling also improves physical and mental wellbeing. Figure 2.1 shows an overview of how urban green spaces contribute to social cohesion, which in turn improves mental & physical health (Jennings & Bamkole, 2019).

2.2.2 Benefits for society

The second level of benefits are for the society, or more specifically the city in which 3D biodiversity is to be implemented. The first main advantage is the mitigation of the Urban Heat Island (UHI) effect in city centres. The UHI effect occurs mainly during heatwaves in the summer. During those hot days, areas mainly consisting of large, paved surfaces and buildings tend to experience higher temperatures when compared to areas with trees and grass. This not only causes great discomfort for the residents of such an area, but it can also negatively affect infrastructure, such as bridges. The UHI effect was present in the Dutch city of Eindhoven during the dry and hot summer of 2018 (Hofgärtner & Zijsltra, 2018). The difference in temperature between the city and greener areas is caused by the higher heat energy storage capacity of buildings, and the increased anthropogenic heat caused by urban human activities. One way to mitigate the resulting heat stress includes adding green space and specifically trees. Vegetation creates a more comfortable microclimate within a city, and the more area is covered with greenery, the better (Ng, Wang & Yuan, 2019). Mitigating the UHI effect also may potentially save up to 30% of current energy consumption in buildings during the summer (Gago, Roldan, Pacheco-Torres & Ordóñez, 2013).

Another advantage is the help 3D greenspaces provide with rainwater runoff in a city. Due to awkward hydrology and climate change causing more frequent heavy rainfall, cities have become prone to flooding. Large amounts of rainwater in short periods of time disrupt traffic and causes water damage. Green roofs appear to be a viable solution to this problem, absorbing most of the rainfall and releasing it slowly. When compared to a regular roof, roofs containing green

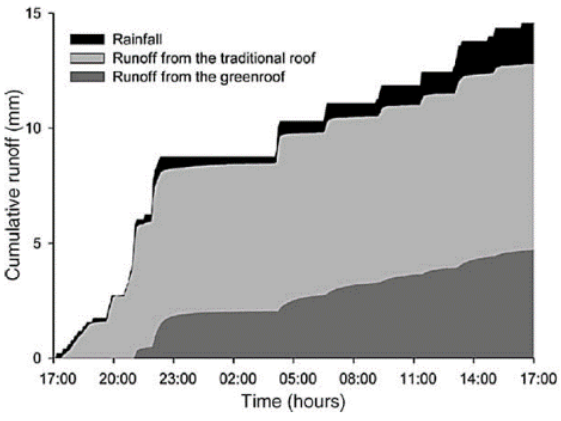


Figure 2.2: Rainfall runoff of a traditional roof compared to a green roof (Mentens et al., 2005)

spaces released substantially less rainwater (Mentens, Raes & Hermy, 2005), as shown in figure 2.2.

Last but not least, green spaces on roofs are good for the general image of a city. Green roofs are generally associated with environmental restoration and care / attention, even simplistic implementation such as mere sedum or grass. Such positive characteristics can contribute to the perceived value and appreciation of a city, and improve the aesthetic of a city in the eye of the public, increasing potential tourism and housing value (Loder, 2014).

2.2.3 Benefits for the environment

The final level of benefits concerns the environment and climate in general. The most straightforward advantage is that the implementation of 3D greenery in an urban environment directly contributes to the conservation and restoration of biodiversity. Biodiversity is vital for the survival of many species, including humans, since it is responsible for biological systems on which much of the agriculture, fresh water supply, and clean air are dependent. Cities have great potential considering biodiversity, yet it is rarely recognized by its planners and managers (Alvey, 2006). However, due to cities becoming bigger and more prominent, incorporating biodiversity throughout its design is vital for its conservation and liveability.

Another advantage on this big scale is the possibility of climate change mitigation. Global warming of the planet causes many weather conditions to become more extreme, including longer periods of drought and heat, and larger amounts of rainfall in shorter periods of time (Van Aalst, 2006). Both of these conditions are unfavourable for the liveability of cities. By increasing the total amount of plants and plant cover through green spaces in cities, more CO2 can be extracted from the air and stored into the ground. This extraction decreases the intensity of climate change and its direct consequences, and in the end increases the liveability of cities, and the planet overall.

2.3 Challenges and considerations

It is important to note that many aforementioned benefits are not necessarily given when creating green space in urban environments. Although the relations to them are strong, there are some considerations to be made when implementing green space in order to maximize its positive effects. These will be discussed in this section of the research.

2.3.1 Limitations of buildings

The 3D aspect of biodiversity implementation means that green spaces will move beyond the ground onto walls and roofs. For this to be possible, the buildings that are subject to 3D biodiversity implementations must be strong enough to withstand the extra weight. Many existing roofs are not manufactured to be as strong as floors, because they are not seen as extra potential living space. Their main function currently is to protect the floors beneath it from the natural elements. For walls, there is the substantial concern that plants may damage its structure and compromise the strength of the entire building. Both of these considerations have a large impact on the practical implications of creating 3D green spaces (Rotterdamse Dakendagen, 2021a).

Another important issue that can arise is the ownership of those green spaces. Many buildings in cities are privately owned, including its walls and roofs. This means that private owners and businesses will be responsible for the cost of construction and maintenance of 3D green spaces on their facility. This issue is partly the reason why city-wide 3D biodiversity implementation is hard, and it highlights the importance of creating incentives for those private owners to implement greenery on their roofs and walls themselves (Oberti & Plantamura, 2018). On the long term, it would be more effective to revise outer walls and roofs suitable as green spaces as public property, which eliminates the need for incentives. Another way to encourage 3D greenery implementation, is making use of Rogers' diffusion innovation theory (Rogers,

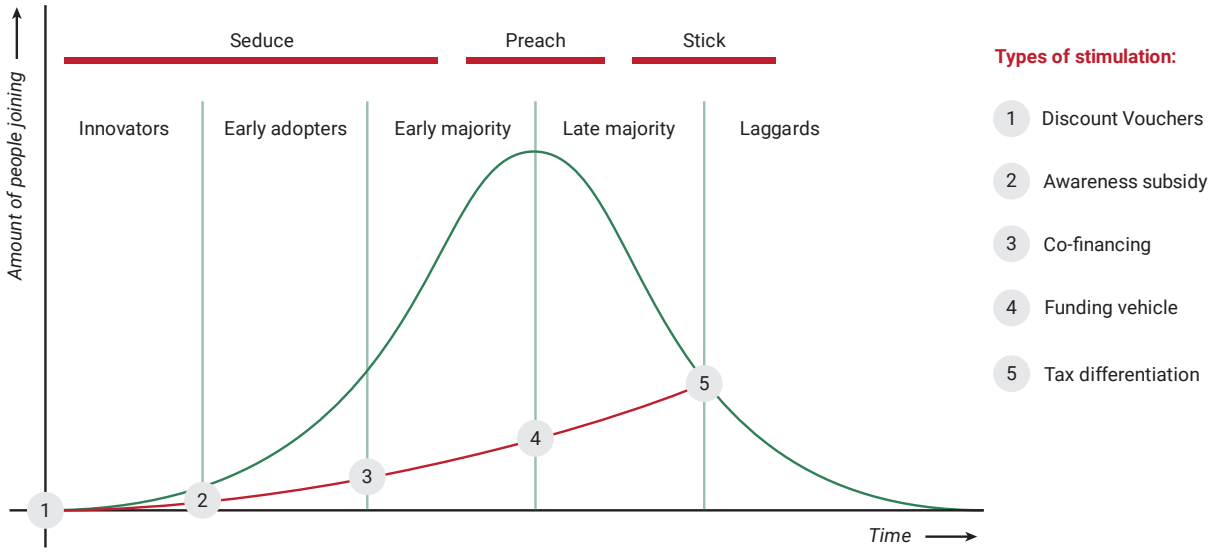


Figure 2.3: Rogers' diffusion of innovations theory combined with stimulation phases. (Rogers, 2003)

2003). It divides the stimulation process into 5 types, which fit the different stages of customer awareness and trends, as shown in figure 2.3.

2.3.2 Implementation of nature

In order for biodiversity to genuinely increase when creating green spaces, one must consider the complex requirements of nature itself. Biodiversity is the cooperation of many natural systems and cycles which all influence each other, so just planting trees and covering areas with grass does not mean the biodiverse potential of those spaces are fully utilized, and nature is rightfully restored. The placement of deadwood, porous stones, and other entities is very important to attract insects and other animals and increase biodiversity, so these decisions must be made carefully. In terms of vegetation, planted areas that are mostly diverse and native to the local area, in terms of genetics, are more resilient against changes in climate (Maes, 2019). Although nature will always be present in outside public spaces, the preconditions on which it grows can be considered and improved, creating a more complex and robust system (van den Berg et al., 2021).

The next issue is about incorporating natural networks and green infrastructure. The environment does not function as separate entities with boundaries, but private ownership and roofs in a modern city does. Biodiversity is declining not only because its networks are shrinking and fragmented by society, but because those remaining areas that are green exist separately and do not interact with each other (Goddard, Dougill & Benton, 2009). Biodiversity benefits most from large natural networks that are cohesive, allowing ground dwelling animals to roam the area and interact with each other, as well as roots of plants and fungi in the soil. To enable this when designing for 3D biodiversity, the aspect of roof-to-roof as well as ground-to-roof connection is essential, not only for residents to access those areas, but for biodiversity to thrive as well.

Next, there is the challenge of maintenance and time. Green spaces tend to change with the seasons and grow over time, which can cause unfavourable sights or effects. This means that simply building 3D green spaces is not everything, since they must also be maintained. In order to effectively implement greenery, one must also incorporate aspects such as water supply and necessary weeding. Some of these maintenance jobs can be automated with the help of smart design, whereas others like may not even be necessary. For example, mowing grass excessively is both expensive and bad for biodiversity, and even beneficial to the growth of pests (Watson, Carignan-

Guillemette, Turcotte, Maire, Proulx, 2019). It is important to think beforehand what maintenance is necessary, how it should be done, and how the costs are covered. There are already some initiatives that give residents the opportunity to care for public greenery, which saves maintenance costs and also enhances community feeling of the city.

2.3.3 User experience design

The considerations most relevant for this research relate to the user of the 3D green spaces. The use of green space can dictate its format based on the wishes of the residents. For example, when there is a large community that wants to meet regularly or activities to be organized, a green space can mainly consist of an empty field. When there is more need for educational value, as in near a school, it can take the form of a nature exhibition and play garden. It is vital for a green space to be designed in line with the need of the public, in order to be valuable to the city (Rotterdamse Dakendagen, 2021b). Therefore, gathering the opinions and wishes from users and incorporating them in the design process is of major importance. Citizens should be part of the solution by engaging them with the implementation and conservation of biodiversity. This will expand the support for 3D biodiversity, which can help spread the idea and its benefits to other areas as well (Francis & Lorimer, 2011). More on this is discussed in the approach of the user research done for this thesis.

Part of the user design is the demographic of the users. Different age groups and cultural ethnicities require different approaches to the design of a green space. Children must be able to explore nature, and adults must be able to rest. Based on the largest demographic, certain activities inside a green space can be designed accordingly to maximize engagement and maybe even generate profit. These opportunities must be explored in order to effectively design a green space that benefits both the owner and its users (De Vries, van Dillen, Groenewegen & Spreeuwenberg, 2013).

Incorporating these considerations in the design process will help maximize the benefits that green spaces can bring to the residents, city, and environment. These considerations are at the base of the requirements of the final design proposal.

Exploration

3. Initiatives & Analysis

3.1 Overview

The second part of the explorative phase consists of an analysis of current initiatives and their stakeholders. The initiatives are located throughout the Netherlands in different cities. Valuable lessons can be learned from analysing them, so that the design proposal resulting from this thesis is effective and avoids known pitfalls. This is done with the help of experience from different experts, as they share their view on 3D biodiversity implementation. This information can be useful when looking at how green roofs can become more attractive for everyone involved. Experts were also interviewed without necessarily being linked to an existing initiative. These interviews are noted in appendix A.1. but will still be part of the analysis.

All findings up until now are analysed and summarized into points of interest. These points will form the baseline for the direction and the requirements of the design concept.

3.2 Current initiatives

The researched initiatives are based on a short list from Naturalis, that expanded during the literature research phase. A total of five initiatives are researched online and with the help of interviews with experts involved. Each initiatives showcases different ways of practical implementation of 3D biodiversity, and the focus of the analysis is on their underlying values and the results. The resulting insights can be used to identify and prevent any pitfalls when designing 3D biodiversity implementation.

3.2.1 De Groene Metropool

The Dutch organization for natural reserves called *Staatsbosbeheer* (state-wide forest management) currently has a program named *De Groene Metropool* (the Green Metropol). This program is looking at the Netherlands as one big metropole, and its efforts are to make it consistently green with a robust network throughout the entire country (Staatsbosbeheer, 2021). Staatsbosbeheer is able to look beyond the borders of one green space, since it is the largest owner of green spaces in the Netherlands, with over 265000 hectares of owned land (Staatsbosbeheer, 2019). Using this ownership, it cooperates with municipalities of the Netherlands to create (new) greener residential areas that decreases fragmentation of nature and at the same time brings nature closer to the residents, see figure 3.1.

The core focus of this project is strengthening the ecological network of the Netherlands. Nature and its biodiversity can thrive if it is perceived as an essential part of the infrastructure of an urban area, just like roads, internet, and sewage. If this switch in perspective is normalized in building projects, it will greatly benefit the biodiversity of the area, which in turn provides the city with all the aforementioned benefits. If nature becomes an integral part of general infrastructure, there is also no need for it to have a profitable business case anymore. It will simply be necessary for the area to be liveable, just like running water or

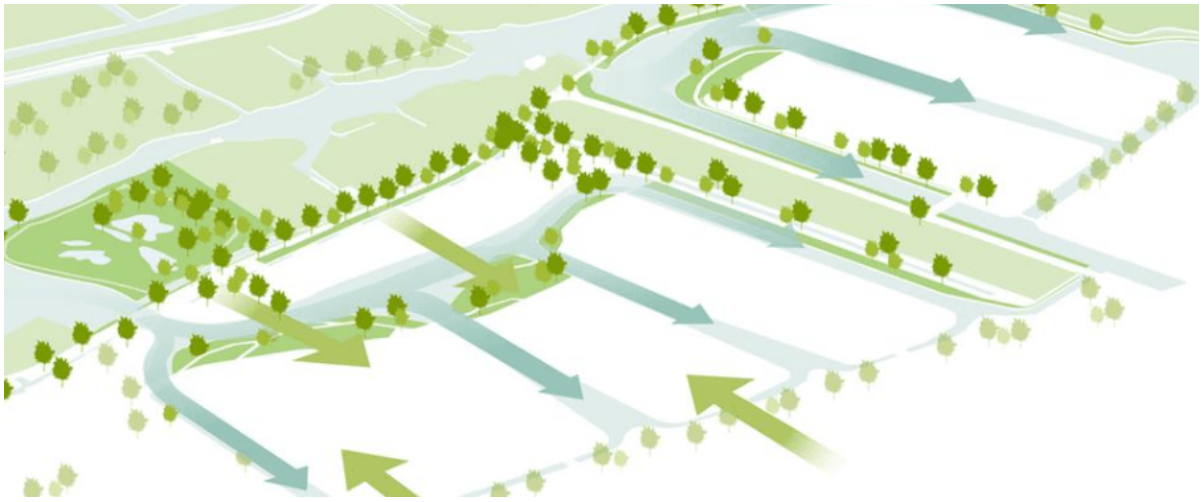


Figure 3.1: Example of an ecological network through a new neighbourhood (Staatsbosbeheer, 2021)

electricity. The Netherlands in general has great potential for a robust natural network for everyone to use, it now also needs to make use of it as well (Walgien, 2020).

"The first thing that I see when I walk through a city, is how many cities already have many open green spaces, but the quality of them often is incredibly mediocre. If you look at the residential areas of the 50s, 60s, and 70s, you will see lots of flats with big spaces in between them. Like lawns, with poplars, a handful of green strips, some shrubbery. Watchable green, I call it. The problem is: the quality of use is incredibly weak. And it's even weaker for the natural environment." Harry Boeschoten, Programming director of De Groene Metropool

3.2.2 Leiden

In Leiden, there is a major overhaul of the area surrounding the station (*stationsgebied*) currently in construction. Post-war buildings and roads are being demolished and redirected to make way for new apartments, infrastructure, and even a cinema. The idea behind the project is to improve the station area so that it becomes a welcoming sight for people entering the city. An important aspect of this improvement is a major increase in greenery in and around the area, being realized on streets, in already existing parks, and on rooftops (Leiden, 2021).

Although the original vision of the municipality depicts the rooftop gardens as a public space, much like a neighbourhood park, the practical implementation ended up being fairly limited, as it was left to the developers. The rooftops will be green and beneficial to the environment, but are most likely to be inaccessible and privately maintained. The ambitions present in the concept vision are only partially met. The residents will not benefit directly from the 3D greenery, which weakens engagement levels as well as any mental or physical health benefits.

It turns out that clients are mostly interested in the economic benefits of a green roof, such as the collection of rainwater. They are also mostly motivated by direct legislation that involves climate adaptation and sustainability. Reasons for the lack of accessible green roofs are: the difficulty it brings in construction, the expensive vertical connections needed, and lack of return on investments.

"There is indeed a lot of ambition in the area of green roofs, but in practice there are barely any roof gardens with a public character. We as architects encourage development of green roofs but developers are more hesitant. If there would be a public function for the roof it is usually only meant for the residents or owners of that building." Frank Venhorst, Neutelings Riedijk Architects

3.2.4 Rotterdam

Rotterdam appears to be ahead when it comes to extensive green roof integration in urban areas. There are projects throughout the city focusing on the possibilities of 3D green spaces and providing actual results. One reason for this relative quick progression is increased awareness, due to initiatives such as the *Rotterdamse Dakendagen* (Rotterdam roof days), a yearly festival showcasing the latest developments in roof functionalities. Another reason is the investments made by the local municipality. Two projects are discussed here.

1. Rotterdam Dakpark

The *Dakpark* (Roof park) in Rotterdam is a large, 1200 meter long rooftop park in the west of the city, near the harbour. Underneath it, a shopping mall can be found, see figure 3.2. The park features trees, a waterway, and community gardens. It is one of the largest rooftop parks in Europe (Dakpark Rotterdam, 2021). Residents of the surrounding area are responsible for the gardens and security, in close cooperation with the municipality.

The park came about when an old marshalling yard of the nearby harbour was put out of use. The residents were in favour of a new park, considering that the surrounding area was densely populated with little public green space available. However, investors and developers were in favour of a shopping mall, as it provides a much higher return on investments. To cope with the conflicting wishes of the two stakeholders, the municipality joined the discussion. Through co-creation between the different stakeholders, the multi-functional hybrid between shopping mall and park came about. The shops made for a strong business case that allowed for investments in the corresponding park. In the end, both parties are satisfied, the building fulfils many functions, which allows the surrounding area to flourish and increase in value (Rotterdamse dakendagen, 2021b).

> *"I think in the end, they made a business case that worked. The shopping malls mean money, and if you are making money, you can find ways to invest that, and reinvest that. And a part of that came to the rooftop park. I think that is a very logic thing, but it is fundamentally different from making as much money as possible. It's trying to create as much value as possible, which is a completely different starting point."* Paul van Roosmalen, project leader of Dakpark, from the municipality of Rotterdam

2. De Peperklip

The Peperklip is a building on the southern side of the river in Rotterdam, filled completely and only with public housing. Because of the fact that it is an already existing building, constructed in the 80's, there were a

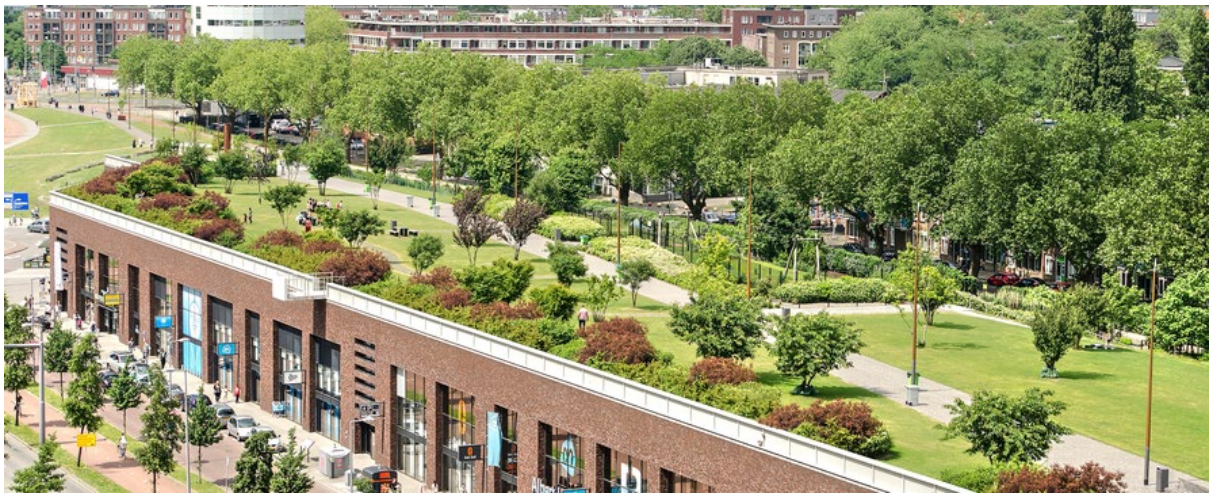


Figure 3.2: Depiction of the Rotterdam Dakpark. Picture by Frans Blok

Figure 3.3: The green roof on the Peperklip. Picture by Vestia

lot of practical limitations for a rooftop garden. The real estate corporation was stimulated by the municipality of Rotterdam to enhance the roof, and the plans were ambitious. However, due to a tight budget, restrictions of what a housing corporation is allowed to do, and cheap efficient construction, the final implementation is limited.

The focus on budget cost meant that the rooftop garden needed a profitable business case. This turned out to be hard, since many benefits of a green roof cannot be expressed in money. Mainly due to the pressing emergency of climate change and biodiversity loss, subsidies of the municipality and government enabled the corporation to still implement a green roof, as effective as possible but inaccessible to the public, see figure 3.3 (Rotterdamse dakendagen, 2021a).

3.2.5 Amsterdam

The capital city of Amsterdam also has many projects with (3D) biodiversity implementation as part of the development of the city. Two projects are described here.

1. De Gezonde Stad

De Gezonde Stad (The Healthy City) is an initiative spread throughout the city of Amsterdam, and wants to encourage citizens to engage in small activities that are beneficial to biodiversity and energy consumption. This is achieved by organizing workshop in which residents learn about the effects of their actions and providing them with the proper materials to increase biodiversity around their own home (De Gezonde Stad, 2021).

It is important to engage citizens with the process of biodiversity implementation, and education on this topic appears to be necessary to increase awareness of the potential benefits it holds for them, the city, and the environment as a whole. Facilitating some beginner tools and steps lowers the bar to implement more greenery and animal friendly areas in their private spaces. Allowing them to help with simple tasks in public spaces also increases feeling of responsibility and community, while at the same time reducing cost of maintenance for the city. This bottom-up approach is especially useful in densely populated areas such as Amsterdam (Francis & Lorimer, 2011). *De Gezonde Stad* makes use of all these tropes, with the help of subsidies gained from the municipality of Amsterdam.

2. ArenAPoort

A south-eastern part of Amsterdam, called the ArenAPoort, is up for major revision in the future. The area

Figure 3.3: Participation in the implementation of biodiversity. Picture by De Gezonde Stad

currently houses a stadium, shopping centre, prominent office buildings like the *Zandkasteel* (sandcastle) and has its own train station. The municipality wants to build up to 5700 new homes in the area, heavily increasing the population density, which is necessary due to the expanding population of the city. The surrounding areas, such as Amstel III, will be overhauled as well (Amsterdam, 2020).

Participation of current and future residents appears to be integrated in the design process already, and there are plans to continue the participation in the next years. This is done through speaking hours and a local information centre, which should provide information and opportunities for residents to share their wishes.

Some wishes are already heard and part of the concept vision of the ArenAPoort. These include the implementation of green roofs and roof gardens as a way to facilitate resting areas and greenery in the dense building plans. These roofs are accessible for residents and employees of that specific building, eliminating the need for public access connections.

Although the wishes of residents are taken into account, they themselves appear to be separate from the development process, so there is some room for more direct cooperation. Green roofs are mentioned as a solution for heat stress, aesthetic public space, biodiversity implementation, and sustainability throughout the concept vision. Nonetheless, concrete decisions regarding green roofs are not made, yet other than "stimulating developers to implement them".

3.3 Stakeholders

The stakeholders of 3D biodiversity are influential for its practical implementation. They each represent a group of people involved in the process, from the very first design drafts all the way through the use and maintenance phase. The list including their values are mostly identified during the analysis of initiatives, and based on other research (Zambrano-Prado et al., 2021). The analysis explores their influence and relations, and looks for any points of interest of use in the ideation phase. The following stakeholders are identified:

- Investors. They bring the money to the table and enable the entire process and realization. Investors need to see the importance of 3D biodiversity and understand its potential in terms of direct value increase of a building and potential profit to be made.

- **Developers.** They are the builders and will have to realize the design. This means that pragmatic solutions should be found during the design process to make their work as easy and cheap as possible.
- **Managers of estate.** They will often be the final owner of the green space, as well as the ones that should be encouraged to implement 3D biodiversity on their buildings. A careful balance between value increase and costs is essential for that.
- **Municipalities.** They act as an overarching supervisor that can look at neighbourhoods as a whole, which is very valuable for the effectivity of biodiversity. An important actor for the creation of plans and assets for 3D greenspaces.
- **Government**. Similar to the municipalities, they are in charge of envisioning large projects and act in the interest of the general population. They also have the power to create legislation which enforces the conservation of biodiversity and the implementation of 3D greenery.
- **Ecologists.** They speak for the environment and biodiversity in general. For them, implementing green spaces wherever possible is essential, as well as the correct plant choice and other assets that improve its positive effect on biodiversity.
- **Architects.** They will focus mainly on the general aesthetics of a building and will have a lot of experience when it comes to the theoretical futuristic possibilities of 3D biodiversity on buildings. Money is often not an issue for their ideas.
- **Users.** This group is influenced the most by the implementation of green spaces, so their wishes and needs are very important for the overall design process. Due to the diversity of this group, it must be researched what types of user are most stereotypical for each case, creating scnearios based on surveys, interviews, and observation. Based on the case, the users can either mainly consist of residents, employees, passers-by, children, or others. Their wishes and needs can vary greatly between groups, so multiple user stakeholders are possible.

3.3.1 Stakeholder Analysis

The stakeholders are all involved in different parts of the process. In general, there are three different stages when implementing 3D biodiversity in the form of green spaces, respectively conceptualizing / legislating, developing / building, and using / maintaining. The stakeholders are distributed within these stages, based on when they are most relevant or have the most input on the implementation, see figure 3.4. The

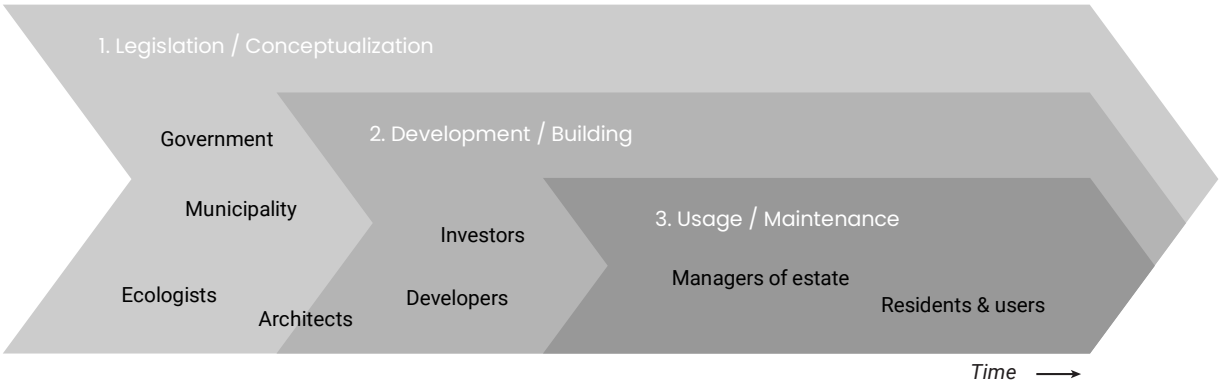


Figure 3.4: The stakeholders divided into 3 stages, based on time and proximity to realization.

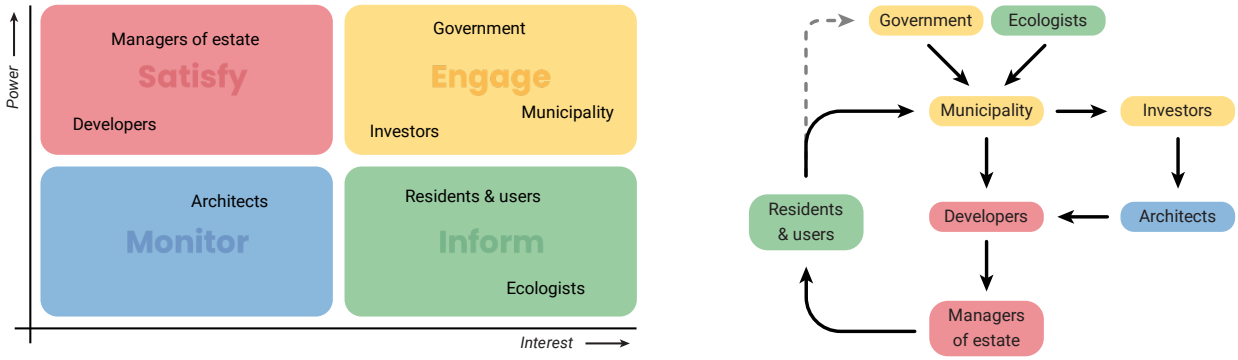


Figure 3.5: the power-interest matrix and actor network of stakeholders involved in 3D biodiversity implementation.

actors of the first stage will influence the development of the second stage, which will in turn affect the usage of the third stage.

The relevance and interest of each stakeholder is evaluated using a power-interest matrix analysis. This matrix places each stakeholder into 4 subsections according to their power over the matter and their interest in it. Together with this power-interest matrix, an actor network is created. The actor network shows how the stakeholders can influence each other. Both evaluation systems can be found in figure 3.5. The analysis helps in identifying which stakeholders need the most attention, whose wishes needs to be met, and who needs to be informed (Smith, 2000).

Based on the matrix, it becomes clear that residents and ecologists have great interest in the outcome but usually have little say about it. This group needs to be listened to and brought into the design process. Developers and manage of estate on the other hand are in charge of buildings on which 3D biodiversity could be implemented, but they lack motivation in doing so. These stakeholders need an incentive, and their wishes and obligations should be taken into consideration. Architects are often concerned with the aesthetics of a building, and have little influence or interest in the process of actual biodiversity implementation. The most important and influential group consists of the government, municipalities and investors. These actors can shape the entire design process with stimulation, legislation and capital. They should be engaged in the design process and motivated to 3D biodiversity implementation, by raising awareness of its benefits, creating stronger incentives, and increasing support base in the population.

The corresponding actor network gives an overview of how each stakeholder is connected to the rest. It reveals that residents do have some power over government and municipality, however often indirectly through voting and participation groups, and often conflicting due to the high diversity of the group. The network also reveals the municipality to be an important stakeholder within the process.

Exploration

4. Case Study Analysis

4.1 Location

The ArenAPoort and the Amsterdamse Poort are the centre of Amsterdam Zuidoost. This south east area is not connected with the city of Amsterdam, but is still part of the municipality, with the cities of Diemen and Ouder-Amstel in between, see figure 4.1 The ArenAPoort and Amsterdamse Poort are connected with the Johan Cruijff Boulevard, a massive pathway with a train station located right on top of it. The boulevard borders the football arena, two concert halls, and two shopping malls. It is the main walkway of that area. Elevated roadways run through the neighbourhood, whereas cyclists and pedestrians share the space underneath.

The entire area of ArenAPoort covers many roofs, so in order to keep the design inside the scope of this research, the site of the Amsterdamse Poort will be the focus of the case study. A breakdown of exactly which roofs are to be redesigned can be found in the approach of the design proposal. The shopping centre is oftentimes seen as the heart of Amsterdam Zuidoost, so the entirety of it is part of the analysis in order to better understand the current situation.

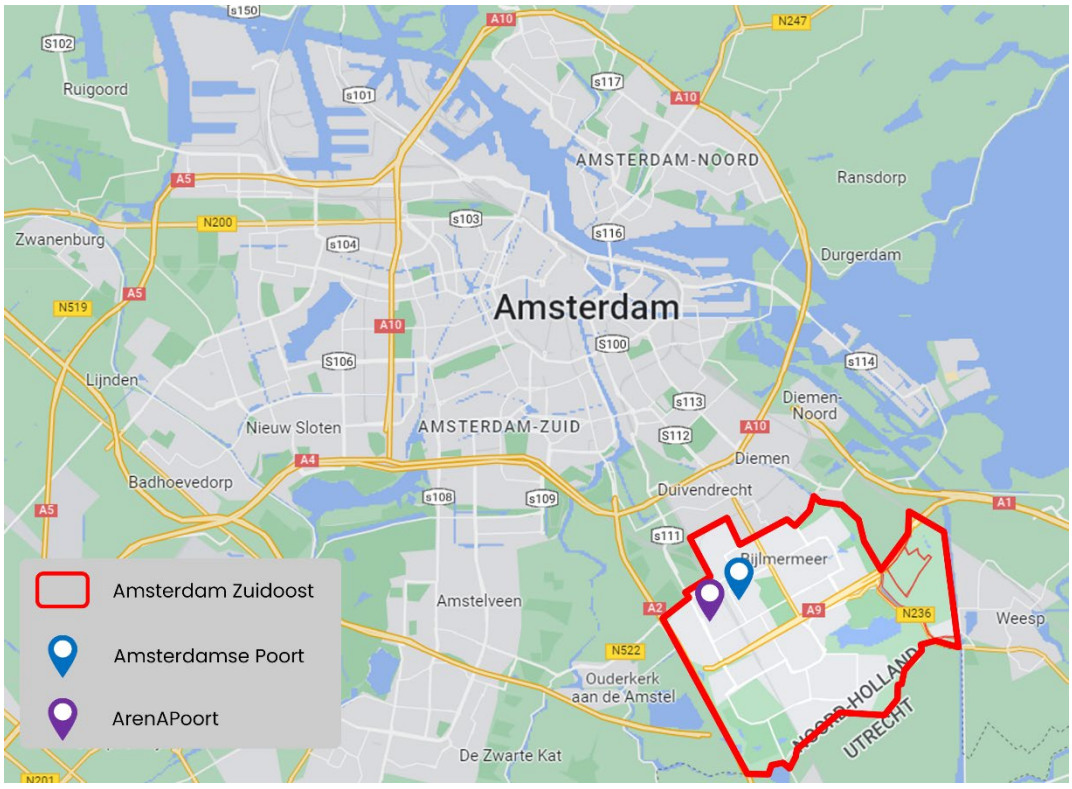


Figure 4.1: Location of the case study in Amsterdam. Picture by Google

Figure 4.2: The original design of Amsterdam Zuidoost. Picture from Stadsarchief Amsterdam

4.2 History

Amsterdam Zuidoost has a rich history, despite it being a fairly new part of the city. After the second World War, there was a desperate need for housing, and a nearby polder of the previously emptied Bijlmermeer was designated as a new housing area. The Bijlmer, as the largest living area of Amsterdam Zuidoost is also called, was designed completely from scratch in accordance to the modernist views of the CIAM movement and Swiss-French architect Le Corbusier. This meant that there was a complete separation of functions; one area would be solely designated for living, the other for recreation, the other for shopping, and so on. Cars and bike lanes would be on different levels, and 90% of all residencies were planned to be high-rise. 80% of the area would be covered in green and publicly accessible. The entire Bijlmer was a "model district", marketed as the city for the modern man (Bijlmermuseum, 2015), shown at its epitome in figure 4.2. However, this massive top-down approach did not turn out as expected.

The high rises turned out to be unpopular with their target audience, young families. They would rather live in small scale houses with their own garden that were built elsewhere in the country. This caused the residencies to be rented to people who had no choice, many of them outcasts and low income migrant workers. When the vacancy of the buildings was at its peak in 1975, the previously Dutch colony of Suriname declared independency, causing a wave of Surinamese refugees to come to the Netherlands. Many of them would find refuge in the empty houses of the Bijlmer. By the end of the seventies, 40% of its residents were from Suriname or the Antilles, 40% from other from West Africa, and 20% were originally Dutch. (Bijlmermuseum, 2015)

The modernistic design approach turned out to have other massive flaws. Privacy and collecitivity turned into anonymity, and the large open public spaces between and in the flats would be riddled with homeless people and criminality. The flats turned out to be too massive to properly maintain, which in combination with incompetent management and policies caused many problems and decay. All these problems made the Bijlmer one of the worst places to live in the Netherlands, and its image became that of a ghetto rather than a modern city.

In the 1990s, when the vacancy of houses reached another peak and many of its housing corporation were on the verge of bankruptcy, it had become clear that the Bijlmer was structurally flawed: too massive, too much high-rise and too little differentiation. A massive overhaul started that would result in the demolition of over half of the 13000 high rise dwellings. They were to be replaced with smaller single-family homes. Functionality would also increase in the area, making space for small shops and firms next to the houses. (Wassenberg, 2006)

Next to this structural change, there was also a big socio-economic renovation. A strong focus on job creation and women empowerment improved liveability of the area. Watchmen and -women increased safety which at the same time decreased unemployment. During the 1980s, on the other side of the train station, a football stadium was constructed, along with large cinemas, theatres, and an office area (Bijlmermuseum, 2015). It acted as a catalyst for structural improvement of the area. All of this helped to re-establish the Bijlmer and slowly change its image for the better.

The systematic changes were made together with the residents. Surveys were sent out to gain insight on the wishes of the residents, and a bureau was set up that acted as communication device between residents and executives. This integral approach had proven fruitful. The majority of residents voted to demolish half of the high rise and got compensated for relocation, which resulted in no major protests or dislocated citizens. (Wassenberg, 2006)

Nowadays, Amsterdam Zuidoost is a diverse and unique part of the city, with over 130 cultures being represented and its own multicultural summer event called Kwaku Festival, see figure 4.3. The Bijlmer is living proof of how a top-down design approach can fall short, and why constant investment and clear communication with residents is incredibly important and helpful. Currently, the area is on the brink of a new massive overhaul, again with new high rises planned. This time, multifunctionality and sustainability are key points for the new housing projects, and history has proven that an integral approach is vital for a liveable neighbourhood. (Wassenberg, 2006)

4.3 Future plans

Similarly to 75 years ago, there is a big demand for new affordable houses, especially in big cities such as Amsterdam. Therefore, future development has been planned for 5700 new houses at the ArenAPoort, and 15000 new homes in Amstel III, the centre for offices south of the ArenAPoort. This would mean a massive increase of residents and a smaller public space to share. (Amsterdam, 2020)

Figure 4.3: The Kwaku festival is a popular cultural activity in the area. Picture by KWAKU

The Amsterdamse Poort will be the city centre for all these new homes. Surrounding the shopping mall, an additional 600 new homes are planned, and the entire area is up for a renovation of 180 million euros, including the shops (3W, 2022). Part of this renovation includes green facades and green roofs throughout Amsterdamse Poort, and a greener shopping centre overall using vegetation, see figure 4.4.

Those green strips, together with green roofs, are essential for the liveability of Amstel III and ArenAPoort, especially now that the density of buildings will be way higher than in the original Bijlmer. However, the green spaces will be mostly private for its residents only.

4.4 Demographic

As mentioned before, the current population of the Bijlmer is incredibly diverse and has prominently Surinamese roots. Next to that, it is not a rich area. Around 70% of all households has a low income, which is the highest number throughout Amsterdam. Appreciation of the neighbourhood has increased in recent years, and objective security followed the same trend. However, the subjective sense of security is still low, and criminality in youth is above average (Hof & Mulder, 2017). In ArenAPoort, there are also students from the nearby Hogeschool Inholland and employees of nearby office centres taking a stroll during their breaks.

In the living area of Amsterdamse Poort especially, things like childfriendliness, sports facilitation and social cohesion score far below the average of Amsterdam (OIS Amsterdam, 2022). Next to that, no one in the area owns their house; everything is social housing. The age of the residents is comparable to the rest of Amsterdam, see figure 4.5. Other comparisons can be found in appendix A.2.

Figure 4.4: Impression of the renovated shopping mall. Picture by Paul de Ruiter Architects

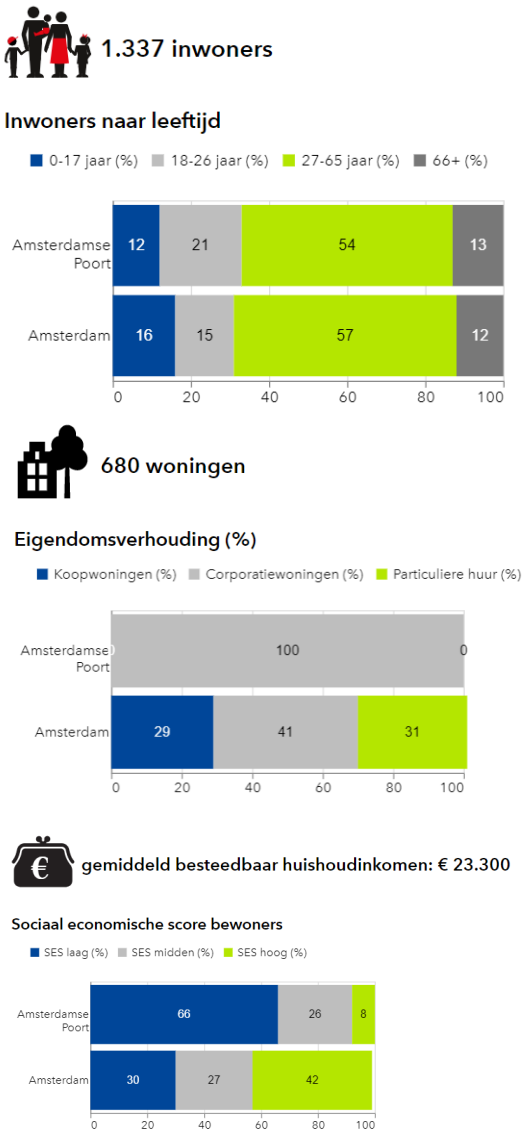


Figure 4.5: The Demographic of Amsterdamse Poort. Picture from IOS Amsterdam

Thanks to the context now figured out, the actual design process can begin. This part describes the approaches taken for each section of the thesis,: the user research, method expansion, and design proposal. Although discussed seperately, these aspects and their approaches are very much connected and depend on each other. This is shown in figure iii.1. As depicted, the user research, together with the previous exploration research, form the breeding ground for the method expansion and design proposal, coming about through an ideation process.

III Approach

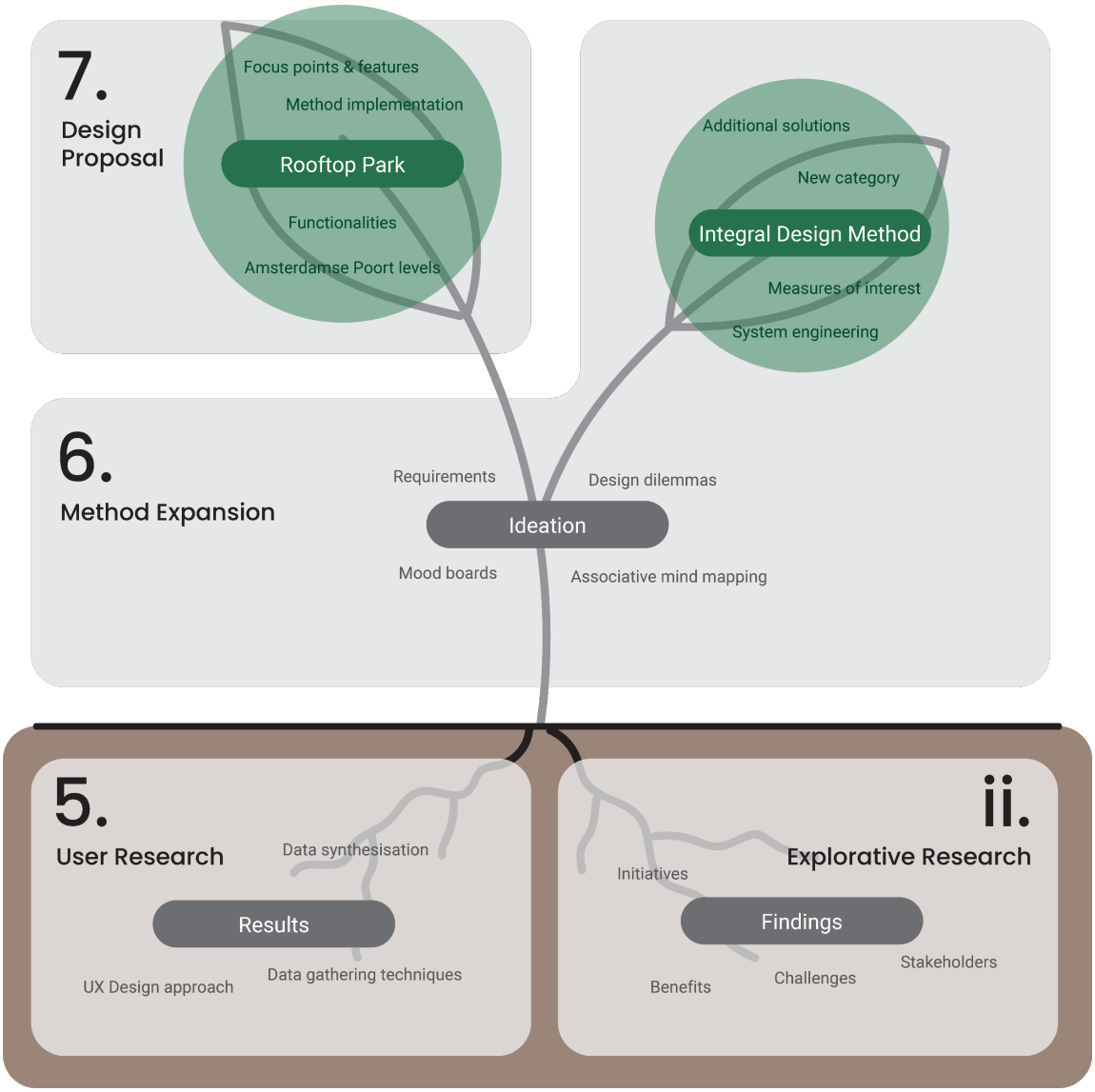


Figure iii.1: A visualization showing how the different sections of the thesis relate to each other

5. Approach User Research

5.1 Background

For this thesis, the focus is on the user experience or UX of 3D biodiversity implementation. This means that there will be an emphasis on the motivations, values and views of the user which will dictate the features and functionality of the design. The following step is to practically implement these features in a way that is accessible and meaningful to the user, resulting in tangible design proposals that can be used in development projects (IDF, 2021). These three steps can be defined as the "why", "what", and "how" of the design, as is shown in figure 5.1.

An important thing to note about UX design is that it incorporates the whole experience around a product, or in this case, the experience around 3D green spaces and biodiversity. The final design and experience should be intuitive, accessible, and meaningful to the targeted users.

This section will discuss some important background information regarding UX of green spaces. The history is analysed, and the importance and potential of implementation are described as well.

5.1.1 History

The user experience of green spaces and nature in general is an old phenomenon that extends all the way back to the medieval times. Before the industrial revolution, towns and cities would often encapsulate farmland. The land provided the food for the citizens, and the city in turn provided organic waste as fertilizer for the farmland. Next to that, the first parks were created. They would often consist of a large area of wildlands exclusively for the noblemen to hunt for sport. The areas were surrounded by a fence to keep the wild animals in and the commoners out.

Industrialization caused a rapid urban expansion that drifted farms towards the edge of cities, and soon it became adamant that there was a desperate need for

Figure 5.1: Three steps in UX design (IDF, 2021)

Figure 5.2: French (left) and English (right) landscape design have little to do with actual natural landscapes. Pictures from Wikimedia Commons

a space to breathe between the heavily populated working class neighbourhoods and factories. The first city parks were gardens of the rich and noblemen that were opened to the public, and large landscaped parks at the edges of the city. These gardens and parks were modelled based on a romanticized idea of the countryside, and were far from wild. This style is known as the French landscape style, which was later replaced by the English landscape style, focussing less on symmetry but still very much romanticized, see figure 5.2. They had lots of social activity and were essentially a playground for the rich and noble. Due to their often faraway locations, the working class living in the cities had no time or money to benefit from them. (Cranz, 2008)

At the end of the 19th century, small pocket parks began to pop up in cities to bring nature closer to the working class, and as a way to reform the city socially, primarily because there was so much immigration to deal with. In this era, parks would often include a field house (much like a club house) to increase social cohesion of the city. The parks were symmetrical and oftentimes incredibly small; nature came secondary to the function of the park.

Throughout the 20th century, recreation became an important aspect of parks, and slowly city planners started to understand the value of networks, albeit for walks and recreation instead of biodiversity. Networks could consist of a ring surrounding the city, grids throughout the city, or green slabs reaching deep into the city centre, such as Amsterdam. (Lohrberg, 2001)

Staatsbosbeheer has an extensive historical timeline that shows the trends in recreation starting at the 1930s (Staatsbosbeheer 2020), which can be found in appendix A.3. It started on a relatively niche scale, with recreation as medical advice. Then, from the 1950s onward, recreation became more en masse, with large scale festivals and as daytrip activity. It can be linked with the increase of free time people experienced. In later years, park recreation became more closely linked to meaningful educative experiences and lifestyle.

5.1.2 Importance

Humanity has always been intimately linked with its natural environment, which has provided many benefits regarding physical and mental health. However, this link appears to be dwindling drastically in recent years. The worries about the amount of experiences of nature, especially with younger generations, is named the "extinction of experience". People have less and less interaction with nature, such as fishing

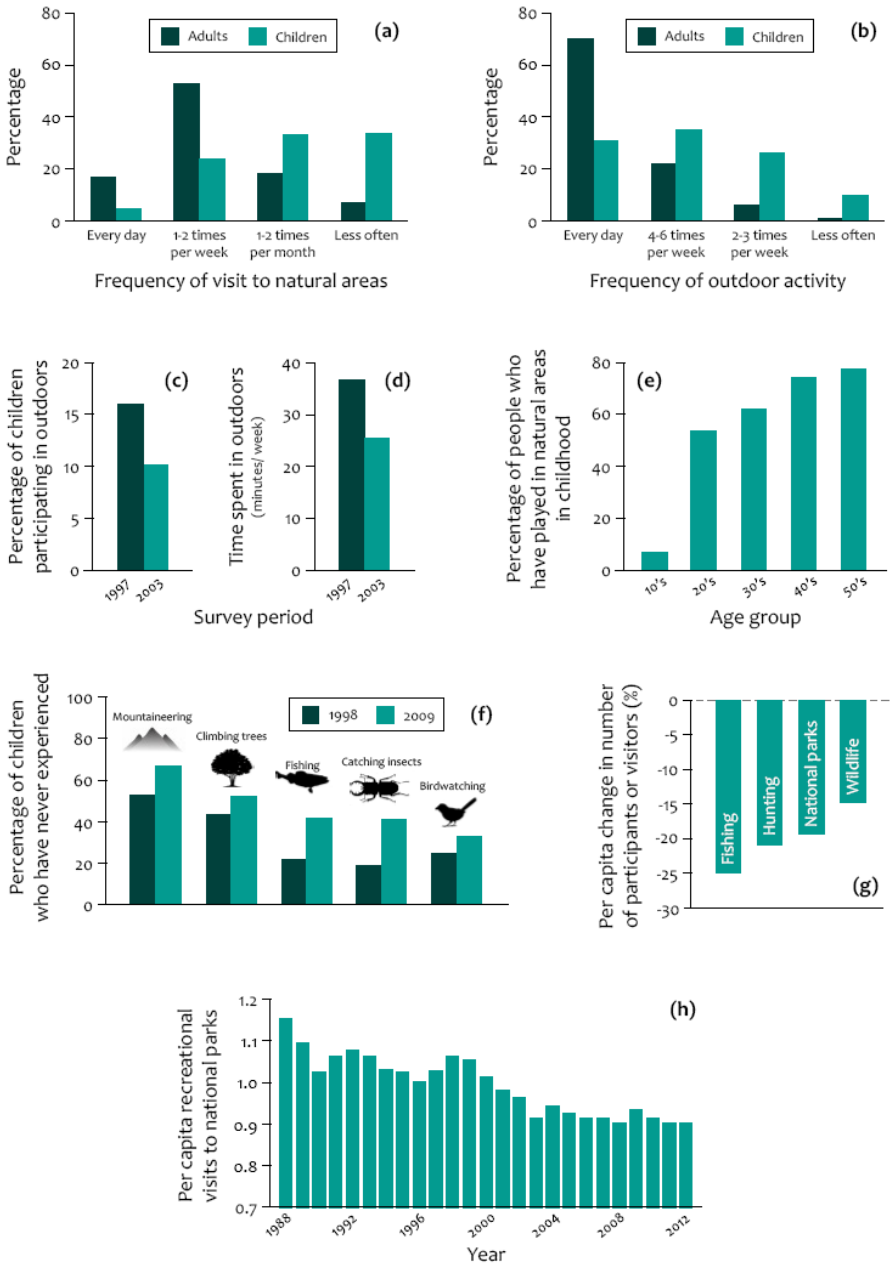


Figure 5.3: Evidence of natural interaction declining over time (Soga & Gaston, 2015)

or catching insects. The trends related to these activities are shown in figure 5.3, based on a study compiling empirical evidence from the United States, United Kingdom, and Japan (Soga & Gaston, 2015).

The danger of this extinction lies in the worsening mental and physical health of those with little experience related to nature, and less support for pro-environmental movements that are essential for long-term survival. What may be even worse is that the extinction of experience is becoming a negative feedback loop. Basically speaking, people with little interaction with nature will feel less connection with the environment, which in turn results in a decrease in interaction with nature. This loop is depicted in figure 5.4.

This research suggests that appreciation for the environment will inadvertently follow from an increase in natural experiences, but the link is not that

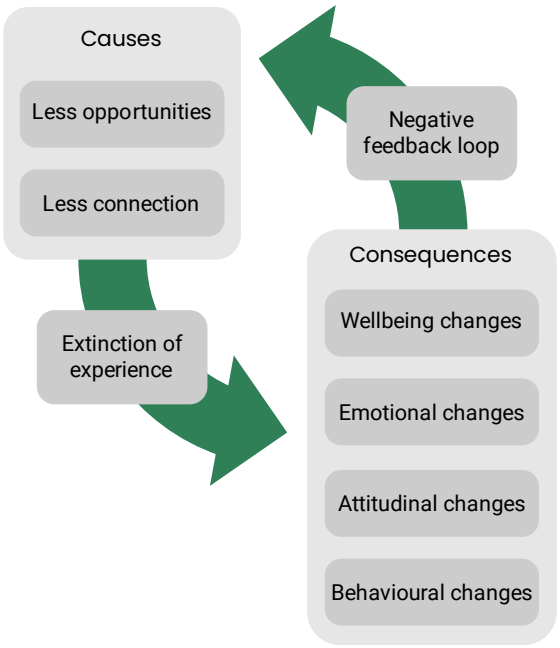


Figure 5.4: Negative feedback loop accelerating extinction of UX (Soga & Gaston, 2015)

straightforward. There are other factors at play when it comes to nature appreciation, namely the reference of meaning surrounding each experience [27]. For example, when a child sees a frog, the reaction of an accompanied adult at that moment can influence the experience greatly; they can be disgusted or curious with the child. Many prominent environmental activists have had an important experience like that in their youth, which appears to be an important time period to create meaningful experiences (Neuteleers & Deliège, 2019).

Another contextual factor that influences the experience is the cultural background in which it takes place. If a big part of the identity of a local population comes from its environment, the link between them is stronger, which in turn means that locals appreciate the environment more. If a culture inherently respects a certain aspect of biodiversity, for example fertile soil, the link is also stronger.

However, designing interactions with nature in such a way that it will mostly provide peak experiences (impressive landscapes, big wildlife) misses the point that it needs to be a personal interaction, however small that may be. Variation seems to be key here, providing many contextual factors so that everyone can find something to appreciate or identify with. Luckily, biodiversity provides that variation on its own when given the time and space to develop in the right conditions.

5.1.3 Potential

The functionality of a park has become more and more extensive over the years, and today there is a tension between the recreational and environmental requirements each green space should meet. However, there is also potential in linking the two by making biodiversity part of a recreational activity, increasing awareness of natural processes through recreation, and creating opportunities for users to interact with nature in a meaningful way.

With over half of the human population currently living in cities, urban nature is a key player to bring back experiences with the environment and strengthen the link once again (Soga & Gaston, 2015). Although some think that nature should be fenced off and kept out of reach of humans for its own protection, it is essential to give residents an opportunity to experience said nature and reverse the effects of the extinction of experience.

The experience of nature is not only feasible from an ecological standpoint, but from an economic point as well. The economy has steadily been progressing from providing goods and services towards providing experiences in recent years. As early as 1998, research recommends experiences over services as a way of increasing value and profit, when done correctly (Pain & Gilmore, 1998). According to these researchers, an experience consists of four realms, each of which can and should be designed for. Their theory is visualized in figure 5.5.

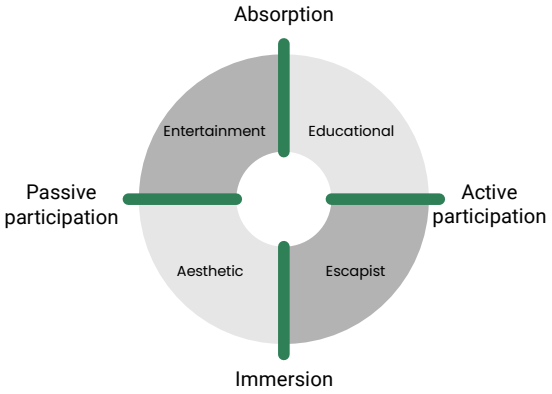


Figure 5.5: The four realms of experience put into concrete principles (Pain & Gilmore, 1998)

All in all, combining the practical benefits of green roofs with user experience design seems like a valuable option to combat multiple complex problems at once. It can bring meaningful experiences to residents which increases support for other environmental solutions, all the while potentially creating revenue with monetized activities, making it interesting for more reluctant stakeholders as well.

5.2 Data gathering

To create a proper contextual frame for the user experience of 3D green spaces, a broad understanding of the motivations and values of its users is necessary. It is also helpful to identify the target groups of the design beforehand, so that the resulting data is concise and useful for a design relevant for its intended users. This understanding can be acquired using a number of different methods, namely surveys, interviews, and observations.

5.2.1 Surveys

Online surveys are easily distributed over a large and varied population and can be used to gain valuable quantitative data. Surveys can reveal the general consensus of a group and showcase what kind of values and wishes are most prominent throughout them. It is an effective method to get a large amount of data relatively quickly, so they are used as part of this UX research.

For this survey, the goal is to reveal the general public's thoughts and experiences with biodiversity, roof gardens, and green spaces in general. Therefore, the survey is split up into three categories, namely:

- The current use and experience of available green spaces
- The understanding and experience of biodiversity
- The wishes and concerns surrounding 3D green spaces (green roofs and connections)

To gain an understanding of what is the current view on (3D) green spaces, respondents will answer questions about their current practices in green spaces, and which features of a park either improves or worsens their experience. Their understanding and experience of biodiversity is measured by their favourite activities related to the

5.2.2 Interviews

Interviews give more in-depth answers than surveys, resulting in qualitative data that can be used to inspire the design proposal. The interviews for this research are done on location in Amsterdam Zuidoost with people present on the street. There are four general questions, which form the base for any other question that arise during the conversation. This way, the interviews are not too rigid, and allow for interpretation and more insight on the values behind each answer. The four base questions are determined as follows:

1. Why do you come to the Amsterdamse Poort?
2. How would you describe the Amsterdamse Poort?
3. What would you like to see in the public green space (on roofs)?
4. What do you think are the biggest challenges when building green roofs here?

The interviews are kept short to lower the bar for interviewees, as people on the street generally do not want to be interrupted from their activities for too

long. The persons interviewed on the street speak mainly for themselves, but by also interviewing representatives of the neighbourhood, more general values should become clear as well.

5.2.3 Observations

Observations describe behavioural patterns of the users and residents around the Amsterdamse Poort. They can reveal certain wishes and needs from the users that they would not necessarily articulate in a survey or interview. At the same time, they generate quantitative data by counting the amount of people related to a certain group or activity. The observations for this research are carried out on four locations, them being:

- Amsterdamse Poort
- Johan Cruijff Boulevard
- Nelson Mandela Park
- Cumulus Park

Each location is being observed for a total of 2 hours, at different times of the day. Next to quantifying the amount of people present, notable actions or activities are also described. For each location, their features and limitations are observed and noted as well.

5.2.4 Amsterdam participation data

An important aspect of data gathering is also looking at data that is already available. The municipality of Amsterdam has done participation meetings with the residents of Amsterdam Zuidoost in 2019 [29]. These gatherings resulted in some points said by the residents and an evaluation of the municipality whether they can do something with them.

Although many points discuss topics not necessarily related to 3D biodiversity implementation, some express direct wishes surrounding the public space and green roofs. These points will be part of the data synthesized in this research.

5.3 Data synthesis

The data gathered throughout the UX research is put together in an overview sheet. This sheet contains all answers from the survey, summarized phrases from the interviews done on location, and comments related to the observed experience of the surrounding areas. This way, all the results are in one place which allows for a better overview and quicker synthesisation. When all data is made readily available, the results are processed using categorization, and turned into user scenarios which will be used as part of the design ideation phase.

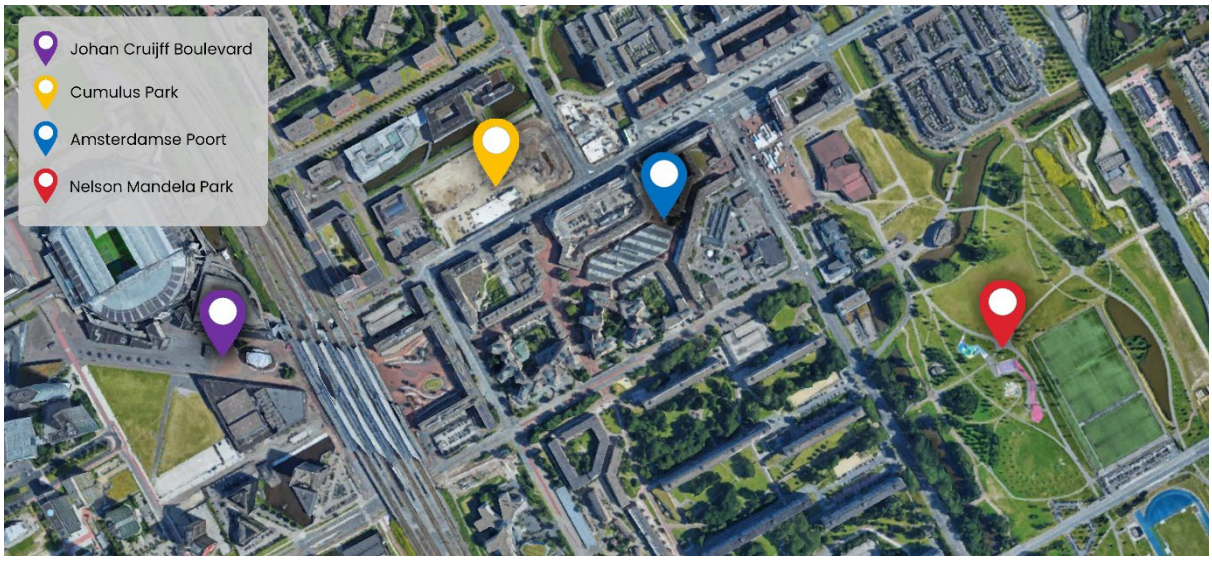


Figure 5.6: Locations of observations around the Amsterdamse Poort. Picture by Google

5.3.1 Categorization

All relevant data is categorized into four categories, each of which are again divided into multiple subsections. The categorization allows for easier processing of the results, as it reveals the general opinions and wishes surrounding each aspect of 3D biodiversity. The categorization is as follows:

1. Current experience of green spaces (parks, forests, lakes, etc.)
    a. Definition
    b. Experience
    c. Features
2. Understanding and experience of biodiversity
    a. Definition
    b. Experience
    c. Responsibility
3. Wishes and concerns surrounding green roofs and connections
    a. Wishes
    b. Concerns
    c. Commitment
4. Other factors
    a. Mentioned examples of green roofs
    b. Amsterdamse Poort opinions

5.3.2 Themes & user scenarios

After the data is categorized, it is used to generate multiple themes. These themes are focus points that come forward multiple times in the results of the UX research. Each theme is elaborated upon and design factors that influence them are also identified. During ideation, the themes can be used to formulate the requirements of the design concept.

Another used form of interpretation consists of user scenarios of green spaces. User scenarios are short stories inspired by the research data that inherently show the needs and requirements of a design, as they highlight what users will do with the public space. The scenarios are fictional but can be used as ideals for the design to strive for.

6. Approach Method Expansion

6.1 Background

The proposed 3D biodiversity implementation will follow a certain design method. This method is supposed to give quick oversight in what solution affects which aspects and how different solutions can be combined in order to design as effectively as possible. The municipality of Amsterdam already has a design method which could be further developed, and it will be used as the baseline of this approach (van den Berg, van der Made, Oosterheerd, Riccetti, 2020). The method resulting from this research will be an addition to the method of Amsterdam, so that the municipality can use it in future projects as well. The new solutions will be formatted in the same manner, as explained here.

6.1.1 System Engineering Basis

The method is based on a system engineering approach which incorporates a decision structure on 3 levels of management, see figure 6.1. Those levels are strategic, tactical, and operational, respectively. Following this systemic approach makes individual design solutions more effective, coherent, and complementary (Gremion, Figueiredo, Vazquez & Alves, 2019).

Strategic management is making decision on the highest level of the pyramid and relates to company ideals such as the overall vision or long-term goals. The second level of the pyramid is tactical management. This is where the ideals of the company are incorporated into more concrete methods and measures. The lowest level of the pyramid is operational, where the methods and measures are put to

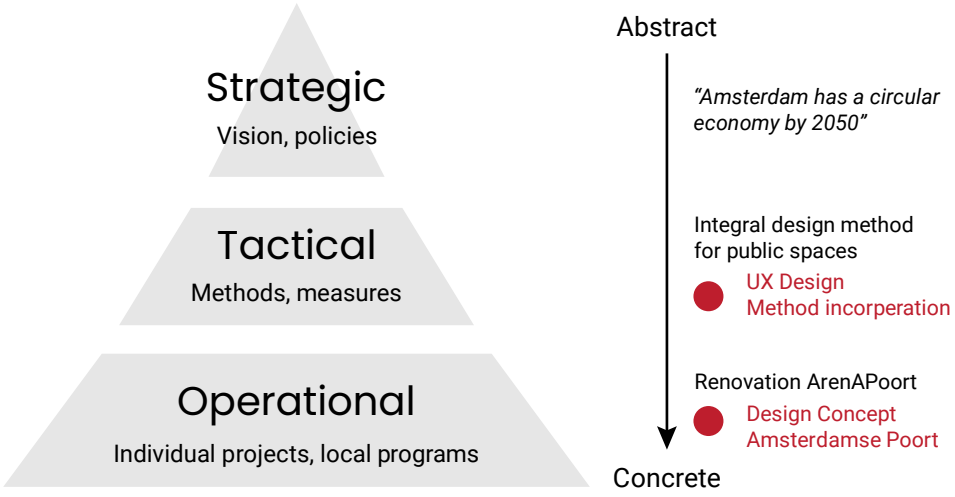


Figure 6.1: A systemic approach to engineering & decision making

use through local projects and short-term programs. The previously determined strategies and ideals are translated into concrete solutions that fit the local requirements of each project.

6.1.2 Themes of design

The municipality of Amsterdam has created its own systemic method for designing public space facilities on a city wide scale, in order for all local projects and renovation to be complementary and work together. This way, the projects do not interfere with each other when looking at mobility or electricity infrastructure, for instance.

There is a total of 7 themes in the current design method, listed as follows:

1. L – Living environment
2. M – Materials
3. R – Mobility
4. B – Soil and subsoil
5. E – Energy
6. F – Flora & fauna
7. W – Water

Each theme is interconnected with each other, and they all operate on 5 levels of design. All the proposed design solutions are categorized in one of these levels. The five levels are listed from small to large scale, as follows:

1. GB – Building
2. KA – Building lot
3. OR – Public Space
4. NE – Network
5. GE – Area

Every theme has their own measures and solutions related to each design level, and the solutions often combine with solutions of other themes on other levels. For example, when looking at the theme of water management on the level of individual buildings, a water retaining roof is a measure that can be taken to hold excess rainwater. A specific way of doing so is by incorporating a green roof. This solution can then be combined with purifying the rainwater after collection, which is a measure related to the theme of soil, for a whole area.

Each solution has a unique code, so that they can be quickly found and linked to other solutions. The build-up of that code is explained in figure 6.2.

6.2 Measures of interest

The current method of Amsterdam has many solutions for its 7 themes, but some particular solutions fit well within the scope of this research. These solutions will be incorporated in the design concept, as well as the promising combinations with newly added measures. The points of interest are listed here per corresponding theme. Interpretations of the solutions as part of the design method can be found in appendix A.4. An example of how the solutions are formatted can be seen in figure 6.3.

6.2.1 Flora & Fauna

The most straight-forward theme that directly relates to this research is the one concerning the greenery in

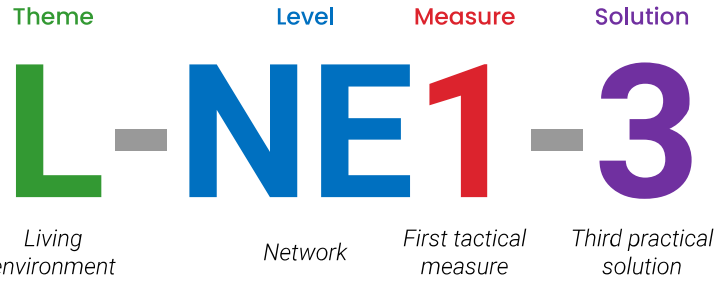


Figure 6.2: Breakdown of an example code used in the Amsterdam design method

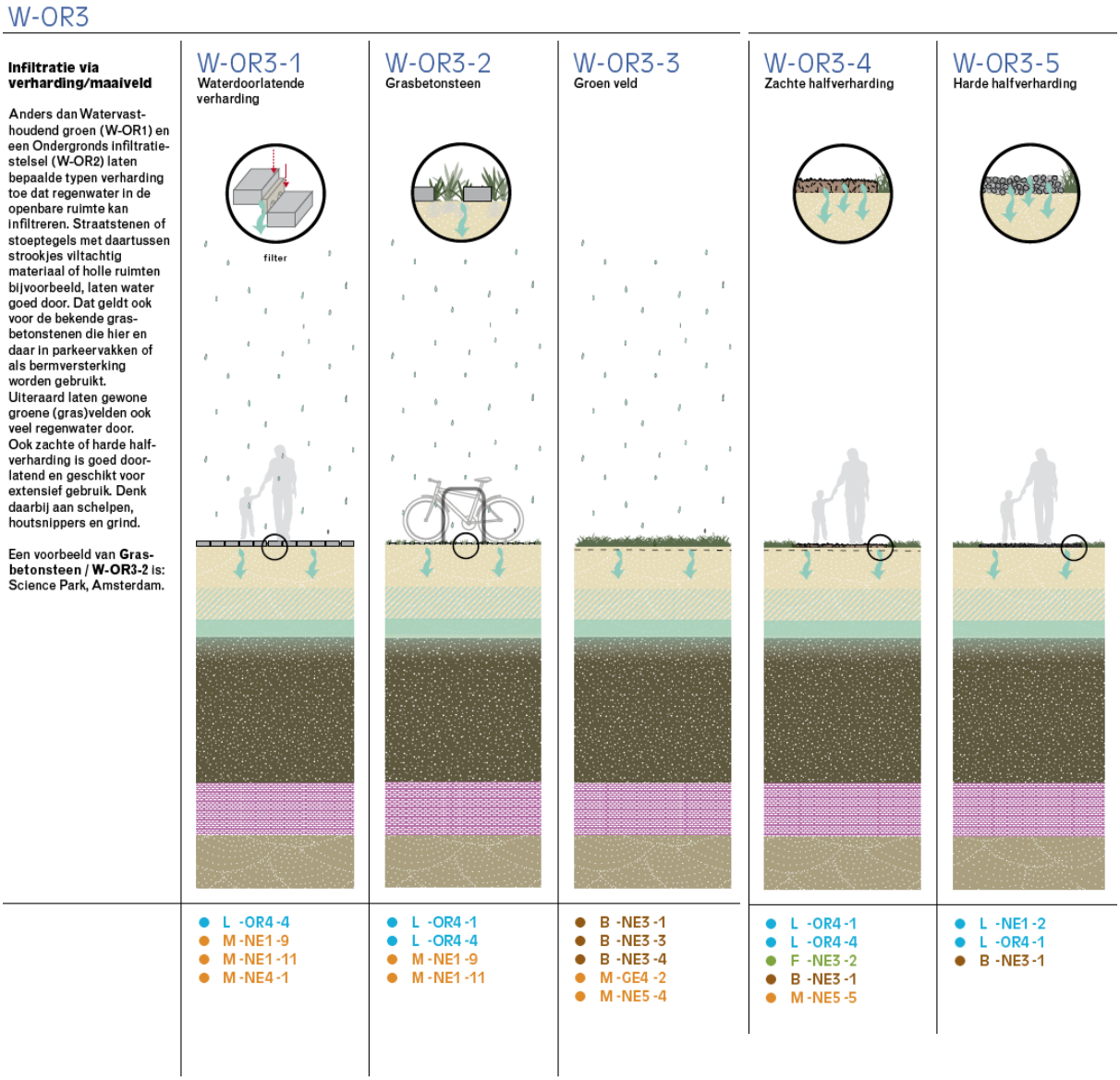


Figure 6.3: An example of solutions part of the method by the city of Amsterdam

public spaces. Using measures from this theme, a designed public space will become more attractive for local biodiversity, including vegetation, insects, and small wildlife like squirrels. Therefore, this theme is essential to incorporate throughout the method expansion and design proposal.

The currently available measures of this theme that are relevant to this research are:

- F-NE2: Fauna passage
- F-NE3: Corridor for small organisms
- F-GB1: Green walls
- F-GB2: Nestling opportunities
- F-GB3: Nature friendly roof

6.2.2 Water

The second theme of relevance is considered to be water. When designing with measures from this theme, the hydrology of the public space will improve, and water use can become more efficient at the same time, with the help of local water storage and reuse. These will be essential in the future, when extreme rainfall will be more common, clean water will be

scarce, and watering gardens with drinking water might be prohibited.

The current measures that can be taken relevant to designing 3D biodiversity are:

- W-GE1: Adding green
- W-OR3: Infiltration through pathways
- W-KA1: Green walls
- W-GB1: Water storage on roof
- W-GB2: Smart rainwater storage

6.2.3 Living environment

Next up, there is the theme of living environment. The living environment of a public space facilitates the pleasure of being outside. This is mainly related to shielding from harsh weather conditions, like the sun or rain. Designing with measures of this theme means a cooler, shielded public space that mitigates the UHI effect instead of amplifying it.

The relevant measures of this theme are:

- L-GE1: Less hardened surfaces
- L-NE1: Creating shadows on pathways
- L-OR1: Creating shadows using structures
- L-OR3: Cooling with plant evaporation
- L-KA3: Green property divisions
- L-GB2: Cooler buildings with evaporation

6.2.4 Energy

The final theme concerns energy generation in the public space. The solution corresponding to this theme are all sustainable ways of creating and conserving energy, in both thermal and electrical form. Using these measures means a self-sufficient sustainable public space that even has the potential to generate revenue by selling the electricity back to its consumers.

This theme is the least relevant of all four, but does have one measure that links to this research:

- E-GB1: Solar or bioenergy generation

6.3 Ideation

The existing integral design method of Amsterdam has already many different solutions and perspectives on how the public space can and should look like. This research aims to provide additional measures that add to the existing solutions, specifically measures that relate to 3D biodiversity implementation. These measures will contain generalized solutions that can be applicable to any form of public green space, just like the rest of the method. They will be based on the insights gained from this research and provide a potential new angle of perspective on public space design due to its emphasis on UX.

The new measures will follow from an extensive ideation process, in which many forms of ideas are thought of with the help of inspiration gained from the previous research done. This ideation phase makes use of different phases and techniques, which are described here.

The resulting measures are also used as fundamental building blocks considering the design proposal of the case study. Therefore, the ideation phase of the method and design proposal will largely overlap, and the approach is only discussed here.

6.3.1 Phases overview

The ideation process acts as a bridge between two points of this research. The starting point consists of all the research done prior, which is mostly data gathered through literature, interviews, and observations. The other end of the bridge consists of feasible and effective measures, that take all aspects into account and can be linked back to the data.

To bridge this gap, an ideation method is used that is based on certain techniques, which can be called games, distributed over three distinctive phases (Gray, Brown & Macanufo, 2010). Each phase contributes an important aspect of ideation, and they are defined as follows:

1. Divergence (opening)
2. Exploration
3. Convergence (closing)

The first phase is a **divergence** of ideas and mostly consists of inspiring the creative mind so that it can be used to its maximum potential. This phase is undisturbed by critical thinking or scepticism, as it enables the complete opposite. No idea is too crazy for this stage, and anything is possible. This mindset will generate a large and diverse set of ideas.

The second phase is about the **exploration** of those ideas. It looks for any patterns or analogies that link certain ideas. Those links are what make certain ideas effective. Prominent aspects of the design are further examined, and their implications are becoming more detailed. However, nothing is set in stone just yet.

The final phase is the **convergence** of ideas. Here, everything is assessed and thought of critically. Ideas are evaluated on their feasibility and relevance, and when this phase is over, there are only concrete yet effective design measures left.

6.3.2 Techniques

Following this ideation approach, the process can be both documented and maximized in its effectivity. To accommodate the three phases, multiple techniques or games are used. Each technique can inspire, experiment with, or assess the ideas, based on how they are used. The used techniques are shown in their chronological positions as part of the ideation journey through the phases in figure 6.4.

The technique used during the divergence phase is associative mind mapping. This means that some abstract terms coming out of prior research are dismantled and anything associated to them is listed. This can be done with textual mind maps, but also with pictures, which creates mood boards. Another technique used is the anti-problem, which showcases the exact opposite of the proposed solution, and may uncover any aspects that previously stayed unnoticed.

During the exploration phase, the focus is more on using the previously identified associations and linking them with each other. This is done by linking different design values to stakeholders and analysing them using the dilemma-driven design framework. This framework is a tool that shows conflicting concerns of mutually exclusive choices within one design. Each value has a positive gain and negative pain, and they should be weighed against each other.

The final phase is embodied with the help of the requirements of the design proposal. The ideas are materialised into design blocks, taking the shape of general measures and solutions that can be implemented both in the method and the case study design.

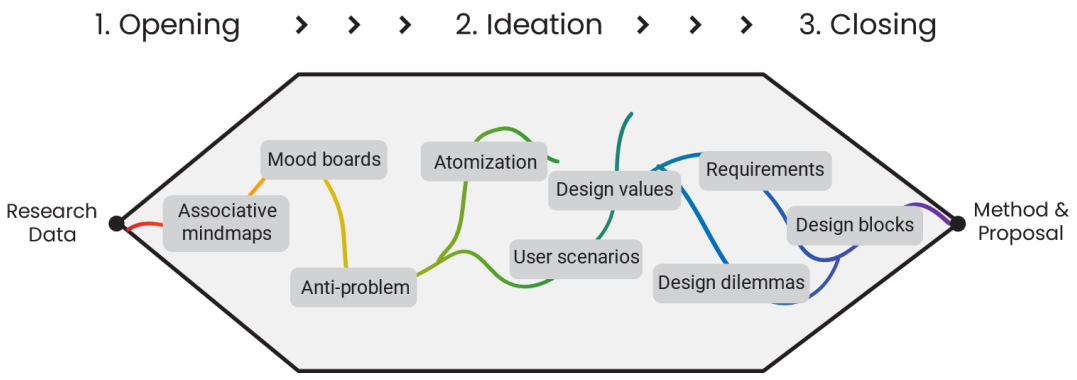


Figure 6.4: The journey taken during ideation visualised with the used techniques

7. Approach Design Proposal

7.1 Identification

The first step of creating a rooftop park is identifying which walls and roofs are suitable for a 3D ecological network. This process is done by visiting the Amsterdamse Poort and looking at its current build-up. Inaccessible roofs and their dimensions are analysed with the help of satellite images provided by Google Earth.

7.1.1 Levels

The Amsterdamse Poort is an interesting shopping mall in the sense that it somewhat already makes use of different levels. This is because it is surrounded by elevated roads that were part of the first modernistic design of the Bijlmer. Parking lots and their access points are elevated above the walking area between the buildings. This unique way of construction means that there are multiple levels, with some roofs already accessible and capable of carrying larger loads.

There are a total of 4 levels identified, which are colour-coded based on their height, see figure 7.1. The first one is the ground level, which serves as the baseline of reference at 0 meters high. Although it has potential to become part of a 3D biodiverse park, it is out of the scope of this research. It is colour coded as green, but not shown on this map to keep oversight.

The next level is colour coded as light blue, and is at the height of the Bijlmer roads surrounding the shopping mall, standing 5 meters above ground level. These roofs are all publicly accessible and currently mostly used as parking lots, which means they have a high load capacity, suitable for carrying water or soil as well. For this research, it is assumed that the parking lots can be relocated underground or elsewhere, so that the destination plan is altered to be that of a park.

The next level is colour coded as purple, and showcases the roofs that are in between the other two levels. They are 8 to 10 meters high. Except for the small walkways connecting front doors to the public space, these roofs are currently mostly inaccessible. Due to their midway position between levels, they offer a great opportunity in creating an access to the higher roofs.

The final level is colour coded as red, and lay about 16 meters above the ground. These roofs are located above social rent residences spanning through the shopping centre. This entire area is currently inaccessible, but due to their elongated shapes and coverage, they can be great for providing connections between the hubs. However, their location above private space should be taken into account as well.

7.1.2 Accessibility

As mentioned before, the shopping mall already incorporates multiple levels of public space. This means that there are also some vertical access points already available. These access points are marked on the map using a round icon. The colour gradients showcase which levels they connect. The points consist of both concrete stairways and elevators. Due to the current set-up of accessibility, they only connect the ground level to the blue roofs, and some purple ones.

Figure 7.1: A map of the current situation of the Amsterdamse Poort, showing its different levels and vertical access points

7.

For the 3D rooftop park to become fully accessible, it should incorporate more access points throughout the area. These potential new access points are marked with square icons and a + sign. They can take on many forms: currently empty walls can be used to locate new stairs, connecting the red roofs to the public space. Or already existing stairways and elevators on the inside of buildings can be extended to go all the way up. Both options were used when looking at potential new vertical access points.

Other ways of making roofs accessible is by connecting them with each other horizontally. This is also displayed on the map, in between the red roofs. These horizontal connections serve as bridges both for the ecological network as well as the users. They are to be placed on the places where the roof are close together, to save additional construction costs and heavy structure loads. To accommodate the accessibility for users throughout the entirety of the park, lines are drawn on the roofs that resemble possible new or additional pathways.

7.2 Functionalities

Next up, the actual space on top of these roofs is to be designed. This is done with the help of different functionalities for individual roofs. The functionalities were part of the ideation that is discussed in a later chapter, but their exact definitions will be described as part of the final proposal.

7.2.1 Distribution

The square icon on certain roofs display which main function that hub should have. There are a total of 6 different functions distributed throughout the park. These are:

- Playgrounds
- Sport fields
- Nature gardens (free vegetation)
- Event fields
- Communal gardens
- Canopy walks

Some functionalities are displayed more than once, since the roofs of Amsterdamse Poort accommodate a large area with plenty of space to design for. The roofs with the same functionality will generally incorporate the same design.

The locations of functionalities are chosen based on what roof is underneath. For example, communal gardens can be owned and used by the residents living underneath, as to not disturb their living space. Currently inaccessible purple roofs will mostly focus on natural functionality so that they retain partly isolated and do not need lots of new infrastructure. The large roof in the middle covers up only shops, and can house other public accommodations like in this case events.

7.3 Design concepts

Considering the large size of the entire rooftop park, the design concept will consist of a generalized design that showcases the fundamental features that are present throughout the park. Next to this, multiple detailed concepts are created based on 8 focus points. These focus points each showcase a different functionality or form of accessibility and are marked with magnifying glasses on the map. This means that a total of 9 concepts are created.

7.3.1 Assumptions & requirements

The design concept makes use of some assumptions and requirements, which are based on the results obtained during previous research. They respectively determine the scope and direction of the design concepts. The assumptions are as follows:

1. There is no limit on economic budget for investment or maintenance.
2. The roofs of the Amsterdamse Poort are built to withstand a load of at least 300 kg/m^2, or can be modified to do so.

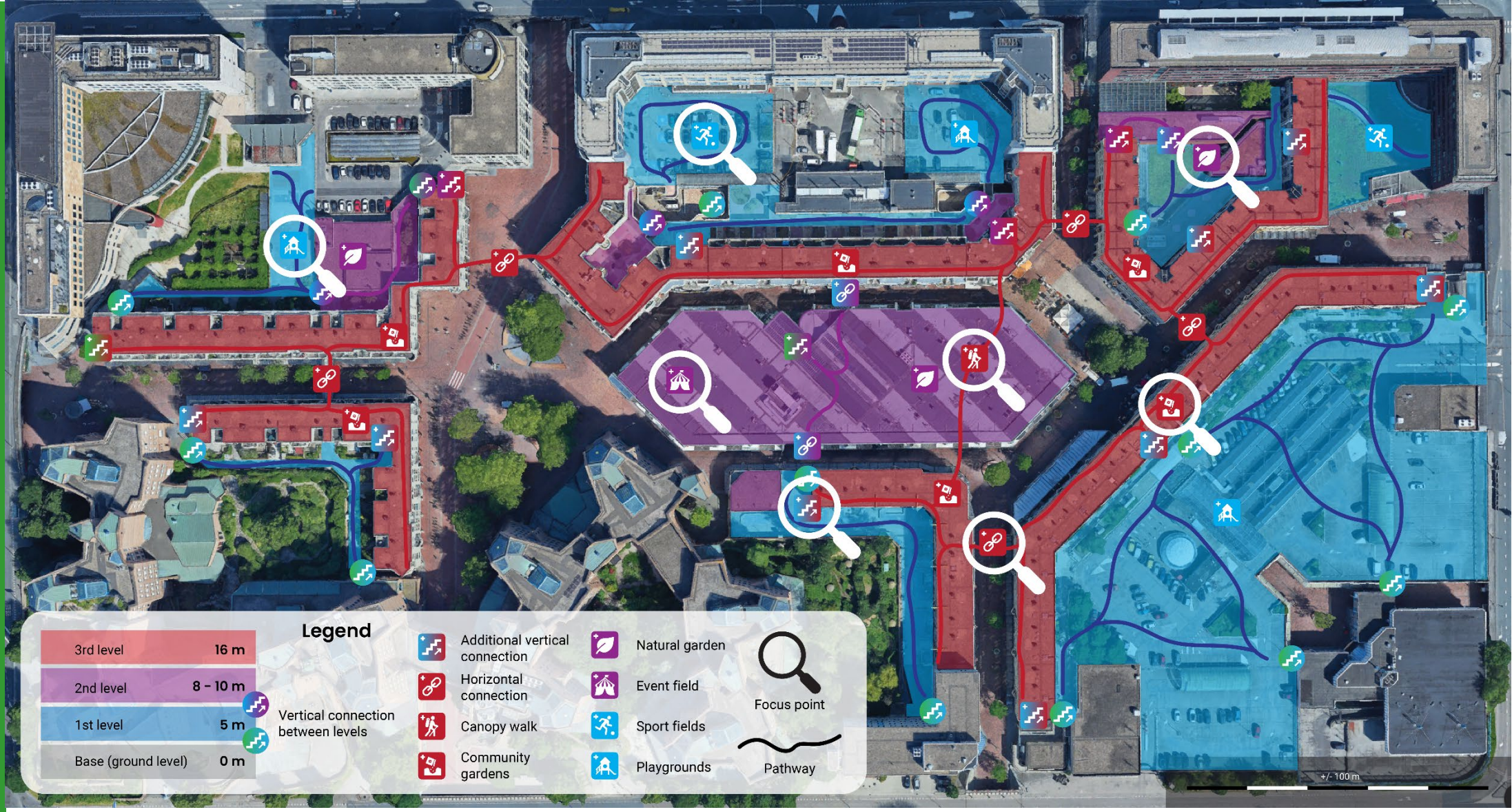


Figure 7.2: A map showing the design proposal of the Amsterdamse Poort, including added accessibility and multiple user functions

With these assumptions, the scope of the design will be limited to mostly showcase user and environmental functionality. However, the feasibility of all aspects is still considered.

The requirements determine what features the design should focus on. Although they are based on the explorative research, the exact definitions stem from the results of the UX research and the ideation process, which are discussed in a later chapter. The requirements are listed here:

- The design has need for little maintenance
- The design is connected between roofs and levels
- The design is accessible and features multiple routes
- The design is safe
- The design is for the people of Amsterdam Zuidoost
- The design brings people in close contact with nature
- The design is beneficial to biodiversity
- The design is weatherproof
- The design is future-proof & self-sustaining

The requirements are used to guide and select ideas that are created during the ideation phase. The 9 concepts aim to make sure all requirements are met. This is evaluated in the conclusion of the research.

7.3.2 Method incorporation

The other major part of this research is the expansion of the integral design method of Amsterdam. The design concepts will incorporate this method with an emphasis on the newly added measures and categories. The concepts will act as examples of possible interpretations of the new solutions. They aim to answer the question of how the tactical measures can practically look like when implemented on an existing site, next to the design question.

Both the general design concept as well as the 8 detailed concepts will showcase multiple measures, and list them individually. The general design showcases measures taken throughout the entirety of the park, and the detailed concepts mostly show more specific implementation of measures and combinations of solutions. The design concepts result from the same ideation process described in the approach of the method expansion, since the proposals are linked to certain additional measures.

This final part showcases all the results obtained and created as part of the thesis. The results are organized in the same order as described in the approach, with three different sections discussed separately. First, the results of the user research are shown. After that, the method expansion is described, as well as the ideation process leading up to it. Next, the design proposal of a rooftop park on Amsterdamse Poort is explained, and linked to the method expansion. In the final chapter, the findings are summarized per section and a reflection is presented for the entire design process.

IV. Results & Conclusions

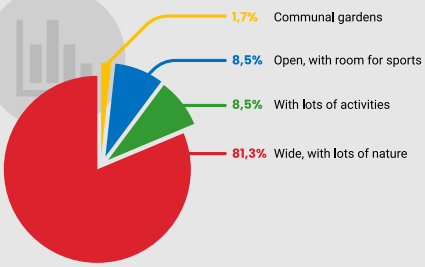
8. User Research

8.1 Data Overview

The user research was conducted with the help of people throughout the Netherlands, the locals and visitors of Amsterdam Zuidoost, and additional interviews with experts and representatives talking about their point of view. All data is shown here categorised in three segments, as discussed in the approach, in figure 8.1. The backdrop symbols represent with which method that particular data was gathered. Their meaning is explained in the legend at the end of the figure.

1. Current definition and experience of public green spaces

1a. Definition - how would you define a green space?



- "I go to the **Amsterdamse Bos** for my daily walks."
- "All **greenery surrounding the buildings** in the Bijlmer is used by basically everyone, people of all ages."
- "There are **shared gardens** that are extremely popular around the Bijlmer."

The nearby **Cumulus Park** is an actual rooftop park, but not widely used by residents.

The **Nelson Mandelapark** is a good example of how local residencies value parks.

1b. Experience - what do you do in a green space?

- "I sometimes **take pictures** of the environment, or **read a book**."
- "The **collect seeds, look at plants,** that sort of thing."
- "I used to **play football** with the neighbour's kids when I was younger."
- "The people here like to eat off the land, meaning that they want to **grow their own food and vegetables**."

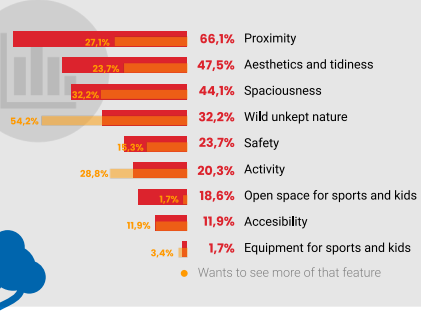
People are **walking their dogs** everywhere, whether or not there is a lot of green space.

People are **practicing kickboxing**, riding on their **skeelers**, playing **football**, or **training** on the present equipment.

Many closeby employees take **lunch break strolls** from the office, **walking and eating**.

Lots of people are **cycling** through, going somewhere. The benches for **sitting** are clear **meeting** spots.

1c. Functionality - what are important features of a green space?



- "There should be **space for natural environments**, not so tidy and cramped up."
- "Children should **be able to play** football and **explore nature**."
- "I really like the **peace and quiet** that comes with a large green space."
- "I like to **picnic** and miss the opportunity to **BBQ** in public spaces."

For the mobility and accessibility of the area, **contiguous asphalt pathways** are a must.

Shops, food stands and **meeting places** are what seems to attract people to the public space.

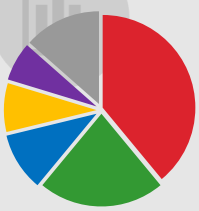
There is need for **cultural functionality** in the area, like a stage or practicing area for music and dance.

People want more **sheltered places** to walk and sit, like benches and pathways.

2. Understanding and experience of biodiversity

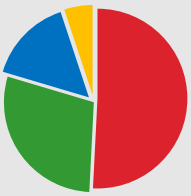
2a. Definition - what represents biodiversity to you?

What does biodiversity entail in general?



- 39% Creating variation in the environment
- 22% Enriching the environment
- 10,2% Protecting the environment
- 8,5% An inclusive environment for nature and human kind
- 6,8% Protecting wildlife and insects
- 13,5% Other

What represents biodiversity in cities?



- 39% Road verges (bermen)
- 22% Green facades and roofs
- 10,2% Insects in the city
- 8,5% Weeds between tiles

- "**All green things, trees, grass, and plants.**"
- "It's about **plants that fit the local environment so that natural balance is achieved.**"
- "It means **diversity among cultures** in the natural sense, but should apply to human cultures as well."

2b. Experience - how do you experience biodiversity?

- 84,7% Walking through varied landscapes
- 64,4% Exploring new environments
- 23,7% Gardening
- 16,9% Search and spot animals and insects
- 5,1% Collect wild mushrooms and plants
- 5,1% Taking photos of nature
- 1,7% Fishing

- "I really focus on **the smell of fresh, clean air**. It should feel clean."
- "**I practiced scouting** as a kid. Then you really get to experience nature."
- "**I don't really experience biodiversity,** but I do want it to be there, because I think that it's healthy."
- "I like to see **more nature** and **less buildings** when I am commuting."
- "The local environment is **too artificial**, and deserves more respect."
- "Some older residents with Surinamese roots display **great knowledge** of nature and want to put that into practice."

Educative natural playgrounds is something the local residents would like to see more of.

2c. Responsibility - what do you do to help biodiversity?

- 57,6% I eat little to no meat or dairy products
- 44,1% I don't use pesticides
- 42,4% I buy biological products of environmentally friendly brands
- 37,3% I have a green garden with an open soil
- 25,4% I invest in sustainable living
- 20,3% I donate to organisations that work on conserving biodiversity
- 18,6% I have an insect hotel
- 3,4% I have a green roof

How big of an impact does biodiversity have on your lifestyle?

I don't think about it that much — I take it into account very often

How responsible do you feel for biodiversity in your local area?

Not much, it is the municipality's job — I want to help as much as I can

- "I have created a **wadi** in my own garden."
- "I feel like I **don't have much of a say** about this in my local area."
- "I am part of an **environmental committee** that works on issues related to biodiversity."

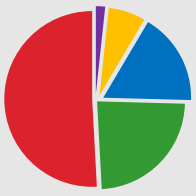
3. Wishes and concerns surrounding green rooftop spaces

3a. Wishes - what makes a good rooftop park?

What are the most important benefits?

- 66,1% Effectivity of cooling buildings
- 61% Efficient use of space
- 54,2% Restoration of nature
- 47,5% Increase of neighbourhood aesthetics
- 27,1% Increase of environmental awareness
- 25,4% Proximity to neighbourhood

Who should pay for maintenance?



- 50,8% Municipality
- 23,7% Everyone (all options)
- 16,9% Owner of the building
- 6,8% Private investors
- 1,7% The residents or visitors

- "A fun thing would be to have a **walking route** with the help of bridges."
- "There should be an **emphasis on nature**, with presence of birds."
- "The resulting cleaner air is **healthy** for the residents."
- "It will really help when there is **clear communication** regarding the public space and relation to the residents."

Local residents expressed their desire for **green roofs** and **rooftop gardens** in the area.

People want more **peaceful places** and room to breathe, away from the events and business that come with it. Roof gardens can help.

3b. Concerns - what challenges are there for rooftop parks?

What are the most prominent challenges?

- 72,9% Budget and business case
- 61% Construction of a strong roof
- 55,9% Maintenance
- 35,6% Accessibility of the roof
- 23,7% Ownership
- 22% Safety of the park

- "The resulting **musqitoe population** can be a nuisance for the residents."
- "**Roots of plants and namely trees coming through the roof** should be prevented."
- "When there is more public space, there is also more **space for criminal activities** too."
- "Residents of the Bijlmer are afraid of the **gentrification** of their neighbourhood."
- "Residents feel like **they are not being heard** by the municipality for their needs."
- "A rooftop park should **not interfere with other functions** that are more beneficial to the local area."

In the evening and night, **people feel unsafe** in the area, and want to see more surveillance.

Local residents are afraid the **unique identity of the Bijlmer will be lost** during renovations.

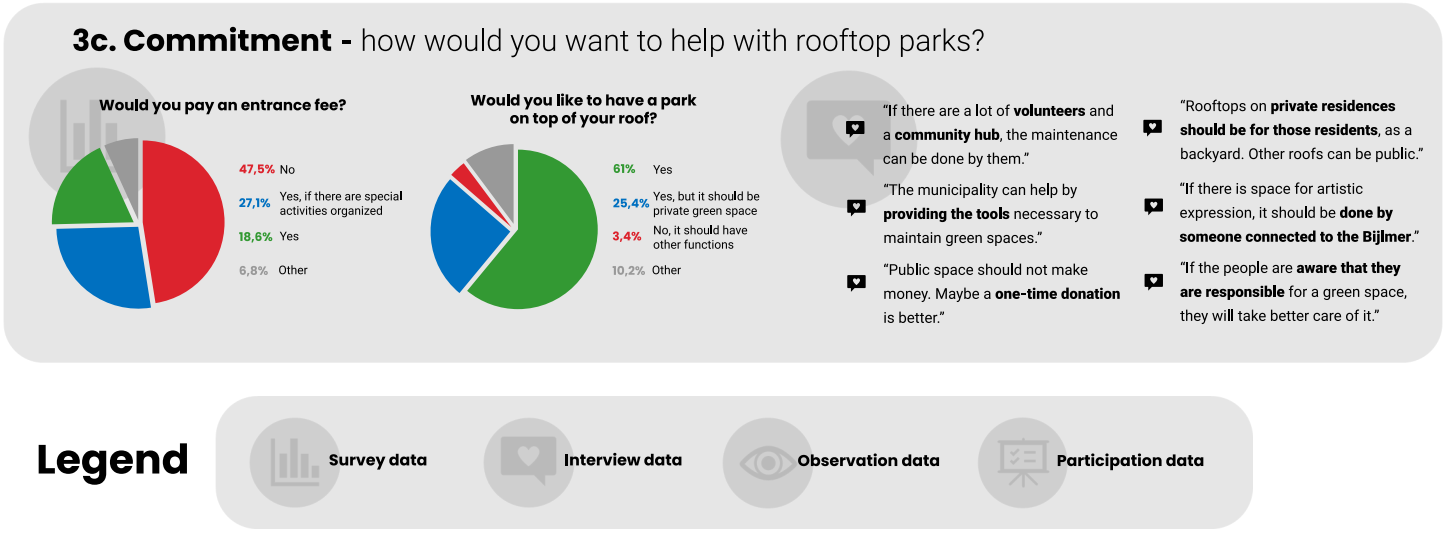


Figure 8.1. Summarizing overview of the user research results

8.2 Conclusions

The gathered data is interpreted first in straightforward conclusions, also done per category, in order to start transforming the gathered data into aspects that can be designed for. The conclusions focus on functionalities or experiences discussed during the user research. They are all directly based on the statistics and quotes in the previous overview.

8.2.1 Current experiences

Taking casual walks appears to be the most common form of green space use, whether it is taking a stroll during lunch break, walking the dog, or just passing through. In the Bijlmer, residents would love a place to grow their own spices and vegetables. Current projects of communal gardening spaces are already very popular.

For other visitors, the scenery is of importance, as well as a place for casual meet-ups. There should be space to participate in sports, for children and adults alike. Wild nature is what people miss the most, and locally, their own gardening opportunities. The Nelson Mandela Park is a good demonstration of how green space in the Bijlmer is used.

8.2.2 Understanding of biodiversity

People have a basic understanding of what biodiversity entails, and it is clear to most that variation of the environment and balance is of great importance. There is room for education. Larger green bodies and plants in general represents biodiversity in the best way.

Biodiversity is mostly experienced through walking and exploring. The wholistic and indirect experiences are important, including more senses than just the visuals. The experience can be more intensive, but not too invasive. Educative natural playgrounds could help increase awareness in children.

Biodiversity plays a relatively large role in people's life, and in the Bijlmer some Surinamese especially have knowledge of natural processes and can put it to good use through private gardens.

8.2.3 Wishes and concerns

Nearly everyone is positive about the development of green roofs in general and in the area of the Amsterdamse Poort. The biggest worry is economical: where does the money come from? For the Bijlmer, safety also is an issue.

Local residents are also concerned with the identity and culture of the Bijlmer and are afraid that it may be lost to the gentrification of the area. Clear communication is extremely important: if there is something like a responsibility or entrance fee, the users want to know what it is for.

8.3 Theme analysis

Based on the overview, there are three different ways identified of how residents and other users use a public park.

8.3.1 Mobility

A common reason to go outside is to move from point A to B. This can be either for recreational purposes or a necessity. During this commuting, the user is experiencing the environment in a mostly indirect manner. For the design, this means that pathways should connect different parts of the park, so that users can get to their destination fast and easy. At the same time, the paths should allow for strolling and recreative walks, with a nice view and no dead ends.

8.3.2 Natural interaction

The UX research is partly focussing on activities relating to biodiversity, so there are some diverse answers on how users can interact with nature. Most interactions are soft, such as photography or spotting animals. Others are more intensive, like collecting leaves or planting seeds. For most experiences, biodiversity itself is an important factor. The peace of mind that inherently is part of (large) natural environments also has an influence.

8.3.3 User interaction

Another form of interaction that is a recurring theme in the data, is user interaction. This is defined as any interaction with the public space that does not involve nature, but other users. Activities such as sports, meetings, or cultural phenomena like music and dance. For these experiences, less natural and more practical constructions are required. Factors like safety and community identity are important when designing for these interactions.

8.4 User Scenarios

The final format consists of scenarios, that came about during ideation. They are based on generalized but distinctively different types of users that were observed during the field research. User scenarios are fictional stories of how users and residents can use green roofs and public spaces and what functionality they will need in order to make these ideal scenarios plausible. The scenarios are inspired by the answers given in the survey and interviews, and the observed behaviour. Any aspects of the scenarios that link to functionality of the public green space is highlighted, so that they can be used as inspiration and evaluation of the design concepts (Rosson & Carroll, 2002).

- Local functionality: Naomi

Naomi spends the day with her grandchildren. See takes them outside to the **closest playground**. She lets the kids play while **sitting** on a bench, watching over them. The kids play **safely**, and grandma doesn't worry too much. After some time, grandma takes the kids to her **own garden**. Here she shows them how to **grow spices** and make tea. When it's time for dinner, the mother picks them up again.

- Employee lunch break: Hank

Hank goes to work on his **bicycle**. It's healthy and faster because he can take **shortcuts** he would not be able to take by car. During lunch, he likes to go outside and **walk through nature**. He likes to get some **local food** as lunch. He can **sit & talk** with his collegues outside. After work, he cycles back home **safely**.

- Meaningful experience: Irene

Irene plans a nice day with her best friend. She goes **shopping** with her at the Amsterdamse Poort. After a while, she looks up **other activities** to do in the area. They decide to look at **local art** that is **meaningful to the area** and **accessible** for everyone to see and end the day doing something **exciting**. Afterwards, they get home **easily**.

Results

9. Method Expansion

9.1 Overview

The Amsterdam method is an integral approach to designing the public space and combining multiple disciplines into effective multifunctional solutions. The method is already available for use but continues to develop, adding more measures and more categories to the solutions. This research suggests an expansion to the integral design method by adding a new category, user functionality (G). Next to that, it provides new additional measures for both this category and other already existing ones. This method expansion aims to answer the design question of how to implement 3D biodiversity, which is one interpretation of the general research question.

9.2 Ideation

The solutions came about during the ideation process. This process consisted of three phases.

- Divergence (opening)
- Exploration
- Convergence (closing)

Each phase created different outputs that were then used for the next step. The outputs of all phases are described here.

9.2.1 Divergence

The first phase was meant to spark the imagination for a fruitful brainstorm session. This inspiration took the form of mind maps, mood boards, and a brainstorming technique called the anti-problem. All of them are in turn inspired by the results of the

Figure 9.1: Associative mind maps of the three categories from the research question

explorative research as well as the UX research, based on the gathered literature, interviews, and observations.

The first mind maps focused on the different categories identified in the research and design question, namely the user, the city, and the environment. They are shown in figure 9.1. These broad and abstract terms were the basis of more specific aspects of 3D biodiversity implementation. The mind maps provided insight on many possible relevant design aspects and also laid the groundwork for identifying the values of each category.

Other mind maps and mood boards focused on some of these aspects of 3D biodiversity and then used them to look at possible interpretations. They can be found in appendix A.6. They consist of large picture collages surrounding one aspect and contain anything from examples of natural user experience to associative imagery. The idea was that nothing is too crazy, so it generated many interesting solutions and new aspects that may not be thought of directly when designing green roofs, although some not necessarily feasible. It mainly acts as inspiration that helps the creative mind during concept generation. The topics that were made into mood boards or new mind maps were each linked to one of the three categories, as follows:

- Play
- Expression
- Community
- Water
- Accessibility
- Communication
- Construction
- Stimulation

Next to these, an anti-problem was solved. This shows how a polar opposite of the perceived design solution would look like and is a clear representation of all the problems the design concept will have to either prevent or solve. This solution is shown in figure 9.2, and depicts a nice but maintenance-heavy garden, with exotic plants and a fixed symmetric design.

9.2.2 Exploration

The next phase focusses on finding links and exploring the available data in a creative way. This was done

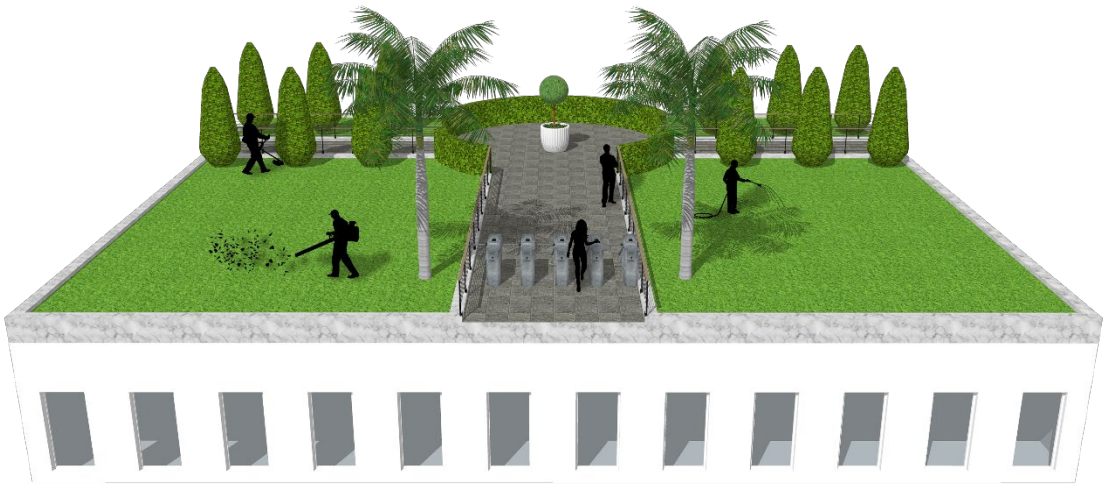


Figure 9.2: The solution to the anti-problem, showcasing everything the final design needs to avoid

Figure 9.2: The categories and their design values

with the help of user scenarios, values, and design dilemmas. The three user scenarios are part of the results of the user research.

The first set of values were again based on the three categories of the research and design question. Each category has their own wishes and needs surrounding 3D biodiversity, and sometimes they can be mutually exclusive. The environment has values like flexibility, which can be hard to combine with efficiency, a value linked to the city. Both values have their ups and downs, and the design dilemmas help in finding a balance or solution between them.

A second set of values focused solely on the users of 3D biodiversity. The three different users and corresponding scenarios also display certain values that can clash with each other. For this reason, extra design dilemmas were visualized as a balance needs to be achieved between these as well. Figure 9.2 shows the categories and their related values. The dillemas between them are shown in appendix A.8.

9.2.3 Convergence

The last phase acts as a means of converging all created content and forming concrete solutions solving clearly stated problems. To achieve this, the requirements of the design concept were used as problems, with each individual requirement being solved in multiple ways. This created a selection of design blocks, that can be found in appendix A.9.

The solutions of the requirements are selected based on the previous research and expertise gathered, so that they are both effective in solving the problem and feasible. They take on the form of customizable measures that can be taken in the public space. After the solutions are selected, they are fitted into the categories of the Amsterdam method as a way of expanding the general toolbox of public space design.

9.3 Additional measures

There are some solutions that tie in with already existing categories of the Amsterdam design method. They are intentionally generalized so that they can fit

into other designs around the city and realised in other ways that were not thought of during the ideation process. Next to this, each measure can also be combined with other measures from the same or different categories. The additional measures are listed here. Their practical solutions, schematic imagery and links between the other measures can be found in appendix A.10.

9.3.1 Mobility

The category of mobility (M) is still largely in development and not part of the current publicized design method. However, some proposed measures part of a public rooftop design can be tied into the category of mobility. The measures mainly focus on the accessibility for users of 3D greenery, so that any form of green roof has added value for its surrounding residents. The new measures are **elevated walkways** (M-NE1) and **vertical accessibility** (M-KA1).

The first measure, **elevated walkways**, is a way of connecting different pathways on different levels. They are non-intrusive in their construction, using fixed points of contact with the building construction. This property can help in distributing the load of such structures to strong points in the foundation of the building, making roofs visible without them necessarily needing to support people on every spot. They can serve as attraction, providing people with a nice view, while leaving the vegetation alone. Figure 9.3 shows an example of such a walkway.

Figure 9.3: Example of a wooden elevated boardwalk. Picture by Greenspace Designs

The second measure for the aspect of mobility is **vertical accessibility**, which focusses on getting users to elevated areas. This is an important aspect for a rooftop park, as it makes them easily accessible in a safe way for a large audience. These vertical connections can be combined with vertically growing greenery so that a natural network is created as well. This adds more functionality to the vertical access point. An example of this can be found in the design proposal.

9.3.2 Living environment

The second relevant category is the living environment (L), as it is closely related to the UX of a public space. However, measures related to the living environment are more about creating a pleasant atmosphere in a passive manner. This is mostly done by shielding visitors from harsh weather conditions, such as rain or sun. An additional measure in this regard that could prove necessary on an elevated rooftop is adding **wind shields** (L-KA4).

The **wind shields** are needed on roofs that have no environmental shielding against the wind, to protect both the present vegetation and users. Adding wind shields to the roof increases safety and makes the overall experience more pleasant. The wind shields should become part of the 3D greenery, as they provide great opportunity for the creation of new micro habitats or shelter for small wildlife (Vanneste et al., 2020). They can also act as division between certain areas with different functionalities or goals, for example between busy grass fields and more isolated green hubs.

9.3.3 Flora & fauna

Flora & fauna (F) is a category mainly focused on enhancing the local natural network. When it comes to 3D biodiversity, there are some measures that can also prove beneficial for the biodiversity and vegetation in other public space designs, even if there are no roofs involved. The proposed additional measures are **resilient matured soil** (F-GE1), **robust vegetation** (F-GE2), and **connections** (F-NE5).

Figure 9.4: An oligotrophic landscape. Picture by Susanne Kuijpers

The first measure is the creation of a **resilient matured soil**. This means a soil that needs little maintenance to sustain itself and adds to local biodiversity in a sustainable way. A resilient soil can be realised by creating intentionally oligotrophic conditions, meaning that there are little nutrients present in the soil, see figure 9.4. Although this sounds contradicting, it actually increases local biodiversity as there is no dominant species overtaking all others (Isbell et al., 2013). It also means that anything that grows on top of such soil will inherently be able to better withstand harsh conditions like draughts. To kickstart healthy soil on top of isolated green roofs, inoculation can be used to create favourable starting conditions. By transplanting soil from other local vacant lots, vegetation and micro-organisms do not need to start all over, which speeds up growth (Benetková et al., 2020).

The next measure focuses on the vegetation, which should consist of **robust vegetation**. When designing a green space that is to be beneficial to the local environment, the plants should be part of it and stay alive without much nutrition (Sinclair, 2011). This can be best achieved by giving the environment plenty of leeway to grow as it pleases, creating and sustaining itself without need for costly maintenance or planning.

Another measure that can be taken focuses on creating a natural network by using **connections**, between both horizontally and vertically aligned green hubs. These connections create opportunities for both plants, insects, and even small wildlife to traverse between green spaces, increasing flexibility and strength of the local ecosystem (Justus & Sarkar, 2002). The complexity of a connection can range from non-intrusive structures like ropes to stepping-stones or small ecoducts.

9.4 Additional category

Next to the aforementioned additional measures, the ideation also resulted in an entirely new category. This category is called User Functionality (G) and, as its name suggests, focuses on the functionality of users of a public space. This whole new category allows for many new measures to be introduced that will add value to a public space and can be combined with other measures of the design method. The measures belonging to this new category are listed here.

9.4.1 Natural play facilities

As part of 3D greenery, natural play facilities offer great opportunity for recreation and education of younger users. Natural playgrounds are favoured over artificially designed versions as natural elements are better for the development of children into adulthood. Natural play facilities can take on the shape of a **water garden** (G-OR1-1), **play forest** (G-OR1-2) or **scavenger hunt** (G-OR1-3).

A **water garden** is in its foundation a playground with access to water. This can take the shape of an open waterway, fountain, or man powered pump. To prevent accumulation of algae or mosquitoes, it is preferred that the available water should flow. Water is one of the most interesting natural elements that are part of natural playgrounds, so it is a great opportunity for added user experience (Wang, Woolley, Tang, Hsiao-yi & Luo, 2017). When a building needs to have a rainwater storage, this water can be reused for the water playground, see figure 9.5.

A **play forest** is a fun way of giving larger vegetation added functionality. By creating small pathways through densely vegetated areas, children can explore

the paths and create their own games that make use of them. Vegetation is, together with water, a favoured natural element for playing and requires little design or planning (Wang et al., 2017).

A **natural scavenger hunt** is a form of educative recreation that needs little design. By encouraging children to scavenge the perimeter and search for certain insects or flowers, they are active in the natural environment and possibly intrigued by it. The scavenger hunt can be digitally enhanced, combining the physical location of QR codes with augmented reality.

9.4.2 Sport facilities

It has been established that visiting a natural environment increases physical well-being indirectly, but there can also be a more direct application. An important reason for adults to go outside is to exercise, and sport facilitation in the area can aide with this healthy habit (Oliveros, Serón, Lanas & Bangdiwala, 2021). The facilities can take the shape of **sport equipment** (G-OR2-1), or **sport fields** (G-OR2-2).

Sport equipment is essentially the allocation of fixed tools that train certain muscles. Different equipment can be put together as a circuit to accommodate a full body workout. It can also take the form of a large climbing rack, leaving the exact forms of training up to the users themselves. Having this equipment available for free may lower the bar for local residents that may not be able to go to a fitness centre.

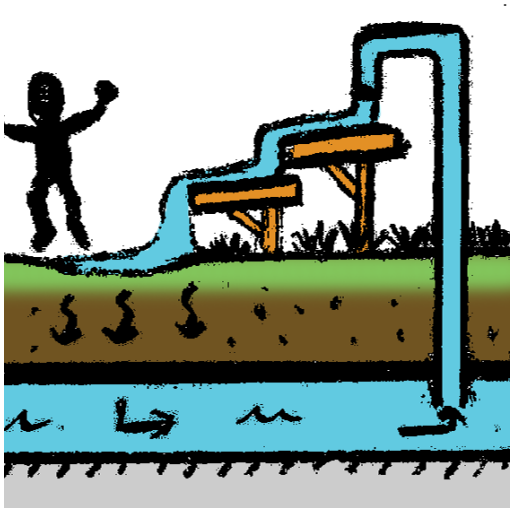


Figure 9.5: Reusing excess rainwater with water access to a playground.

The other option is a **sport field**, like a football or basketball field. It can give both children and older parties an opportunity to play sports and socialize. The field can be part of a healthy soil if it makes use of real grass, although this does require additional maintenance.

9.4.3 Cultural facilitation

Public space can also accommodate some cultural functionality, as a way for people to express themselves or come together. This will strengthen their bond with the public space and increases the feeling of a shared responsibility (Fonseca, Lukosch & Brazier, 2018). The cultural functionality can be realised as either a **sculpture garden** (G-OR3-1) or **podium** (G-OR3-2).

A **sculpture garden** is a broad term covering any form of tangible art that becomes part of the local environment. Sculpture gardens can facilitate actual sculptures, or other forms of art such as graffiti or temporary exhibitions. It can function as an aesthetic attraction both for local residents as well as one-time visitors of the area. It is also non-intrusive to the vegetation nearby.

The other option entails a publicly accessible **podium**. This podium can be either fully accessible or open for rent in order to create revenue. It can be used by any local cultural incentive, like theatre groups, musicians, or be part of a festival. A proper podium has space for an audience, so a larger open space is a necessary part of the design. This can be combined with many other user functionalities and also be part of a healthy resilient soil by keeping it uncovered.

9.4.4 Meeting spaces

Although any public space can essentially be a meeting space, certain attributes can be allocated to aide

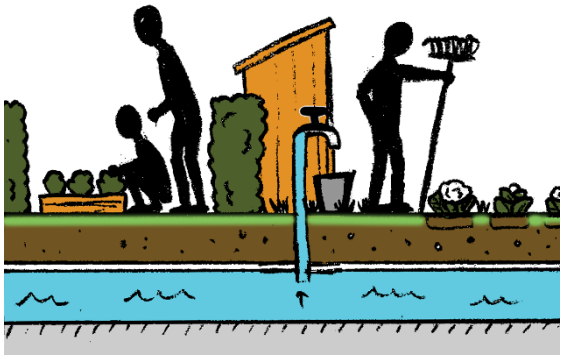


Figure 9.6: Communal gardens brings local residents in direct contact with natural processes.

in this process. This is favourable as it reinforces social cohesion of a neighbourhood which in turn increases the perceived safety (Fonseca et al., 2018). The attributes are listed as follows: **standing tables** (G-OR4-1), **circling seats** (G-OR4-2), **green rooftop terrace** (G-OR4-3), and **shared garden** (G-OR4-4).

The first option, **standing tables**, is the least intrusive one and can best be combined with other facilitations like cafeteria or shops. A simple elevated flat surface can facilitate many forms of meetings, such as a quick lunch or chat. It can take the shape of standalone objects or be integrated in walls or fencing around the area.

Secondly, **circling seats** is another format that reimburses meetings. It is distinctively different from normal benching as the seats face each other instead of all looking in one direction. This allows for easier interaction between users that they can give shape themselves, for example through conversation or card games.

A more direct facilitation is a **green rooftop terrace.** It is a concept that is currently one of the most popular options when designing an accessible green roof. A rooftop terrace lets users lean back and enjoy a nice view, while being served drinks or bites from the nearby participating cafeteria. This allows for a direct form of revenue generation that can turn an otherwise costly green roof into a more interesting investment.

Another interesting option can be a **shared garden** on top of private residencies, see figure 9.6. A green roof also enables residents of apartments to have their own gardening space that they can use together, reimbursing both the social cohesion and feeling of shared responsibility. A shared private garden is potentially less effective for the natural environment, but if some of the measures are communicated as advice, it can also serve an educative purpose.

9.4.5 Horizontal connections

Horizontal connections are already partly discussed as part of the category of Mobility, but since there is also an element of user experience to it, some iterations of the connections are fitted into here. The horizontal connections focus on connecting different elevated green hubs with each other in an interesting manner. Two iterations of this idea are **tree routes** (G-KA1-1) and **routes with a view** (G-KA1-2).

Tree routes make use of actual trees or artificial poles in between 3D greenery to create an elevated walkway. This type of structure is more exciting than a regular bridge and uses the local natural environment to get from A to B. It can be done in many ways, increasing either the play factor or accessibility of the route. It depends on what the target group is.

The other option of designing **routes with a view** is even more broad, in the sense that it is essentially any form of walkway that provides a nice view over the area. The view can be accommodated with information panels, making users more aware of what they might be looking at.

9.4.6 Vertical connections

Another important aspect that is inherently part of 3D greenery are **vertical connections**. Again, although already mentioned as a measure improving Mobility, there are iterations that focus less on accessibility and more on recreation. The options for vertical user connectivity are **climbing walls** (G-GB1-1), **ropes** (G-GB1-2), and **slides** (G-GB1-3).

The **climbing walls** are a fun and physical option for able people to get higher up. To ensure safety from falling, they should not get any much higher than 2 meters, much like a bouldering wall. The climbing walls can be designed traditionally using grips, or using porous rocks. The latter option is also beneficial for local biodiversity since it acts as a steppingstone. This combines the usable connection with a vertical natural connection, adding to the multifunctionality of the design.

Another option is to use **ropes**, either in a singular matter or in a certain shape like a web or a rope. Ropes are a non-intrusive way to create a physically exciting connection between hubs, if the height difference allows for safe passage. This option can also be combined with a natural connection as plants and insects can use the ropes too. A distinction between ropes for recreational use and for natural passage can be made in order to keep both safe from each other.

A final option is the implementation of **slides**, allowing mainly children to slide down from higher areas to lower laying ones. It is a more traditional and tried vertical passage present in most public playgrounds, but still recreational and very recognisable to the users.

All additional measures, solutions and the new category are formatted in the same way as the existing measures in the Amsterdam design method, which can be seen in appendix A.10. An example page of the formatted measures is shown in figure 9.8.

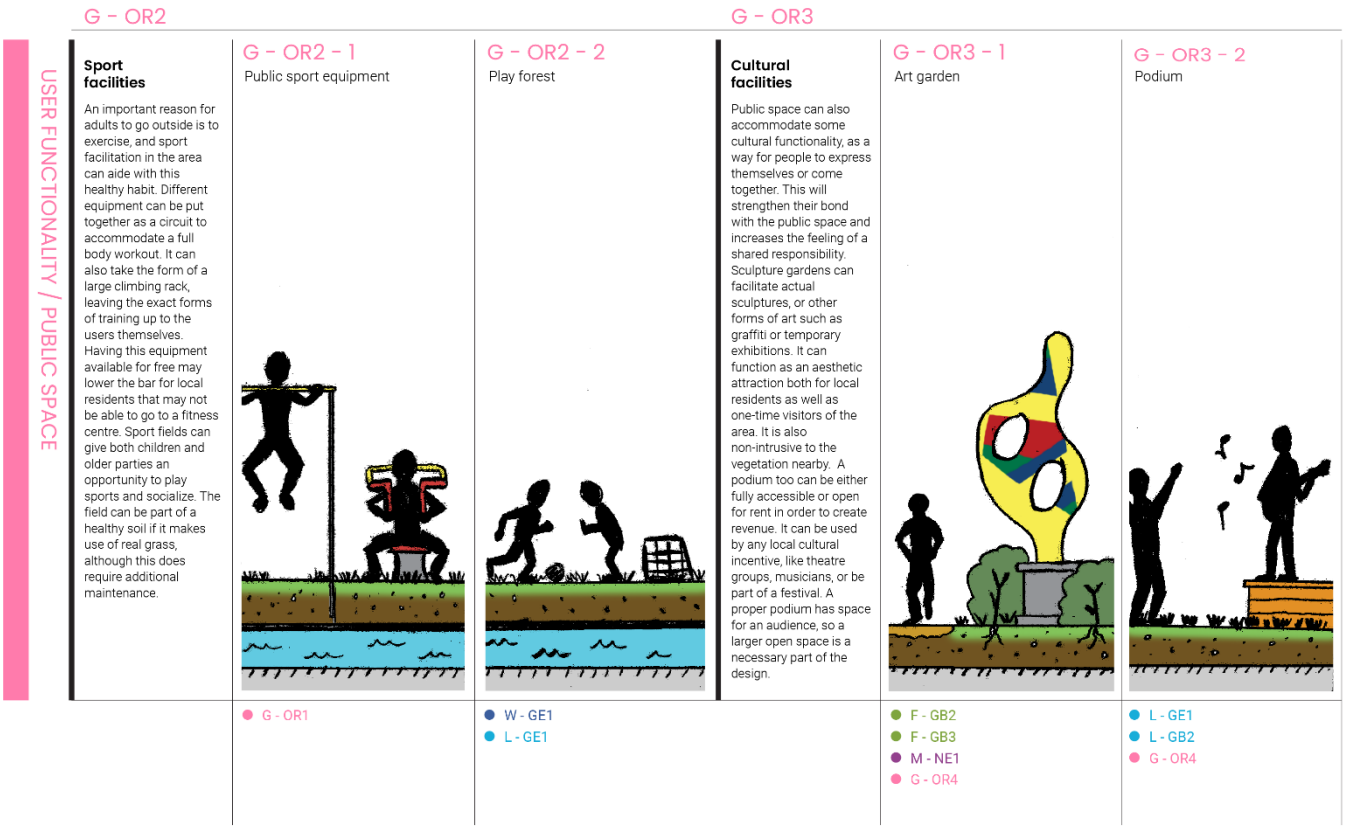


Figure 9.8: An example page with two measures and solutions from the new category

Results

10. Design Proposal

10.1 Overview

The design proposal consists of several concepts that make use of the integral design method by the municipality of Amsterdam, with the added solutions for user functionality. The concepts are part of one large rooftop park design, almost covering the entirety of the Amsterdamse Poort. The proposed designs are worked out on a conceptual level to showcase the possibilities of the expanded integral design method.

There are a total of 8 different rooftop designs, each featuring a different user functionality. The 8 designs are as follows:

1. Natural play roof
2. Sports roof
3. Natural roof
4. Shared gardening roof
5. Event roof
6. Canopy walk
7. Horizontal connection
8. Vertical connection

All designs are based on the previously discussed results of the explorative literature and UX research. They will mostly focus on the environmental and user functionality. However, one generalized concept design will showcase the construction and general features that is at the base of all 8 concepts and the rest of the rooftop park.

10.2 General Design

The rooftop park will have some features that are present throughout the park. These features are categorised into 4 sections, based on the focus points of the design question. These sections are biodiversity, society, local, and future aspects. The aspects are summarized in figure 10.1.

10.2.1 Design for biodiversity

One of the core reasons to implement green roofs on a large scale is a positive impact on the local biodiversity. A rooftop park should adhere to three features to maximize environmental benefits: **resilience**, **connectivity**, and **flexibility**.

The **resilience** will help in creating and maintaining a sustainable green park, even during prolonged droughts or large scale storms. To create a resilient environment, there should be as much open soil as possible, such as grass fields instead of paved squares or walkways.

Next, the base of plants should be of a local nature, from nearby natural areas or vacant lots. This will result in a genetically rich diverse area that is less prone to plagues or disease. One practical way to achieve this is through inoculation, so that rich soil is directly transferred to the roof, including all micro-organisms and fungi underground.

Lastly, creating a slight oligotrophic (nutrient-poor) environment will increase both biodiversity and resilience. Plants may take longer to grow and there will be less biomass, comparable to a dune landscape. This

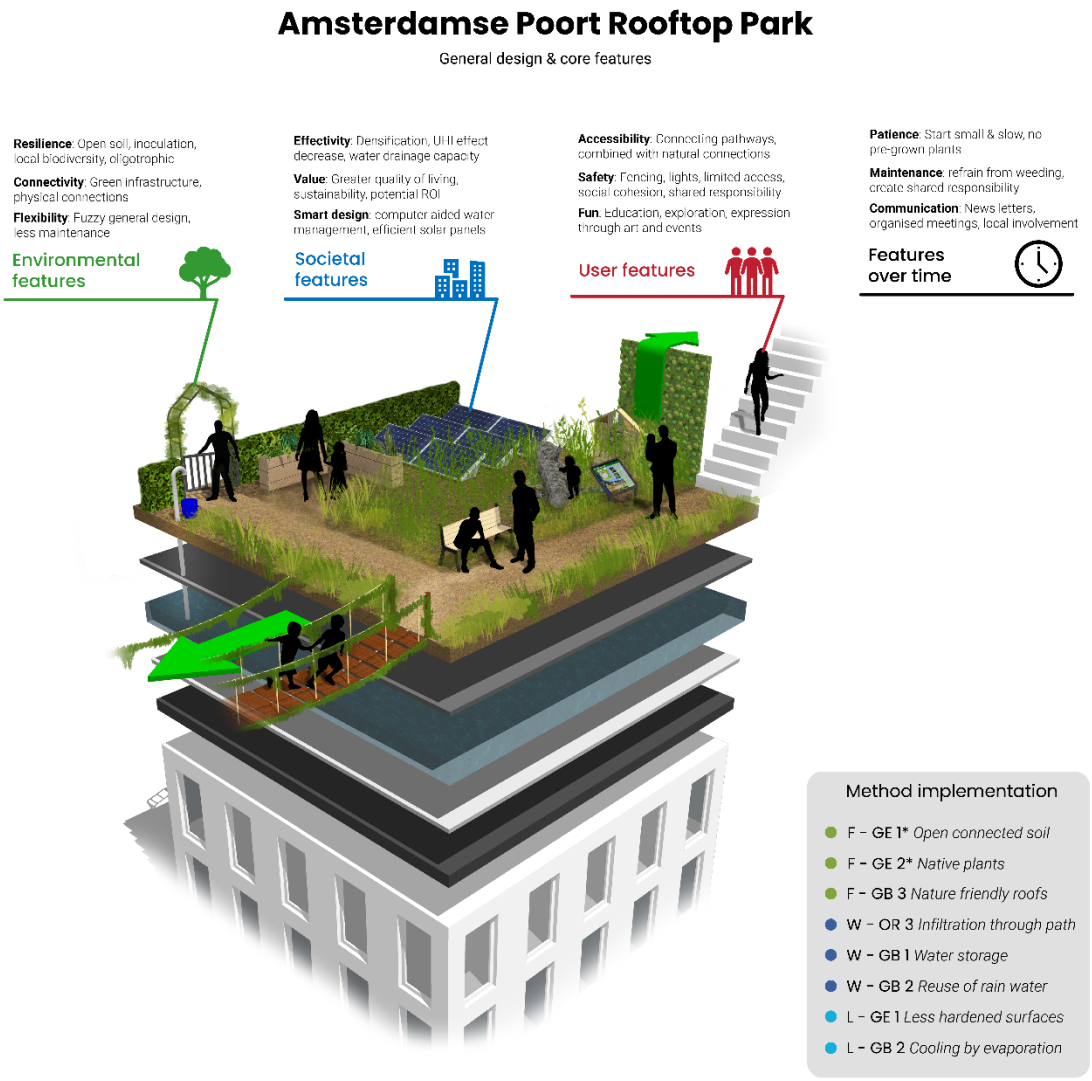


Figure 10.1: The generalized design concept with its features and implemented measures

allows for sustainable water management and independence of external sources of nutrition, and also reduces need for maintenance such as pruning.

The **connectivity** of the overall park means that the different roofs and green areas are connected to each other physically. This can be done through multiple ways and combined with accessibility for users. Connectivity is another way to create a more robust, sustainable environment that is less costly to maintain. It allows insects to crawl between hubs and makes them and everything above them in the food chain less dependent on vitality of one green area in which they would otherwise be stuck.

Although this will prove most effective on a larger scale, it starts with creating a network between green hubs throughout the city. This can be standardised when green spaces are seen as vital infrastructure in need of physical connectivity, like roads or electricity. If a green network becomes part of standard legislation, new neighbourhoods can be part of a larger and more robust environment, which will prove vital when the climate turns harsher.

Lastly, by adding **flexibility** in park design, it is allowed to change over time and becomes more adaptable to changing environmental conditions. Instead of planning out the exact location of each and every plant for the sake of aesthetics, a green space can be designed in a more general manner, using gradients and fuzzier designated areas.

This different approach to designing green spaces again reduces the need for maintenance. There is less necessity to weed out certain plants because there is no pre-determined rendition of the greenery. The environment designs itself on the available base, which automatically results in the most adapted and robust option possible. It is important to communicate this new perception on green spaces to all stakeholders involved, so that the greenery is valued and appreciated in a different manner. By allowing nature to show its true colours, it creates an opportunity to educate people on what that practically entails as well.

10.2.2 Design for society

When designing a green space in a city, there are many stakeholders and aspects involved which should not be overruled for the sake of nature. However, natural and societal interests are not mutually exclusive. In fact, they can work together by adhering to three aspects of the design: **effectivity**, **value** and **smart design**.

The first aspect, **effectivity**, is of major importance. The densification of cities creates new design challenges, especially for already dense cities like Amsterdam. Each square meter of the city needs to add as much to it as practically possible. Green roofs are an effective use of space that would otherwise be largely monofunctional.

Next to the biodiversity and user benefits, it also has the benefit of migrating the UHI effect, which is essential in densely-packed cities. It will result in a direct energy consumption decrease related to cooling buildings with AC units during hot summers.

Using the sponge effect that a vegetative layer has, water drainage is automatically regulated to discharge excess rain water over a prolonged period of time. This is a sustainable solution against water flooding dense cities during heavy thunderstorms, much more than expanding the sewage. When combined with an underlying water storage, this solution can be even more effective as well.

The **value** of all underlying and surrounding buildings is also bound to increase when adding greenery on roofs. Especially accessible roofs can act as a nearby green park or private garden. This creates a better return on the initial investments of a sustainable green roof by attracting more people, just like the increased aesthetic or lower electricity costs.

A green roof can also be **smart design**. The previously mentioned water storage can be made smart, so that it responds to for example the local weather conditions or other factors like usage. If a water storage is emptied right before a large storm, more excess rainfall can be taken in by the roof and relieve the sewage system. This technology is already proven as demonstrated by project Resilio. If that water storage is also accessible for local gardening or recreational purposes, it adds even more multifunctionality.

Oftentimes, there is an idea that green roofs and solar panels are mutually exclusive. However, since solar panels actually function better when combined with a green roof, green soil should be at the base of all solar panels put on top of roofs. Panels can be fitted wherever there is no major user functionality present, or a roof is hard to make accessible, like on top of skyscrapers, smaller buildings, or angled parts of a rooftop.

10.2.3 Design for residents

For green roofs to be a complete picture, there should also be space for people to access and interact with the environment. There is a multitude of indirect benefits to this as discussed in the literature research. In order to maximise those benefits, the design should

have three generalised features related to its users, namely **accessibility**, **safety**, and **fun**.

Accessibility to a green roof forms the baseline for all other features and corresponding benefits. Users should be able to easily access the green roofs as if it were an extra floor on that building. By extending stairways on the inside of a building used to access other floors, a roof can be made easily accessible.

The previously discussed connectivity related to biodiversity can be combined with accessibility of green rooftops. By creating connections for both people and nature, a rooftop park will thrive. Suspension bridges are one example of non-invasive structures that can be combined with strongpoints of underlying buildings. Otherwise, using trees as steps in between is another sustainable way of creating such a connection.

Areas of rooftops should be clearly designated as public or private spaces. However, one roof can be split into both. The inherently limited accessibility of a rooftop park can be used to the advantage of local residents and employees, by regulating these entrances.

This automatically brings along the next important feature of a rooftop park, **safety**. There are regular safety needs necessary like fencing against falling and lighting to make the park a nice place to be. Next to this, the safety can be indirectly increased by improving the social cohesion of a neighbourhood. If the local population is given the opportunity and are stimulated to work together on a shared garden, it will give them a feeling of responsibility over that space. From the UX research, it became clear that there is a large demand for gardening spaces in Amsterdam Zuidoost already.

The park should have gateway entrances that can be closed off in the evening to keep out unwanted guests at night time. The local residents or shopkeepers can again bear this responsibility, which not only lowers park maintenance costs, but also enhances the feeling of safety.

Finally, to come to the full potential of a rooftop park, it should offer some **fun** too. This can take many shapes and forms, and not all have to be designed for. The most important form of fun that should be present throughout the park is interacting with nature. Children should be allowed to stray off the beaten paths and explore the area. This is proven to be of major importance for a healthy development and should be encouraged instead of prohibited.

The ever changing environment allows for some interesting insights which should be put in a spotlight to further increase awareness of natural functions. By providing information about certain natural processes or species, users are more involved in otherwise mundane looking areas. This information can be displayed on simple message boards, but can also be made more interactive using QR-codes, audio tours, or augmented reality (AR) apps.

The park should provide easy accessibility as mentioned previously, but there can also be opportunity for more exciting ways to explore the area, if the user wants to do so. The 3D aspect of a rooftop park allows for more interesting ways to get from A to B, for example using climbing walls or suspended nets to create alternative connections between certain hubs. This should be done in a safe manner, and can also be combined with physical environmental connections.

Lastly, the park should not be overdesigned with every corner having a fixed use . It should also be a place for the local population to express themselves, providing the space as opportunity. Much like the environmental side of the design, some aspects of the park can intentionally be designed ambiguously, as a base for the local population to give their own spin to it. This can take the form of e.g. art, games, or events. There should be some form of coordination so that it does not take destructive forms, but the park is more likely to succeed when residents can make it their own.

Figure 10.2: The park design will be flexible, which results in different looks throughout its life

10.2.4 Design for the future

Once a natural rooftop park is designed and built, the investment continues. It is important to keep coming back to this ever-changing design to keep things in check and in balance. The three aspects that are at the forefront of this proposal considering time are **patience, maintenance**, and **communication**.

The biodiversity benefits described are most effective when the park is handled with proper **patience**. The idea is that the substrate, connections and other predetermined features are the base on which nature can take its own shape, whatever that entails. For this reason, putting already grown plants in the ground should be kept to a minimum, as it will only drive up maintenance costs and decrease sustainability. The environmental goal of the park is to be as genetically diverse and robust as possible, and for this, quick fixes will not do. Seeds of certain flowers that attract important insects can be spread as a way of stimulation, but again there is no need for excessive planning of each plant location.

Next, there is the **maintenance** of the greenery, which is often seen as costly. As many normally undesired weeds are actually native and beneficial to survival of other species, like dandelions, weeding should be only limited to unblocking pathways and entrances, and removing plants dangerous to the construction, like tree saplings. The most heavy maintenance is likely to be for the underlying smart water storage; checking the sensors and keeping the waterways free.

The necessary weeding and pruning can partly be done by local residents, tying back into enhancing the shared responsibility described earlier. This can also decrease maintenance costs but should be communicated properly to the residents so that they understand the tasks at hand.

This communication is already mentioned a few times and so essential throughout the entire lifetime of the park. Users are likely to not understand some design choices when they have no place to get an explanation. The owner of the park, whether that be the municipality or a third-party organisation, should invest in keeping residents up to date with any shared responsibilities or happenings on the green roofs.

This park is likely to look distinctively different from other parks throughout the seasons, especially at the start. Considering the common misconception of biodiversity, that it is always aesthetic or lush green, this too should be made aware to all involved stakeholders and especially the users.

This can be done through short news letters sent to the nearby addresses, or creating opportunities for local residents to get together and discuss points of interest. Whichever form of implementation is used, it is a vital aspect to keeping the neighbourhood involved in the park, and fully worth the investment.

10.2.5 Method implementation

The integral design method of Amsterdam was used to shape the design and showcase the features and benefits that the solutions can bring. Measures The measures used are listed in figure 10.1. The new additional measures from the method expansion are highlighted using a star (*).

10.3 Specific designs

A handful of more specific design concepts have been made based on the existing location in the Amsterdamse Poort. Each of these showcase a different type of combined user and natural functionality, based on the expanded design method of the municipality of Amsterdam and all prior research. The designs are visualized with a render of a conceptual version.

10.3.1 Natural play roof

The natural play roof is a playground for children to explore biodiversity and increase their awareness of it. It features a natural interactive environment with plenty of space for the imagination of children to thrive, see figure 10.3. Open playgrounds which allow for exploration are much more interesting than tightly designed spaces with monofunctional equipment. They are also cheaper in development and maintenance. Therefore, this particular natural play roof features no plastic equipment, but focuses on creating opportunity for children to fill it in with their own imagination.

The biodiverse environment can be used to educate children as much as adults, in a fun and interactive way. The play forest is combined with a provided scavenger hunt, that will encourage children to look for certain plants or insects.

This play roof also features some multifunctionality. Next to the scavenger forest, a living wall is combined with a climbing wall using ropes and nets. These can be used by children, plants and insects to ensure that physical connection. There is also a water way featuring a pump. Water is a nice element to play with, and also provides effective cooling during hot summer days. It can be pumped up from the reused rainwater storage underneath, as most of it will end up back in the soil anyway.

The playground is surrounded by natural fencing with the use of hedges, and its entrances are limited and can be closed off at night time by certain residents or shopkeepers to keep unwanted activity away. There is some seating available for supervisors to keep an eye on the playing children, and lighting to enhance safety.

Next to the general measures, this design specifically makes use of the following tactical measures provided by the Amsterdam design method:

- F-NE5-2* Vertical ropes as connection
- W-GB2-4 Local water storage reuse
- L-KA3-1 Green property division
- G-OR1-1* Water garden
- G-OR1-2* Play forest
- G-OR1-3* Natural scavenger hunt
- G-GB1-2* Climbing ropes

Figure 10.3: The conceptual natural play roof design

10.3.2 Sports roof

The sports roof features some popular forms of outside recreation in combination with a healthy and sustainable environment, see figure 10.4. From the UX research it became clear that particularly football is a popular outside sport practiced by the local kids. For example: football or basketball fields can be made of actual grass fields so that water can be taken in by the soil. This will require extra maintenance as the grass should then be cut regularly, but this can be a shared responsibility.

The sports roof is also accessible via entrance points that can be shut during night time. The football fields are surrounded by high fencing to prevent balls flying off the roof or into windows of surrounding buildings. These fences can act as extra support for climbing plants like ivy. However, the fencing should be kept clear on at least one side in order to maintain visibility for supervisors.

Next to sport fields, other forms of equipment can be put in place. Observations of nearby parks showed that these outdoor fitness fields are used for exercise by adults that may not be able to go to a gym. They make physical health accessible, which is of vital essence for the local residents in Amsterdamse Poort.

These measures are showcased in this design:

- L-KA3-1 Green property division
- G-OR2-1* Outdoor fitness equipment
- G-OR2-2* Sport fields

Figure 10.4: The conceptual sport roof design

10.3.3 Natural roof

The natural roof shifts the focus from the user to biodiversity. It showcases a completely fuzzy design where the environment can design itself in a flexible and largely unbothered way, which will result in even lower maintenance costs. A render is shown in figure 10.5.

However, this design is not completely without any user experience. The resulting greenery can be accompanied with some form of artistic expression, for example statues designed and built by local artists. Other options could be graffiti walls, or porous stone structures that can be explored and overgrown.

To ensure little soil interference, a large part of the pathways on this roof are elevated, so that vegetation can continue to grow and connect underneath. It also adds to the experience of walking through a continuous green sea of nature. However, straying off the path is not prohibited, as there should still be a chance for people to explore.

Due to its more subtle implementation of user functionality, this roof is a great opportunity for fitting solar panels on one side of it. As research suggests, these panels will provide electricity efficiently due to the surrounding vegetation cooling them. This way, a natural roof adds even more multifunctionality to the overall design.

The natural roof features these measures:

- F-GB1-3 Green walls on construction
- F-GB2-3 Insect hotels
- F-GB3-3 Nature roof
- E-GB1-1 Solar panels on roof
- F-NE5-3* Ropes as connection
- F-NE5-6* Stepping stones
- M-NE1-2* Elevated walkways
- G-OR3-1* Sculpture garden

Figure 10.5: The conceptual natural roof design

10.3.4 Shared garden roof

The shared gardens can be designed on top of private residencies. These roofs have a smaller area and will have limited access. For these reasons, it can be designed as an opportunity for residents to claim a small piece of land for gardening purposes, as shown in figure 10.6. This keeps the roof mostly private which is desirable when living directly underneath.

The UX research concluded that local residents of the Bijlmer are very interested in eating off the land. Shared gardens around the area have proven to be extremely popular. Gardening together can aid in giving residents the feeling of autonomy and responsibility, as well as increase social cohesion. Part of the gardening area can also be assigned to the nearby primary school.

It is important that participating residents are properly informed with some limitations of rooftop gardening. Due to weight issues, heavy interventions like tiles are likely not possible. And, although water can be made accessible from the rainwater storage underneath, it should be regulated to prevent overuse.

The tactical measures used specifically in this concept are:

- W-GB2-4 Water reuse on building
- L-KA3-3 Property division using hedges
- L-KA4-3* Hedges as wind shields
- G-OR4-4* Shared garden space

Figure 10.6: The conceptual shared garden roof design

10.3.5 Event roof

The event roof focuses less on creating a natural environment and more on user functionality. It is located right in the middle of the Amsterdamse Poort, at the heart of the shopping mall. This large roof is split in two using a natural porous stone wall, and one half is designed to be suitable for larger-scale meetings and events, see figure 10.7.

It consists of a large open grass field that can be used for any type of meet-up, whether it be an outdoor yoga session or part of a festival. It is the most accessible roof with multiple connections to other rooftop hubs, and an elevator elongated from one already located inside the shopping mall. A small permanent café is located near the field, and has a small area as rooftop terrace to its availability. Next to this, one corner features some seats, but most of the field is purposely empty and available for people to enjoy their own activities.

The pointed end of the roof is accommodated with a small podium, which can be used for local theatre or as part of the nearby Kwaku Festival. The podium can be made available against a fee, which together with the small café, has the potential to create revenue. The rooftops of both these extra structures should not be left out of the equation, and can be fitted with solar panels to accommodate electricity.

This roof features these measures from the method:

- L-GE1-1 Less hardened surfaces
- E-GB1-1 Solar panels on roofs
- L-KA4-1* Natural stone wall
- L-KA4-3* Hedges as windshields
- M-KA1-3* Accessibility by elevator
- G-OR3-1* Public podium
- G-OR4-2* Circling seats
- G-OR4-3* Green rooftop terrace

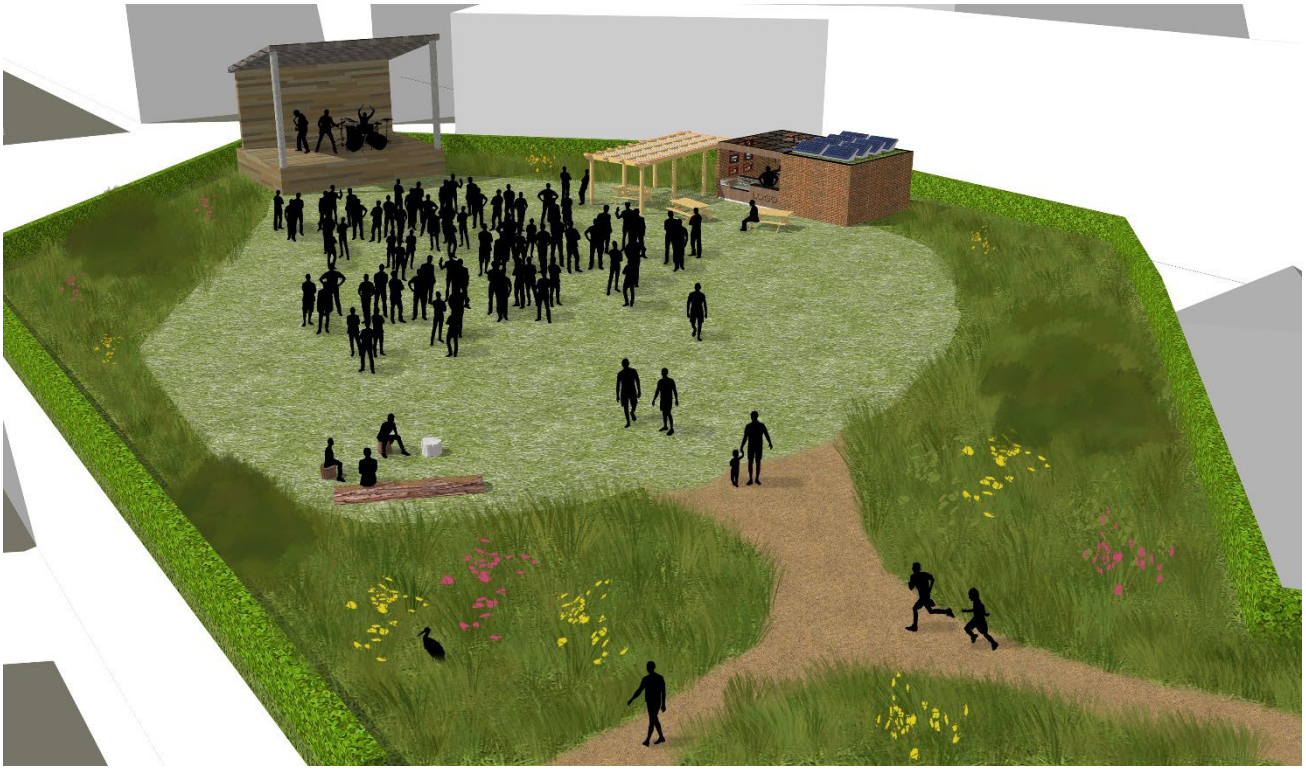


Figure 10.7: The conceptual event roof design

10.3.6 Canopy walk

The canopy walk is an interesting part of the park. It consists of a suspended walking bridge spanning between two higher roofs, and looking over the large lower roof of the shopping mall. This half of the lower roof is an isolated hub of nature, in the sense that it is not directly accessible by any users, but more of a resting place for local wildlife. The design is shown in figure 10.8.

Instead, the area can be overlooked by the overhanging walkway, which is a non-invasive form of experiencing nature. This type of soft interaction has proven popular among adults as a form of experiencing the green environment. By creating a hub for birds and insects to come to rest, it becomes an interesting place to watch over or photograph. With the help of provided information through apps or message boards, the experience can be of an educative nature too.

The canopy walk is intentionally a wobbly bridge to make it more lively and exciting, but unfortunately also inherently inaccessible. For this reason, the roofs that it connects can also be accessed through other more accessible entrances. The incorporation of nets enclosing the bridge can also ensure safety.

Because of the way suspended bridges divide their constructive forces using ropes, it is suited to be attached to the strong points of a building's foundation. This requires less modification of a roof, decreasing initial investment costs.

This design makes use of the following measures:

- F-GB2 Nestling opportunities
- F-GB3-3 Natural roof
- F-GE1-1* Dune landscape
- M-NE1-1* Suspension bridge
- G-OR1-3* Natural scavenger hunt
- G-KA1-2* Routes with a view

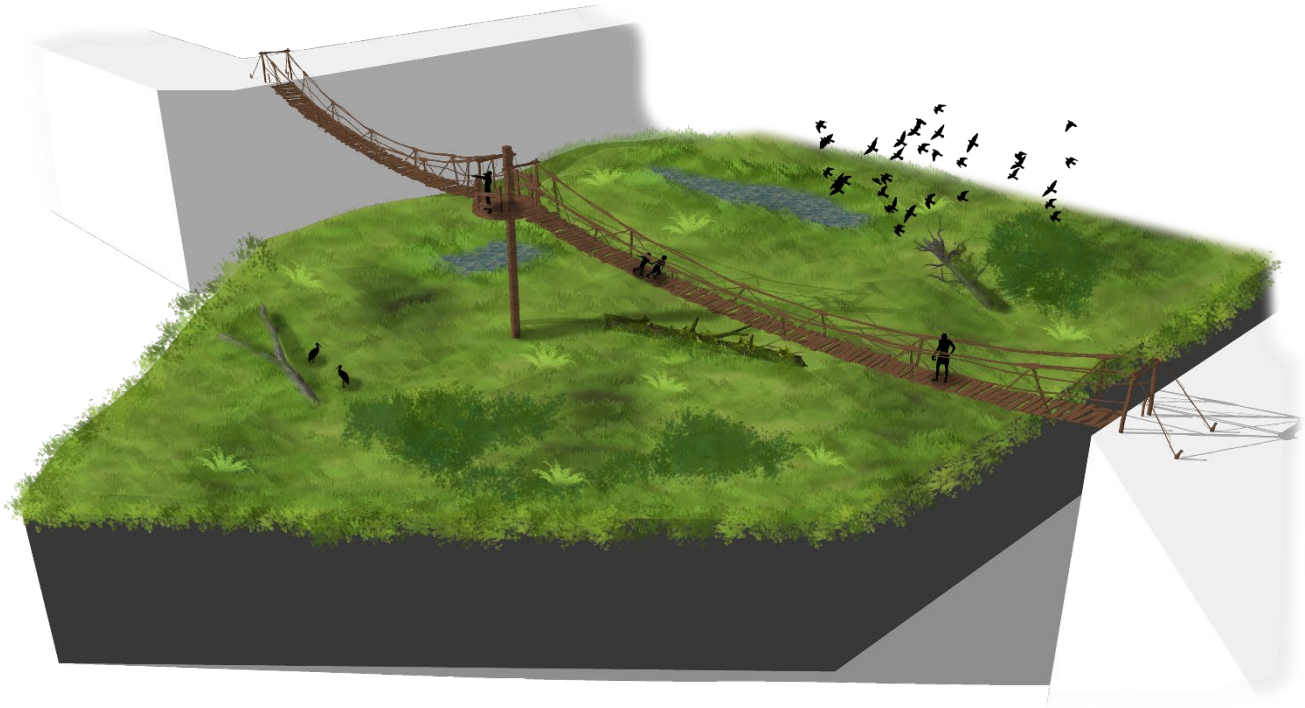


Figure 10.8: The conceptual canopy walk design

10.3.7 Horizontal connections

The horizontal connections that make the park one holistic experience are the most radical parts of the design, as this is done nowhere else in the Netherlands. However, they are a vital part for a successful rooftop park spanning over multiple roofs, both for a robust natural environment and user experience. They also offer many opportunities in these two areas.

Horizontal connections can be of different levels based on their construction complexity. They range from simple ropes or cables spanning from one building to the other, to deepened ecoducts featuring direct soil connection and comfortable pathways for users. This specific design is more of a midway, featuring a bridge with narrow ecoducts on the side, connecting the soil and pathways between two roofs.

Such connections will increase the sustainability and robustness of the overall environment, as it allows territory expansion for insects and even small wildlife, giving them more leeway during harsh times. This way, the whole park is connected and can in turn be part of a larger natural network throughout the city, which is vital for a sustainable robust biodiverse environment with little necessary interference or maintenance.

Such a physical connection can be properly combined with user accessibility of a rooftop, eliminating the need for each roof to have an individual entrance. To top it all off, elevated pathways above street areas provide nice views over the area and a more interesting experience.

These measures have shaped this design:

- F-NE2-1 Passage for fauna
- F-NE3-1 Corridor for small organisms
- F-NE5-3* Ecoducts
- M-NE1-1* Suspension bridges
- G-KA1-2* Routes with a view

Figure 10.9: The conceptual horizontal connection design

10.3.8 Vertical connection

Vertical connections are often overlooked when green roofs are implemented, but can aide in making them more robust and sustainable. This vertical connection shows off how accessibility for residents can be combined with a direct physical connection between green hubs on roofs, as shown in figure 10.10.

The stairs are elongated from their original end position on the first roof to connect all levels including the highest roof. Along those stairs is a small stroke of soil connecting the two roofs as well. This stroke is made up of smaller compartments to prevent the soil and water from flushing away. These compartments are separated by porous walls that allow for easy algae and lichen growth, so that they stay connected. The walls are very low so that plants can also act as bridges for smaller life forms.

Next to increasing the accessibility of a roof by adding stairs, a more adventurous way of getting up high is added next to it. Climbing walls make for great play and exercise, both for kids and adults. Depending on the height differences between roofs, the wall can be elongated so that they cover it from top to bottom. Because the current height difference is 8 meters, the climbing wall is cut short to ensure safety.

The measures used for this specific design are:

- F-NE3-3 Corridor small organisms in wall
- F-GB1-2 Self-attaching climbing plants
- F-NE5-1* Green walls as connection
- F-NE5-5* Steppingstones
- M-KA1-1* Vertical stairs
- G-GB1-1* Climbing wall

Figure 10.10: The conceptual vertical connection design

Results & Conclusions

11. Final Conclusion

11.1 Research Question

The final chapter of this thesis will discuss the entire design process and following results, giving the final conclusions and recommendations related to each part of the research. Next to this, the design question is answered and any additional remarks are stated as well. To recap, the design question stated at the very beginning of this thesis was as follows:

How can 3D biodiversity in dense cities be realized to benefit the environment, society, and local residents, now and in the future?

The answer is found throughout the results of the method expansion and design proposal. The effectivity of all benefits of 3D biodiversity can best be maximized by incorporating multifunctional solutions and understanding the mechanics behind biodiversity, as well as potential user experiences surrounding it. 3D biodiversity has potential to contribute to the solution of many complex problems that dense cities face, so maximizing that should at least be considered when developing new neighbourhoods or buildings.

11.1.1 Recommendations

The research has shown that biodiversity is not a straight forward endeavour solved with adding plants or insect hotels to a design. In order for it to actually strengthen or restore the local environment, it should be considered an integral part of it throughout the design process. This is best realized by shifting the perspective of greenery on buildings from standalone solutions to a vital piece of infrastructure, like electricity or sewage. Neighbourhoods should contain a physical natural network that links to other networks throughout the area. This network should be part of the fundamentals of the design, and fixed in early stages of the design process. The proposed design solutions can help in combining such networks with densification of such neighbourhoods.

Next to this, 3D biodiversity should be combined with other functionalities like water storage or energy generation. It enhances efficiency of solar panels, allows for CO_2 sequestration and acts like a sponge which relieves the sewage system of a city, while maintaining itself reusing that water. The additional energy saving as a result from its cooling capabilities, makes 3D biodiversity a worthful investment for any building or public space.

Another recommendation is involving local residents and visitors of the area with 3D biodiversity using educative recreation and allowing interaction, albeit indirectly. Natural areas have proven popular recreative spots for all layers of the population, with many additional benefits related to health and wellbeing. 3D biodiversity can facilitate this in many ways as shown in the designs, especially in dense parts of the city.

Finally, there should be a large shift in perspective on what biodiversity looks like. The current idea of immediate lush greenery throughout all seasons in a fixed design, results in unnecessary high investments, maintenance costs and unsustainable greenery, contributing very little to local biodiversity. A recommended perspective would be one that changes with the seasons, allows for both death and growth of

plants, focussing more on the process instead of the result. Plants should be considered more than substrate to attract insects or animals, but an actual part of biodiversity, as they can migrate or expand too.

The benefits and potential of 3D biodiversity are often overlooked or misunderstood by involved stakeholders. They should be emphasized with the help of legislation, communication, and education. Although initial investments will always be high due to the necessary additional construction, it can be lowered by keeping the green design fuzzy and starting small. Maintenance costs can also be lowered by designing the vegetation in this way, so that weeding and watering becomes less necessary. The local population can also be involved to take care of the remaining tasks.

11.1.2 Naturalis & Amsterdam

The original idea was to make sure the involved parties of Naturalis and the municipality of Amsterdam can use the results for their own research and development. This thesis has given them insight on the design methods used, and how users of public space can become part of the solution rather than a nuisance. The new additional solutions can be directly implemented in the design method of the city of Amsterdam, as is demonstrated in appendix A.10. The municipality can also implement the ideation technique of design values into other development project, so instead of superficial fulfilments of stated wishes, they can tackle problems at their core.

Naturalis has had a more advisory role throughout the thesis, giving insight on natural processes and how current implementations often fall short on properly restoring biodiversity in a sustainable way. This thesis acts as a gateway of all that expertise by projecting it on an actual public space design, creating an example of how actual biodiversity restoration in the public space can look like. Next to this, Naturalis can take the results of the user research into consideration, as they shed light on how users like to interact with nature. Using this insight, Naturalis can help other development projects in becoming successful both for nature and users.

11.2 Reflection

This thesis contains three different result sections, each discussed separately. Due to constraints in time and resources, some parts of the research can be potentially improved. The most important aspects that can be reconsidered in further research are proposed here.

11.2.1 User research

The user research was done in order to better understand the potential users of 3D biodiversity, and incorporate them in the design process. Although the methods used have generated useful insights and results, the user research was not as extensive as necessary in order to fully understand all different motivations and views of public greenery in Amsterdamse Poort. The survey was distributed throughout the Netherlands, instead of only the local population, which created contradictory results. The observations were done during rainy winter days while in a lockdown, which was likely to have influenced the observed behaviour.

These problems were noted, but due to the limited time and resources available, the results remain the only ones available. Attempting to solve the issue, the answers given in the street interviews and by representatives had the focus during ideation. However, in order to fully give users a chance to enhance the design, the original idea of a participatory design session should be implemented in the process.

11.2.2 Method expansion

The design method of the municipality of Amsterdam has been expanded with additional solutions and a new category. These solutions all link back to specific findings in literature and the user research through the ideation process, however this link could have been stronger. Some materials of inspiration were lost in the process, which created gaps between the

results and the research. Generally speaking, the ideation process should have been documented more extensively.

Despite this, the expanded method does give a new perspective on public space that was originally not included. The solutions are intentionally ambiguous as they should allow for customization and alteration by other designers, so that the solutions are fitting in the context of each individual development project.

11.2.3 Design proposal

The design proposal for the Amsterdamse Poort was cut into 8 smaller concept and one overarching design. Despite the cutback, it still resulted in many aspects that needed to be thought of 9 different times, meaning that the designs remain somewhat superficial and lack more in-depth aspects like dimensions, legislation, or material use. Therefore, the current proposal is on a conceptual level, which may not be ready to be implemented into the renovation plans of the shopping centre.

However, the created proposal still showcases how different solutions can work together and create a multifunctional 3D rooftop park. It can inspire other designers that want to implement 3D biodiversity and UX. Any further research can analyse one specific part of the proposal and give more meaningful practical solutions to the aspects currently not discussed.

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And thank you for reading!

This section contains all references and appendices that were referred to in the thesis. Thanks for reading the report!

V

References & Appendix

12. References

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A. Appendix

References & appendix

Table of contents

A.1 Naturalis Assignment Description

Development of green rooftops for biodiversity and urban recreation in cooperation with Naturalis

Assignment with Naturalis in Leiden:

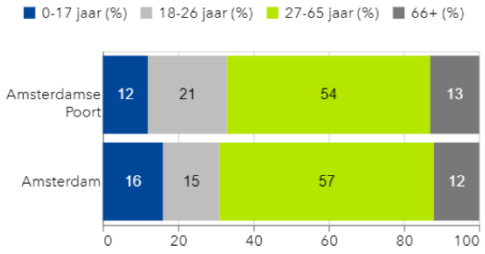
In just one century, the urban area in the Netherlands has increased 10 fold, from less than 2% around 1900 to about 20% nowadays. At the same time the amount of terrestrial nature areas decreased from 28% to 15%, whereas the agricultural areas remained more or less the same, occupying ca. 2/3 of the Dutch land surface. Ergo, the urbanization in the Netherlands is almost completely at the cost of nature. Recently an increased awareness arose about the importance of ecosystem services and the decline of biodiversity essential for providing these services. Consequently, cities need to accommodate more and more biodiversity in order to enhance biodiversity as well as to keep ecosystem services intact. For this, effective and healthy ecological networks are essential, connecting areas inside and outside the built areas. Usually, these networks are visualized in 2 dimensions. However, the idea is that it should and could be 3 dimensional. Much place is occupied by buildings with walls and roofs and these can function as ecological facades and roofs; in other words, compensate for the lost habitats and the surface taken by stones and concrete by bringing nature on (top of) the buildings and create a 3 dimensional ecological network. This will also mitigate the urban heat stress and awkward hydrology. And, connecting this 'top-level' green structure opens opportunities for an eco-recreational route for people, so enlarging the possibilities of recreation and taking off some of the pressures of too heavily used ground floor recreational infrastructure.

In our view this brings two design issues. How can we create a 'roof walk' with fly overs and (suspension) bridges, suited (and safe) for ordinary walks as well as for more adventurous adolescents? What are the technical options/possibilities, what are social and property issues? Pilots can be developed for industrial sites in Leiden and for the Amstelstad III program in Amsterdam. Another design issue can be how this greening of buildings can be integrated with the use of roofs for the generation of solar energy.

A.2 Amsterdamse Poort Demographics

1.337 inwoners

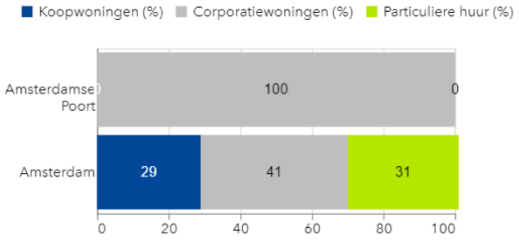
Inwoners naar leeftijd



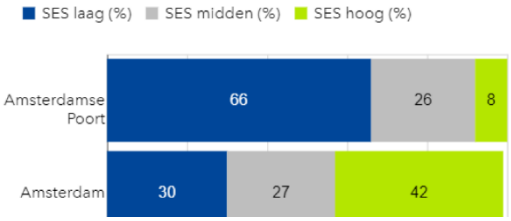
680 woningen

gemiddeld besteedbaar huishoudinkomen: € 23.300

Eigendomsverhouding (%)



Sociaal economische score bewoners



De positie van Amsterdamse Poort in Amsterdam

Veel beter dan Amsterdam gemiddeld	Beter	Gemiddeld voor Amsterdam	Slechter	Veel slechter dan Amsterdam gemiddeld
	Boodschappen (1-10)	A/B (%)	Buurtontwikkeling (1-10)	Eigen buurt (1-10)
			Schoon straat (1-10)	Parkeren auto (1-10)
				% Minimahuishoudens
				Kindvriendelijk (1-10)
				Sportgelegenheden (1-10)
				Meest kwetsbaar (% 66+)
				(zeer) gezond (%)
				Sociale cohesie (1-10)
				SES (gemiddeld)

	2016	2017	2018	2019	2020	2021	2022	Amsterdamse Poort	Amsterdam
Eigen buurt (1-10)	-	7,2	-	6,6	-	-	-	n.b.	+0,1
Buurtontwikkeling (1-10)	-	6,8	-	6,7	-	-	-	n.b.	+0,1

Ontwikkeling laatste 4 jaar

	2016	2017	2018	2019	2020	2021	2022	Amsterdamse Poort	Amsterdam
Schoon straat (1-10)	-	6,4	-	6,2	-	-	-	n.b.	-0,1
Wel eens onveilig voelen buurt (%)	-	-	-	-	-	-	-	n.b.	+2
Parkeren auto (1-10)	-	5,1	-	4	-	-	-	n.b.	+0,3
Boodschappen (1-10)	-	8,2	-	8,3	-	-	-	n.b.	+0,1
% Minimahuishoudens	51	50	50	41	-	-	-	-9	-2
Kindvriendelijk (1-10)	-	5,8	-	4,7	-	-	-	n.b.	0
Advies Havo/VWO (%)	-	-	-	-	-	-	-	n.b.	+2,9
Sportgelegenheden (1-10)	-	7,2	-	5,7	-	-	-	n.b.	-0,3
Meest kwetsbaar (% 66+)	49	50	50	50	-	-	-	n.b.	n.b.
(zeer) gezond (%)	62	-	-	-	67	-	-	+5	+3
A/B (%)	-	-	34,1	34,9	-	34,6	32,6	-1,5	+13,2
Sociale cohesie (1-10)	4,7	4,9	5,2	4,8	5	-	-	+0,3	+0,1
SES (gemiddeld)	4,1	4,1	4,2	4,1	-	-	-	n.b.	n.b.

Recreatiegebieden in Nederland

1900 | 1935 | 1950 | 1965 | 1970 | 1975

Maatschappelijke context

5 miljoen inwoners
1 miljoen stedelingen
89% groene druk (<19 jaar t.o.v. de rest)
12% grijze druk (>65 jaar t.o.v. de rest)
1% niet-nederlanders
werkweek gemiddeld 61 uur

WOII

babyboom

TRENDS ACTIVITEITEN
barbecuen
bermtoerisme
dagcamperen
bioscoop
concours hippique
fietsen
honduitlaten
kanoën
Koninginnedag
kermis
paardrijden
picknicken
pretpark (oude stijl)
rusten
scouting / padvinders
softdrugs
stoeterij
strandtent
varen
vissen
voetbalclubevents
maatschappelijk werk
vogels kijken
wandelen
zonnebaden

11 miljoen inwoners
4 miljoen stedelingen
72% groene druk
19% grijze druk
2% niet-nederlanders
werkweek gemiddeld 42 uur

Trends in recreatie

beurscrisis 1929

Recreatie als medisch advies
Patiënten Alkmaar kamperen in de duinen (1930)

Recreatie als ontspanning
Amsterdammers in het Vondelpark (1955)

Bermtoerisme
(jaren zestig)
paaltjesroutes wandelen

Massarecreatie
Sloterplas (1967)

Recreatie als evenement
Woodstock in het Kralingse Bos (1970)

Recreatie als uitje
Picknicken aan de IJsselmeerdijk bij Durgerdam (1973)

Recreatie als verblijf
Dagkamperen in het Amsterdamse Bos (1973)

1965: START RIJKSBELEID RECREATIEGEBIEDEN
onder het nieuwe Ministerie van Cultuur, Recreatie en Maatschappelijk werk (CRM) 1965-1982

Ministerie van Cultuur, Recreatie en Maatschappelijk werk (CRM)

Ministerie van Landbouw, Natuur en Visserij - later: Voedselkwaliteit (LNV) 1935-2010

Beleid

Oprichting Staatsbosbeheer (1899)

Streekplannen (vanaf ca. 1930)

Woningwet (1901)

Eerste Rijkswegenplan (1927)

Uitbreidingsplan Amsterdam (AUP, 1935)
Recreatie is "een element van de grootste betekenis in het maatschappelijk leven"

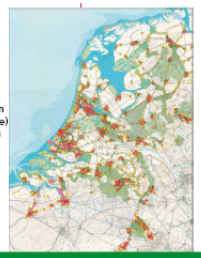
Basisplan Rotterdam (1946)

Nota Westen des Lands (1958)
Schrikbeeld metropolen met gebrek aan groen en recreatieruimte

Eerste Nota RO (1960)

Wet Ruimtelijke Ordening (1965)

2e Nota Ruimtelijke Ordening (1966)
Beheersen stedelijke groei
Groeikernen
Bufferzones tussen Stadsgewesten
Groene Sterren (openluchtrecreatie)
Nationale landschappen en parken



3e Nota RO (1973-1985)
Landinrichtingswet
Financiële regeling agrarisch natuurbeheer en grote openluchtrecreatie

Verstedelijkingsnota 1976

Stedelijke parken en wandelingen

Groene Sterren

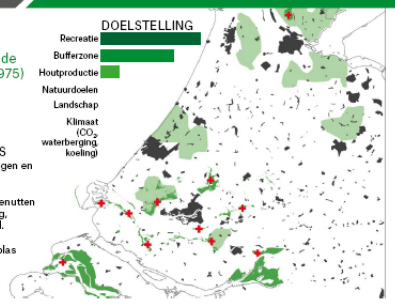
Ontwerp, realisatie en beheer

ONTWERPPRINCIPES
- werkverschaffingsprojecten i.c.m. grondwerk havens e.d.
- hoge capaciteit
- verhouding 1:1:1 bos, open ruimte en water

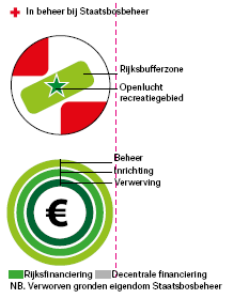
Kralingse Bos (1911-1953)

Amsterdamse Bos (1927-1964)

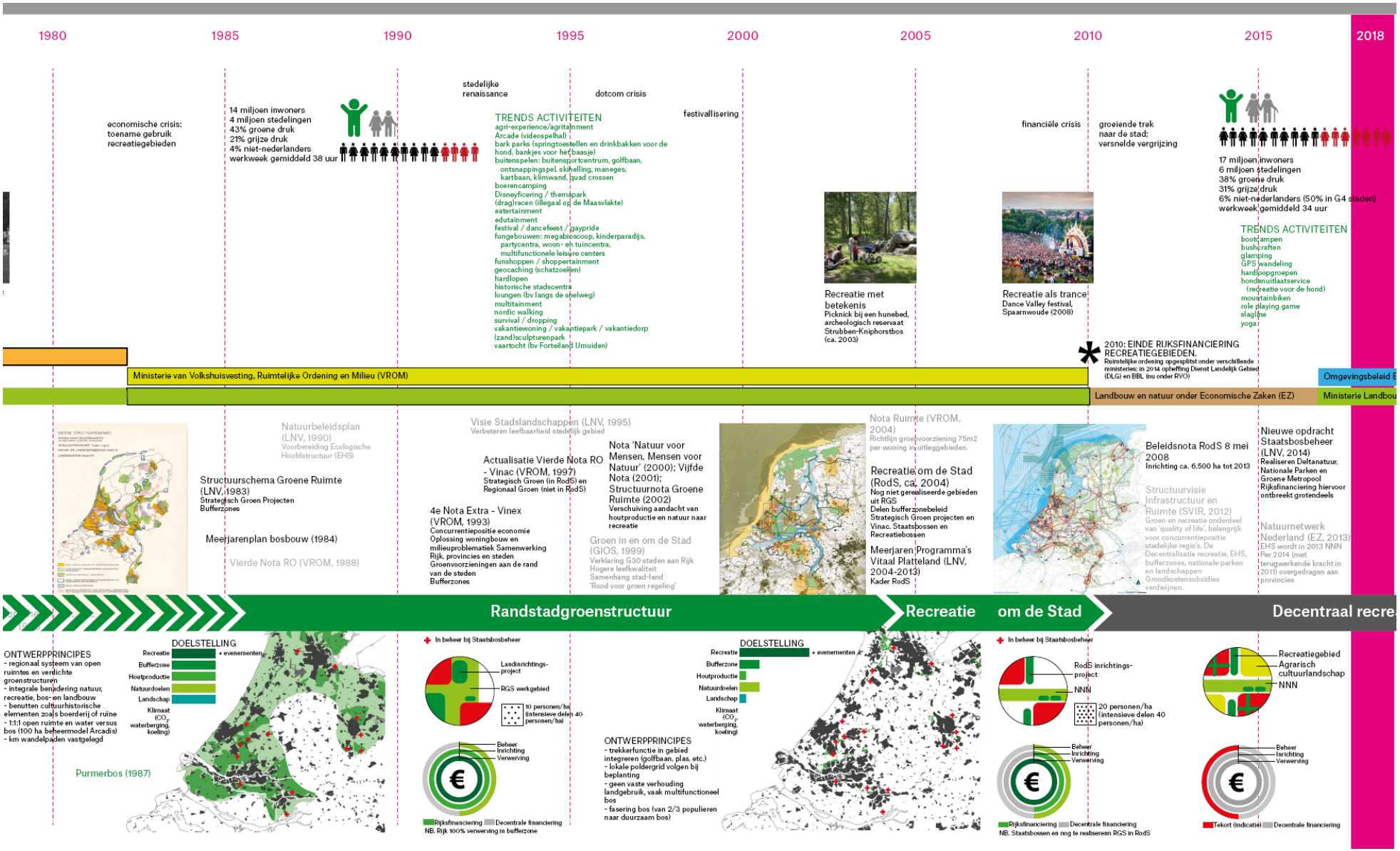
Spaarnwoude (1963-ca. 1975)

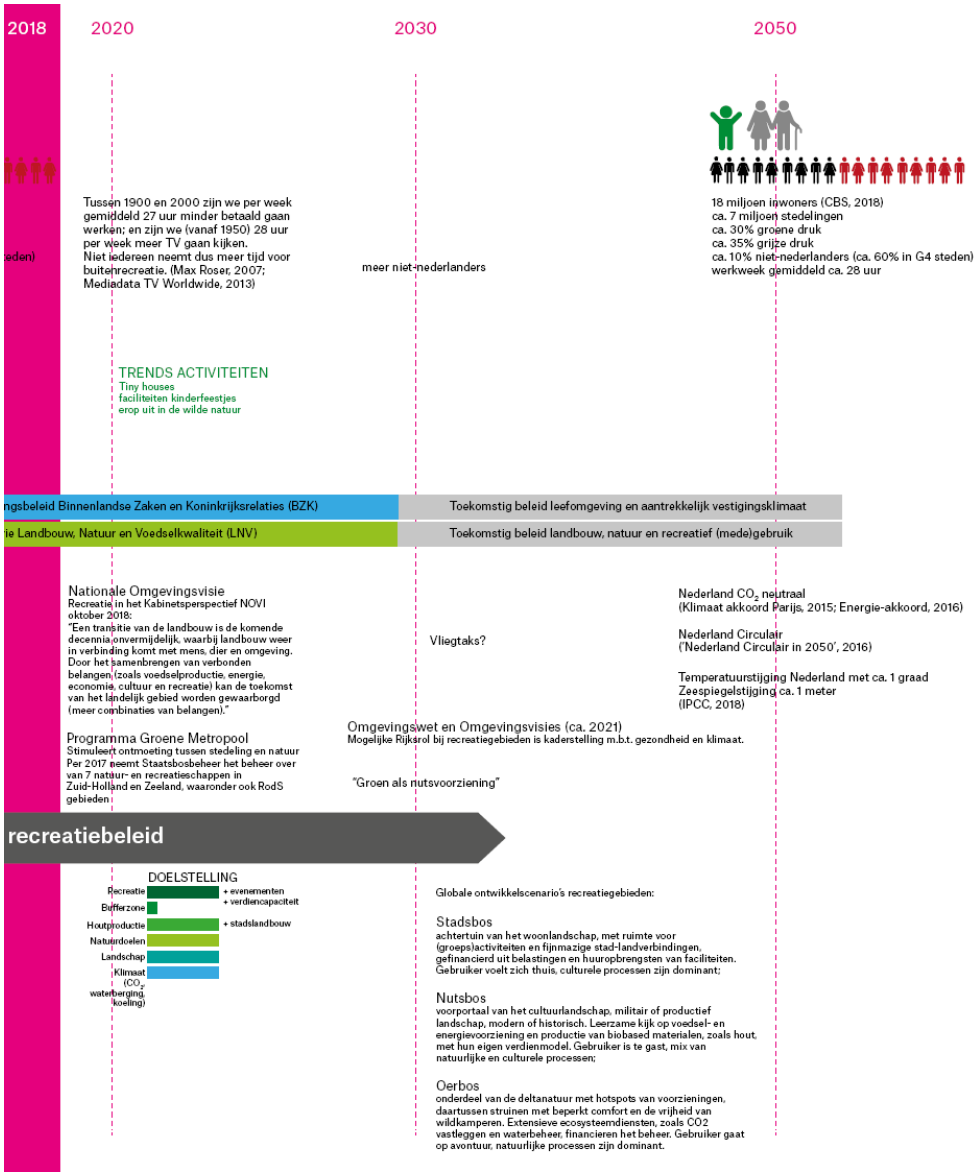


ONTWERPPRINCIPES
- routing met bestemmingen en rondjes
- goede ontsluiting
- bestaande landschap benutten in elementen, percellering, dichtgegroeide sloten e.d.
- geen vaste verhouding landgebruik, vaak zwemplas



vereniging delta metropool


1980
1985
1990
1995
2000
2005
2010
2015
2018
economische crisis: toename gebruik recreatiegebieden
14 miljoen inwoners
4 miljoen stedelingen
43% groene druk
21% grijze druk
4% niet-nederlanders
werkweek gemiddeld 38 uur
stedelijke renaissance
dotcom crisis
festivallisering
financiële crisis
groeiende trek naar de stad; versnelde vergrijzing
17 miljoen inwoners
6 miljoen stedelingen
38% groene druk
31% grijze druk
6% niet-nederlanders (50% in G4 steden)
werkweek gemiddeld 34 uur
TRENDS ACTIVITEITEN
agri-experience/agritainment
Arcade (videospelhal)
bark parks (springtoestellen en drinkbakken voor de hond, bankjes voor het baasje)
buitenspelen: buitensportcentrum, golfbaan, ontsnappingspel, skihelling, maneges, kartbaan, klimwand, quad crossen
boerencamping
Disneyficering / themapark
(dragiracen (illegaal op de Maasvlakte)
eatertainment
edutainment
festival / dancefeest / gaypride
fungebouwen: megabioscoop, kinderparadijs, partycentra, woon- en tuincentra, multifunctionele leisure centers
funshoppen / shoppertainment
geocaching (schatzoeken)
hardlopen
historische stadscentra
loungen (bv langs de snelweg)
multitainment
nordic walking
survival / dropping
vakantiewoning / vakantiepark / vakantiedorp
(zand)sculpturenpark
vaartocht (bv Forteiland Umuiden)
Recreatie met betekenis
Picknick bij een hunebed, archeologisch reservaat Strubben-Kniphorstbos (ca. 2003)
Recreatie als trance
Dance Valley festival, Spaarnwoude (2008)
2010: EINDE RIJKSFINANCIERING RECREATIEGEBIEDEN.
Ruimtelijke ordening opgesplitst onder verschillende ministeries; in 2014 opheffing Dienst Landelijk Gebied (DLG) en BBL (nu onder RVO)
TRENDS ACTIVITEITEN
bootcampen
bushcraften
glamping
GPS wandeling
hardloopgroepen
hondenuitlaatservice (recreatie voor de hond)
mountainbiken
role playing game
slagtine
yoga
Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu (VROM)
Omgevingsbeleid E
Landbouw en natuur onder Economische Zaken (EZ)
Ministerie Landbou
Natuurbeleidsplan (LNV, 1990)
Voorbereiding Ecologische Hoofdstructuur (EHS)
Structuurschema Groene Ruimte (LNV,1983)
Strategisch Groen Projecten
Bufferzones
Meerjarenplan bosbouw (1984)
Vierde Nota RO (VROM, 1988)
Visie Stadslandschappen (LNV, 1995)
Verbeteren leefbaarheid stedelijk gebied
Actualisatie Vierde Nota RO - Vinac (VROM, 1997)
Strategisch Groen (in RodS) en Regionaal Groen (niet in RodS)
4e Nota Extra - Vinex (VROM, 1993)
Concurrentiepositie economie
Oplossing woningbouw en milieuproblematiek Samenwerking Rijk, provincies en steden
Groenvoorzieningen aan de rand van de steden
Bufferzones
Nota 'Natuur voor Mensen, Mensen voor Natuur' (2000); Vijfde Nota (2001); Structuurnota Groene Ruimte (2002)
Verschuiving aandacht van houtproductie en natuur naar recreatie
Groen in en om de Stad (GIOS, 1999)
Verklaring G30 steden aan Rijk
Hogere leefkwaliteit
Samenhang stad-land
'Rood voor groen regeling'
Nota Ruimte (VROM, 2004)
Richtlijn groenvoorziening 75m2 per woning in uitleggebieden.
Recreatie om de Stad (RodS, ca. 2004)
Nog niet gerealiseerde gebieden uit RGS
Delen bufferzonebeleid
Strategisch Groen projecten en Vinac. Staatsbossen en Recreatiebossen
Meerjaren Programma's Vitaal Platteland (LNV, 2004-2013)
Kader RodS
Beleidsnota RodS 8 mei 2008
Inrichting ca. 6.500 ha tot 2013
Structuurvisie Infrastructuur en Ruimte (SVIR, 2012)
Groen en recreatie onderdeel van 'quality of life', belangrijk voor concurrentiepositie stedelijke regio's. De Decentralisatie recreatie, EHS, bufferzones, nationale parken en landschappen
Grondkostensubsidies verdwijnen.
Nieuwe opdracht Staatsbosbeheer (LNV, 2014)
Realiseren Deltanatuur, Nationale Parken en Groene Metropool
Rijksfinanciering hiervoor ontbreekt grotendeels
Natuurnetwerk Nederland (EZ, 2013)
EHS wordt in 2013 NNN
Per 2014 (met terugwerkende kracht in 2011) overgedragen aan provincies
Randstadgroenstructuur
Recreatie om de Stad
Decentraal recre
ONTWERPPRINCIPES
- regionaal systeem van open ruimtes en verdichte groenstructuren
- integrale benadering natuur, recreatie, bos- en landbouw
- benutten cultuurhistorische elementen zoals boerderij of ruïne
- 1:1:1 open ruimte en water versus bos (100 ha beheermodel Arcadis)
- km wandelpaden vastgelegd
DOELSTELLING
Recreatie
Bufferzone
Houtproductie
Natuurdoelen
Landschap
Klimaat (CO_2, waterberging, koeling)
+ evenementen
Purmerbos (1987)
In beheer bij Staatsbosbeheer
Landinrichtings-project
RGS werkgebied
10 personen/ha (intensieve delen 40 personen/ha)
Beheer
Inrichting
Verwerving
Rijksfinanciering
Decentrale financiering
NB. Rijk 100% verwerving in bufferzone
ONTWERPPRINCIPES
- trekkerfunctie in gebied integreren (golfbaan, plas, etc.)
- lokale poldergrid volgen bij beplanting
- geen vaste verhouding landgebruik, vaak multifunctioneel bos
- fasering bos (van 2/3 populieren naar duurzaam bos)
RodS inrichtings-project
NNN
20 personen/ha (intensieve delen 40 personen/ha)
NB. Staatsbossen en nog te realiseren RGS in RodS
Recreatiegebied
Agrarisch cultuurlandschap
NNN
Tekort (indicatief)


2018
2020
2030
2050
Tussen 1900 en 2000 zijn we per week gemiddeld 27 uur minder betaald gaan werken; en zijn we (vanaf 1950) 28 uur per week meer TV gaan kijken. Niet iedereen neemt dus meer tijd voor buitenrecreatie. (Max Roser, 2007; Mediadata TV Worldwide, 2013)
meer niet-nederlanders
18 miljoen inwoners (CBS, 2018)
ca. 7 miljoen stedelingen
ca. 30% groene druk
ca. 35% grijze druk
ca. 10% niet-nederlanders (ca. 60% in G4 steden)
werkweek gemiddeld ca. 28 uur
TRENDS ACTIVITEITEN
Tiny houses
faciliteiten kinderfeestjes
erop uit in de wilde natuur
ngsbeleid Binnenlandse Zaken en Koninkrijksrelaties (BZK)
Toekomstig beleid leefomgeving en aantrekkelijk vestigingsklimaat
ie Landbouw, Natuur en Voedselkwaliteit (LNV)
Toekomstig beleid landbouw, natuur en recreatief (mede)gebruik
Nationale Omgevingsvisie
Recreatie in het Kabinetsperspectief NOVI oktober 2018:
"Een transitie van de landbouw is de komende decennia onvermijdelijk, waarbij landbouw weer in verbinding komt met mens, dier en omgeving. Door het samenbrengen van verbonden belangen, (zoals voedselproductie, energie, economie, cultuur en recreatie) kan de toekomst van het landelijk gebied worden gewaarborgd (meer combinaties van belangen)."
Programma Groene Metropool
Stimuleert ontmoeting tussen stedeling en natuur
Per 2017 neemt Staatsbosbeheer het beheer over van 7 natuur- en recreatieschappen in Zuid-Holland en Zeeland, waaronder ook RodS gebieden
Vliegtaks?
Nederland CO_2 neutraal
(Klimaat akkoord Parijs, 2015; Energie-akkoord, 2016)
Nederland Circulair
('Nederland Circulair in 2050', 2016)
Temperatuurstijging Nederland met ca. 1 graad
Zeespiegelstijging ca. 1 meter
(IPCC, 2018)
Omgevingswet en Omgevingsvisies (ca. 2021)
Mogelijke Rijksrol bij recreatiegebieden is kaderstelling m.b.t. gezondheid en klimaat.
"Groen als nutsvoorziening"
recreatiebeleid
DOELSTELLING
Recreatie
+ evenementen
+ verdiencapaciteit
Bufferzone
Houtproductie
+ stadslandbouw
Natuurdoelen
Landschap
Klimaat
(CO_2 waterberging, koeling)
Globale ontwikkelscenario's recreatiegebieden:
Stadsbos
achtertuin van het woonlandschap, met ruimte voor (groeps)activiteiten en fijnmazige stad-landverbindingen, gefinancierd uit belastingen en huuropbrengsten van faciliteiten. Gebruiker voelt zich thuis, culturele processen zijn dominant;
Nutsbos
voorportaal van het cultuurlandschap, militair of productief landschap, modern of historisch. Leerzame kijk op voedsel- en energievoorziening en productie van biobased materialen, zoals hout, met hun eigen verdienmodel. Gebruiker is te gast, mix van natuurlijke en culturele processen;
Oerbos
onderdeel van de deltanatuur met hotspots van voorzieningen, daartussen struinen met beperkt comfort en de vrijheid van wildkamperen. Extensieve ecosysteemdiensten, zoals CO2 vastleggen en waterbeheer, financieren het beheer. Gebruiker gaat op avontuur, natuurlijke processen zijn dominant.

F-NE2

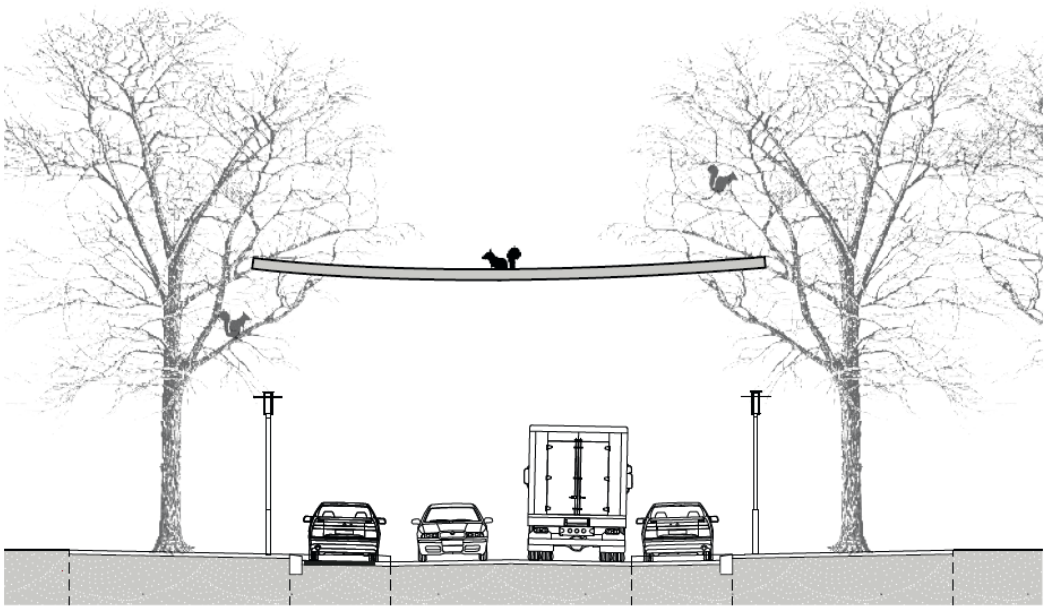
FAUNA / INFRASTRUCTUUR

Faunapassage

Grote wegen en andere infrastructurele werken kunnen ervoor zorgen dat het leefgebied van planten en dieren versnipperd raakt. Planten en dieren hebben minder mogelijkheden zich over en tussen gebieden te verspreiden en bewegen. Faunapassages zorgen ervoor dat de verschillende leefgebied met elkaar verbonden blijven/worden. Dieren die zich over de grond verplaatsen, kunnen zo van en naar delen van de stad bewegen die grenzen aan grote parken, buitenwater en polders. Denk bijvoorbeeld aan de padden, egels, eekhoorns en ringslangen. Een veel toegepaste passage is een tunnel in of onder het wegdek waar dieren via schermen naartoe worden geleid, maar een eekhoornbrug behoort ook tot de mogelijkheden.

Een voorbeeld van **Faunapassage bodemdieren / F-NE2-2** is: de faunapassage onder de Provincialeweg bij Bijlmerweide, Amsterdam-Zuidoost (DL1, p. 160).

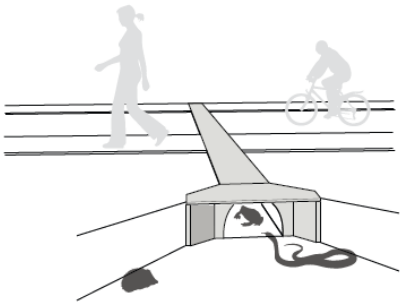
F-NE2-1
Eekhoornbrug



- M -NE6 -2

FAUNA / INFRASTRUCTUUR

F-NE2-2
Faunapassage bodemdieren



- B -OR3 -3
- M -NE1 -9

F-NE3

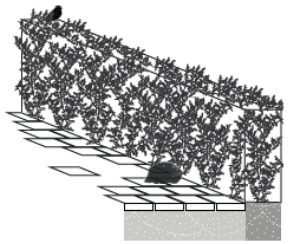
Corridor kleine organismen

Naast het aanleggen van faunapassages (F-NE2) is het aanleggen van groene corridors in de stad van groot belang voor de verspreiding van kleine planten en dieren. Een goed aangelegde corridor is niet alleen een leefgebied op zichzelf, maar is onderdeel van een netwerk doordat het een verbinding vormt tussen leefgebieden en soort-genoten.
Een voor de hand liggende corridor is een dichte groene haag, een gewilde plek voor zangvogels en insecten. Een nieuwer fenomeen is de wildernismuur: een 'slordig' gestapelde muur met gaten en spleten die gebruikt worden als schuilplek of foerageerplek. De vlinder- en bijenidylle is een uit-werking die steeds meer aandacht krijgt, vooral omdat deze soorten het nu erg moeilijk hebben. Het gaat hierbij om een strook (of veld) met specifieke kruiden, bloemen en planten waar vlinders en bijen baat bij hebben.

Voorbeelden van Corridor voor kleine organismen (F-NE3) zijn: een **Vlinder- en bijenidylle / F-NE3-4** aangelegd in het Kleine Loopveld, het Gijsbrecht van Aemstelpark, het Vondelpark en het Amstelpark.

F-NE3-1
FLORA & FAUNA / DROGE ZONE

Haag



- L -NE1-3
- W-OR2-4

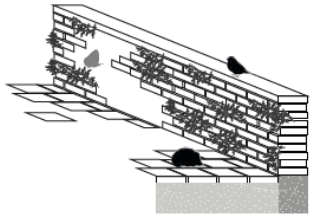
F-NE3-2
FLORA & FAUNA / DROGE ZONE

Boomspiegel

- W-GE1-1
- B -NE4-2
- B -NE4-4
- B -OR1-3
- M -NE2-2
- M -NE4-3
- M -NE5-5

F-NE3-3
FLORA & FAUNA / DROGE ZONE

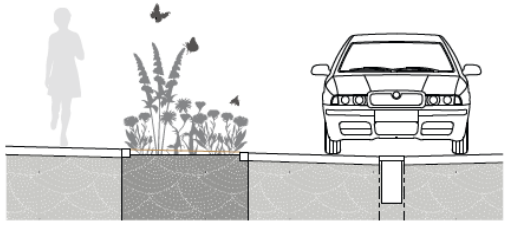
Wildernismuur



- E -GE2-1
- E -OR4-1
- M -NE4-1
- M -GB2-1
- M -GB2-3

F-NE3-4
FLORA & FAUNA / INFRASTRUCTUUR

Vlinder- en bijenidylle



- W-GE1-1
- W-GE3-2
- W-OR1-3
- W-OR2-2
- W-OR2-4
- B -NE3-1
- B -NE5-2
- B -NE6-1
- B -OR2-1

FLORA & FAUNA / GEBOUW

F-GB1

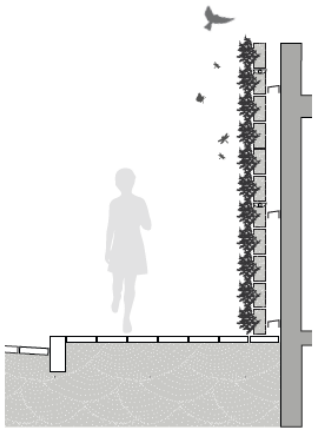
FLORA & FAUNA

Groene wand

Voor meer flora en fauna in de stad zijn groene wanden een relatief eenvoudig te realiseren maatregel. Ze bieden tot op grote hoogte mogelijkheden voor planten, insecten en vogels. Van de verschillende mogelijkheden is de Modulaire groene gevel (F-GB1-1) het meest ambitieus. Dit is een soort voorzetgevel opgebouwd uit bakken/cassettes. De planten wortelen niet in het maaiveld. De resultaten zijn vaak indrukwekkend. Dit type groene wand vergt soms wel een bevloeiingssysteem (bijvoorbeeld een waterdak waaruit water sijpelt). Bevloeiing is niet nodig als de groene wand in de vorm van duinvegetatie of rotsformaties wordt aangelegd. Een eenvoudige groene wand bestaat uit zelfhechtende klimplanten. Daarvoor zijn vrijwel geen voorzieningen nodig, mits de klimmers goed kunnen wortelen in de strook grond onder aan de gevel. Aandachtspunt is het kiezen voor klimmers die geen schade aanbrengen aan metselwerk, kozijnen of gevelplaten. Tot slot is het ook mogelijk om op de gevel een licht raamwerk (draad, hout) aan te brengen waar bepaalde klimplanten zich goed doorheen kunnen vlechten.

Een voorbeeld van **Klimplant op constructie / F-GB1-3** is: de gevels van Park 2020, Hoofddorp (DL1, p. 154).

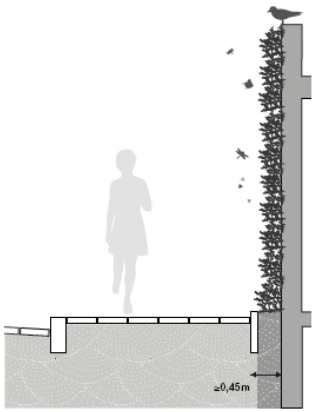
F-GB1-1
Modulaire groene gevel



- E -GE2 -1
- E -GE4 -1
- E -OR4 -1
- M -OR2 -1

FLORA & FAUNA

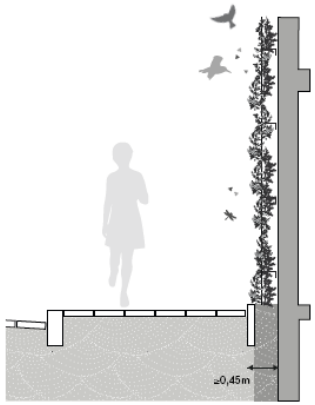
F-GB1-2
Zelfhechtende klimplant



- L -GB1 -1
- E -GE2 -1
- E -GE4 -1
- E -OR4 -1

FLORA & FAUNA

F-GB1-3
Klimplant op constructie



- L -GB1 -1
- E -GE2 -1
- E -GE4 -1
- E -OR4 -1
- M -GE3 -1

F-GB2

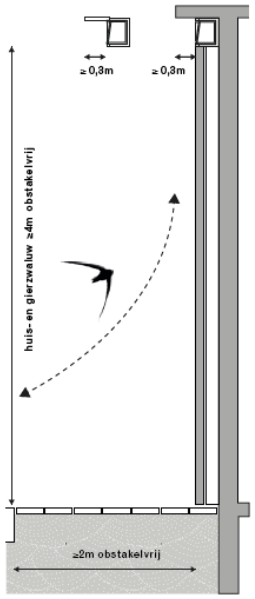
FAUNA

Verblijfs- en nestmogelijkheden

De aanwezigheid van verblijfs- en nestmogelijkheden maakt de omgeving aantrekkelijk voor verschillende soorten dieren. Gevels en daken zijn een goede plek voor de realisatie hiervan. Per doelsoort zijn er diverse modellen prefab-nestgelegenheden (inbouw en opbouw) op de markt. Bijvoorbeeld voor (gier)-zwaluwen en vleermuizen, soorten die al eeuwenlang bij Amsterdam horen.
Per soort gelden specifieke aanwijzingen over de beste plek, maar in het algemeen wordt afgeraden om de nestgelegenheden op pal zuid georiënteerde gevels (hitte) te plaatsen en nooit lager dan 4 meter van het maaiveld.
Voor insecten (waaronder bijen) zijn ook speciale nestgelegenheden ontwikkeld voor aan of in een gevel. Een vrijstaande optie is het insectenhotel (circa 150 × 150 cm) dat meestal op het dak wordt geplaatst en huisvesting biedt aan een scala aan insecten. Belangrijk is dat deze op een zonnige en windluwe plek staat, met een park of tuinen in de omgeving (voedsel foerageergebied).

Een voorbeeld van **Vleermuiskast / F- GB2-2** is: Wisseloord, Amsterdam.

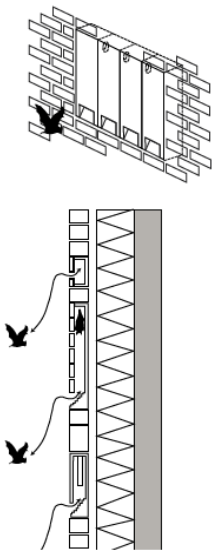
F-GB2-1
Nestkast



- L -GB1 -5
- L -GB3 -4
- E -GE2 -1
- E -GE4 -1
- M -OR1 -5
- M -OR1 -7

FAUNA

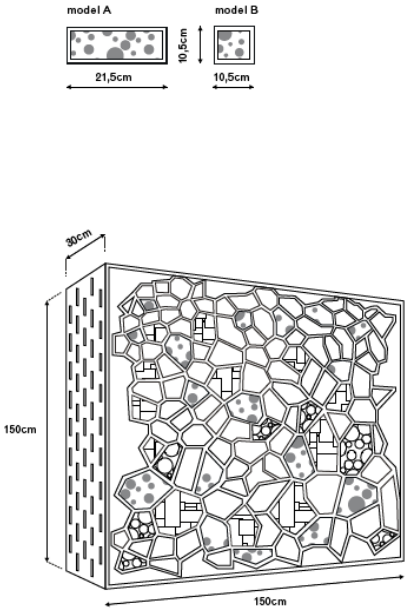
F-GB2-2
Vleermuiskast



- L -GB3 -4
- E -GE2 -1
- M -OR1 -5
- M -GB2 -3

FAUNA

F-GB2-3
Insectenhotel



- L -GB2 -3
- E -GE2 -1
- E -OR4 -1

F-GB3

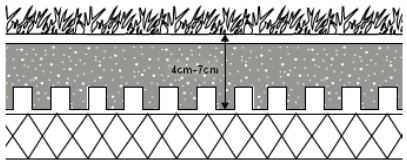
Natuurvriendelijk dak

Natuurvriendelijke daken bieden vanwege de opbouw waardevolle vestigings-plekken voor diverse planten en dieren en dragen zo bij aan de biodiversiteit in de stad. Afhankelijk van de opbouw van het dak zijn verschillende vorm van natuurvriendelijke daken toepasbaar. Bij groene daken varieert het van extensief met een dunne grondlaag tot intensief met een dikke grondlaag waarop zelfs bomen kunnen groeien. Zogeheten bruine daken bestaan uit een mengsel van zand, steentjes (puin), schelpen en soms boom-schors. Zulke daken bieden goede nestelplekken voor onder meer het visdiefje, scholekster en zwarte roodstaart. Tot slot is er de uitvoering als waterdak, die zich richt op aquatische (of moeras) organismen, vlinders en vogels, hierbij zakt regenwater door een laag substraat en vloeit deels gecontroleerd weg via een drainagesysteem (eventueel naar de groene gevels).

Een voorbeeld van een **Natuurdak / F-GB3-3** is: het dakpark op Vivaldi, hoek Barbara Strozzilaan/ Antonio Vivaldistraat, Amsterdam (DL1, p. 148).

FLORA & FAUNA

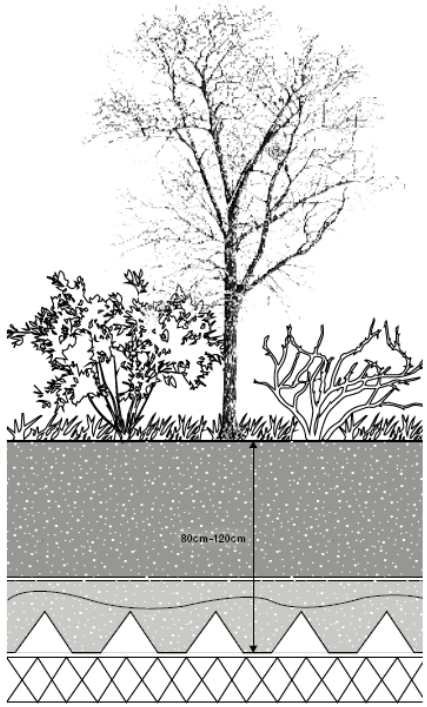
F-GB3-1
Extensief dak



- L -GB2 -2
- E -GE2 -1
- E -GE4 -1
- E -GB1 -1

FLORA & FAUNA

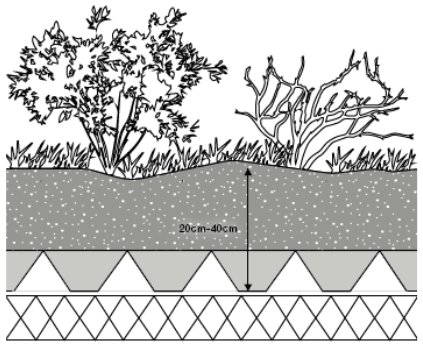
F-GB3-2
Intensief dak



- L -GB2 -1
- W -GB1 -3
- E -GE4 -1
- M -GE3 -1

FLORA & FAUNA

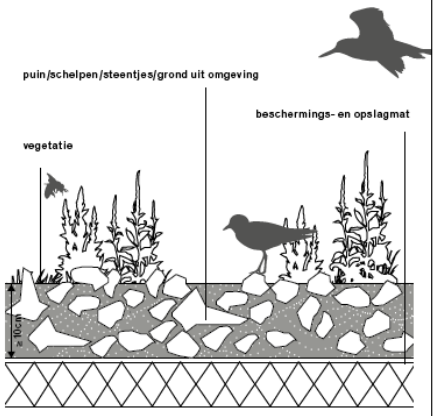
F-GB3-3
Natuurdak



- W-GB1-3
- E -GE4-1
- E -OR4-1
- M-GE4-3
- M-NE5-2

FLORA & FAUNA

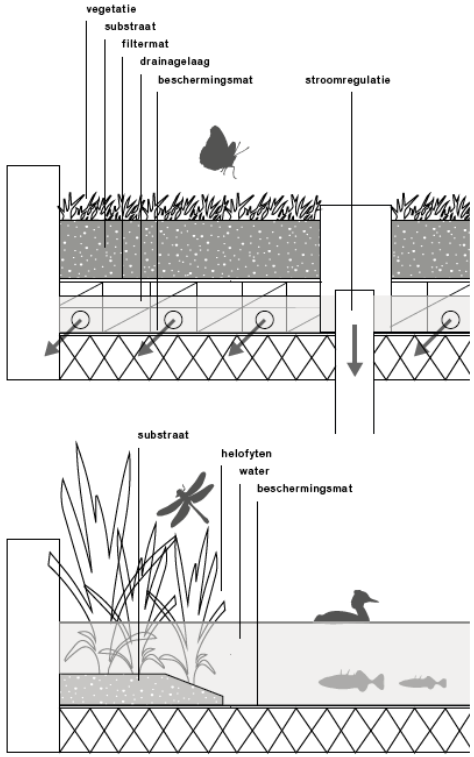
F-GB3-4
Bruin dak



- W-GB1-3
- E -GE4-1
- E -OR4-1
- E -GB1-1
- E -GB1-3
- M-GE3-2
- M-NE2-1

FLORA & FAUNA

F-GB3-5
Waterdak met beplanting



- W-GB1-3
- E -GE4-1
- E -GB1-1
- E -GB1-2
- M-NE9-4
- M-OR2-1

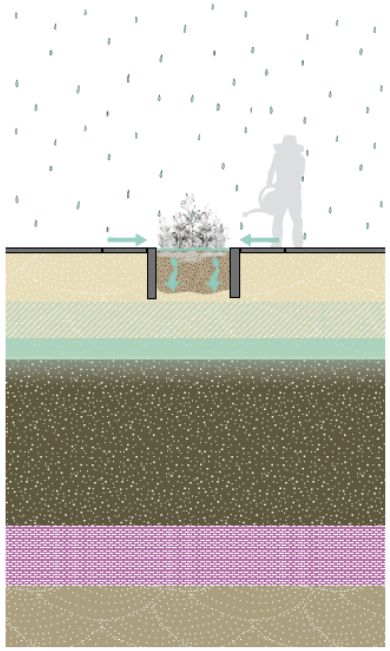
W-GE1

Vergroenen

Gebiedsbreed zijn er meerdere opties om het maaiveld, het oppervlaktewater en de regenwaterbehandeling te 'vergroenen'. In het algemeen is het erg effectief om niet meer verharding (asfalt, straatstenen) dan strikt noodzakelijk aan te leggen ten gunste van meer groen, oppervlaktewater of waterberging. Het oppervlaktewater (singels, sloten, vijvers, grachten) wordt ecologisch een stuk waardevoller met de aanleg van natuurlijke oevers in een flauwe helling. Zulke oevers worden ook visueel aantrekkelijker gevonden dan traditionele beschoeide oevers.

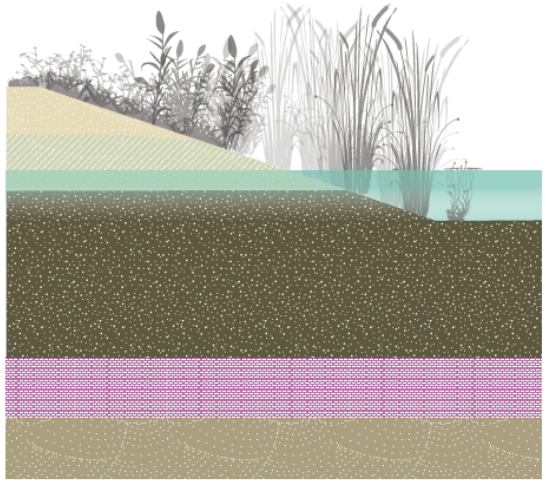
Een voorbeeld van **Natuurlijke oever / W-GE1-2** is: Haarlemmertrekvaart tussen Haarlemmerpoort, Amsterdam en Halfweg.

W-GE1-1
Verharding eruit, groen erin



- L -KA3 -1
- L -KA3 -3
- F -NE1 -1
- F -NE3 -4
- E -GB1 -2
- B -NE3 -1
- B -OR2 -1
- M -NE9 -2

W-GE1-2
Natuurlijke oever



- L -NE1 -2
- L -OR2 -1
- M -GE4-1
- M -GE4-2
- M -NE4 -2
- M -NE6 -3

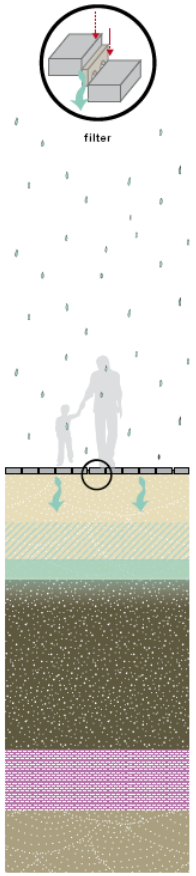
W-OR3

Infiltratie via verharding/maaiveld

Anders dan Watervast-houdend groen (W-OR1) en een Ondergronds infiltratie-stelsel (W-OR2) laten bepaalde typen verharding toe dat regenwater in de openbare ruimte kan infiltreren. Straatstenen of stoeptegels met daartussen strookjes viltachtig materiaal of holle ruimten bijvoorbeeld, laten water goed door. Dat geldt ook voor de bekende gras-betonstenen die hier en daar in parkeervakken of als bermversterking worden gebruikt.
Uiteraard laten gewone groene (gras)velden ook veel regenwater door.
Ook zachte of harde half-verharding is goed door-latend en geschikt voor extensief gebruik. Denk daarbij aan schelpen, houtsnippers en grind.

Een voorbeeld van **Gras-betonsteen / W-OR3-2** is: Science Park, Amsterdam.

W-OR3-1
Waterdoorlatende verharding



- L -OR4 -4
- M -NE1 -9
- M -NE1 -11
- M -NE4 -1

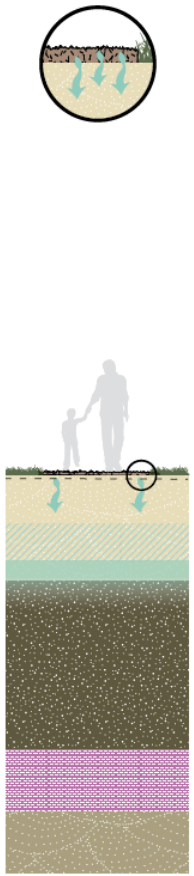
W-OR3-2
Grasbetonsteen

- L -OR4 -1
- L -OR4 -4
- M -NE1 -9
- M -NE1 -11

W-OR3-3
Groen veld

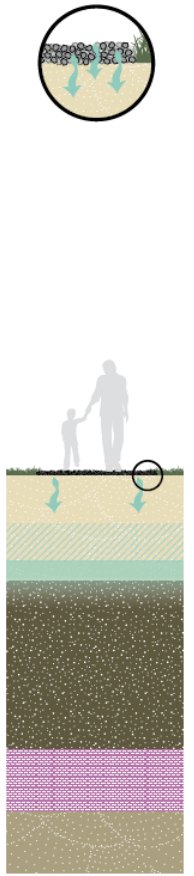
- B -NE3 -1
- B -NE3 -3
- B -NE3 -4
- M -GE4 -2
- M -NE5 -4

W-OR3-4
Zachte halfverharding



- L -OR4 -1
- L -OR4 -4
- F -NE3 -2
- B -NE3 -1
- M -NE5 -5

W-OR3-5
Harde halfverharding



- L -NE1 -2
- L -OR4 -1
- B -NE3 -1

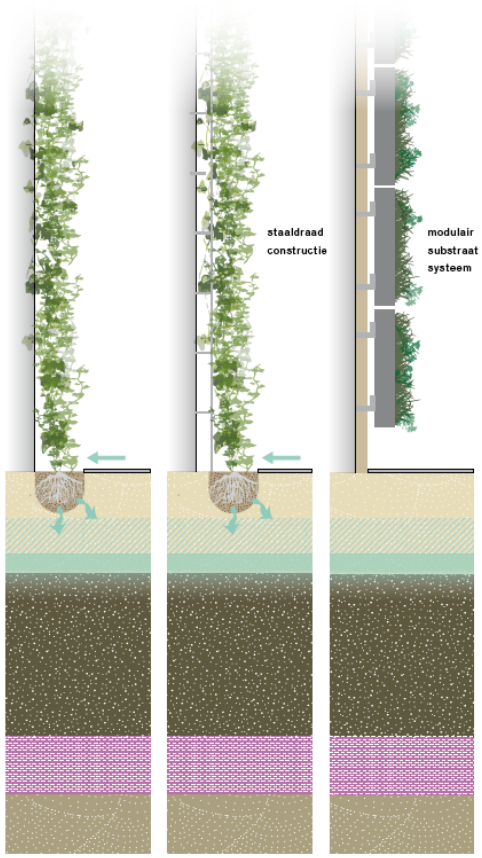
W-KA1

Groene wand

Op de grens tussen kavel en openbare ruimte zijn groene gevels en geveltuinen goede maatregelen om regenwater vast te houden, te verdampen en eventueel naar de bodem af te voeren. Een geveltuin, een strook opengewerkt trottoir langs de gevels van huizen, is een simpele lowtech-oplossing. Een randvoorwaarde voor eenvoudige groene gevels/wanden is dat de beplanting in het maaiveld kan wortelen. Daarnaast is een licht raamwerk aan de gevel (hout, staaldraad et cetera) waaraan de beplanting zich kan hechten erg handig. Geavanceerde groene wanden bestaan uit zware cassettes met substraat, die stevig aan de gevel zijn bevestigd. De beplanting in die cassettes vereist een automatisch bevochtigingssysteem. Een duurzaam watergeefsysteem maakt gebruik van het lekwater van een waterdoorlatend dak (zie W-GB1).

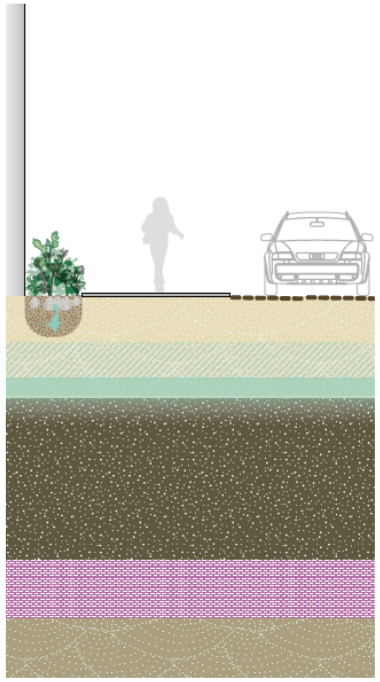
Een voorbeeld van **Groene gevel / W-KA1-1** is: GWL-terrein (tussen Van Hogendorpstraat, Van Hallstraat en Haarlemmerweg), Amsterdam (DL1, p. 95).

W-KA1-1
Groene gevel



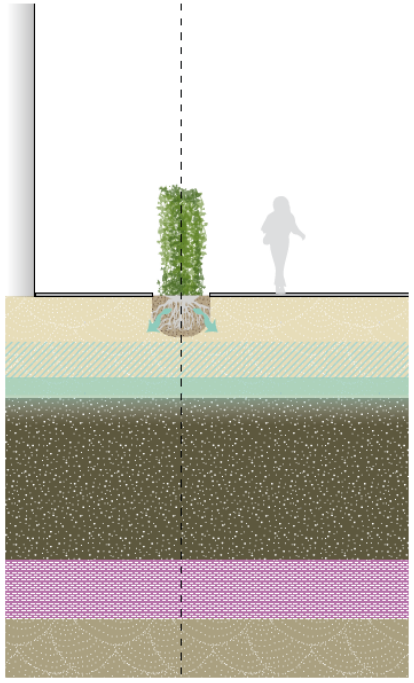
- L -OR1 -7
- L -GB1 -1
- L -GB1 -2
- L -GB2 -3

W-KA1-2
Geveltuin



- L -KA2 -1
- M -GE2 -1
- M -GE4 -3
- M -NE7 -1

W-KA1-3
Haag of struik



- L -OR3 -1
- L -GB1 -1
- M -NE5 -2

WATER / GEBOUW

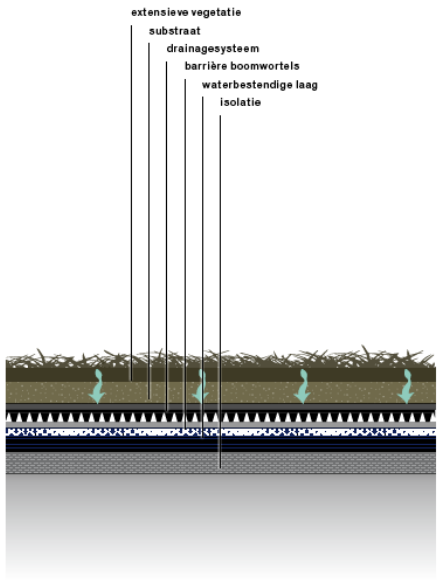
W-GB1

Watervasthoudend dak

Deze daken zijn ingericht voor groen of recreatie en kunnen lichte regenbuien vasthouden. Een extensief groen dak bestaat vaak alleen uit een dunne laag substraat met vetplanten zoals sedum als begroeiing. Een intensief groen dak heeft een dikte van circa 15-80 cm en is geschikt voor tuinieren en soms zelfs kleine bomen. Uiteraard heeft zo'n dak ook een fors gewicht dat constructief moet worden opgevangen. Bij recreatie op daktuinen staat sport, spel of een terrasfunctie voorop, maar de laag eronder is wel degelijk geschikt om water vast te houden. In elk van deze dakvormen ligt onderin een drainagesysteem met aansluiting op een hemelwaterafvoer, voor momenten van hevige en langdurige regenval.

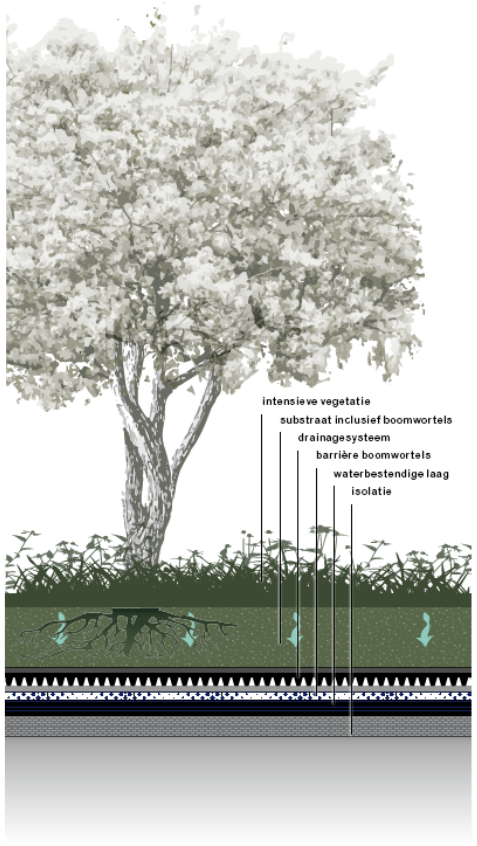
Een voorbeeld van **Infiltratiedak met recreatie / W-GB1-3** is: kantoorgebouw B. Amsterdam op de Johan Huizingalaan, Amsterdam.

W-GB1-1
Extensief groen dak



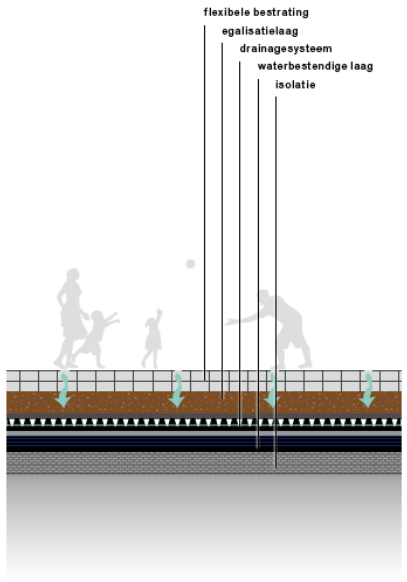
- L -GB2 -2
- E -GE1 -4
- E -GE2 -1
- E -GE4 -1
- E -OR4 -1
- M -NE5 -1
- M -NE6 -2

W-GB1-2
Intensief groen dak



- E -OR2 -2
- M -GB3 -1

W-GB1-3
Infiltratiedak met recreatie



- L -GB2 -2
- L -GB3 -1
- E -OR2 -2
- E -GB1 -1
- M -OR2 -1

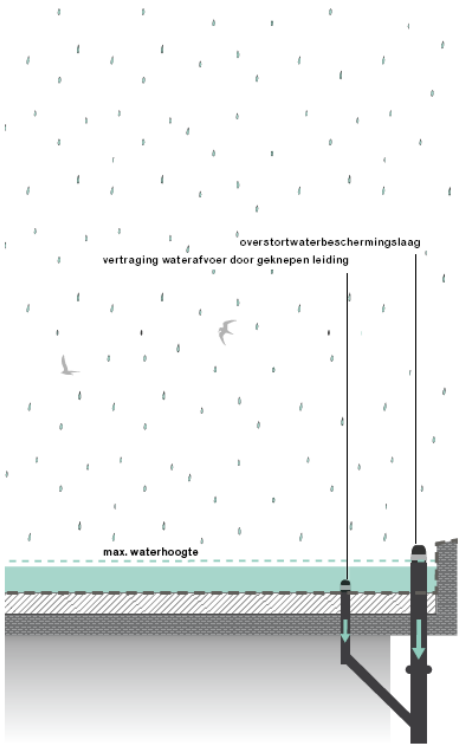
W-GB2

Hergebruik regenwater

Een vorm van duurzaam watergebruik is het gebruik van regenwater voor toilet-spoeling en het besproeien van de tuin. Een goed middel om regenwater op te vangen en tijdelijk vast te houden voor later gebruik, is een waterbergend dak. Er zijn verschillende vormen van waterbergende daken. De overeenkomst tussen de waterbergende daken is dat de dakranden verhoogd zijn zodat een ondiepe kuip wordt gevormd.
Een 'slim waterdak' lijkt op een gewoon groen dak, maar het substraat rust op een dikke laag kunststof kratten die veel water bergen. Beide dakvormen vereisen een zwaardere draagconstructie en een overloop naar de hemel-waterafvoer bij hevige en langdurige regenval. Regenwaterberging kan ook op of onder maaiveld-niveau plaatsvinden, bijvoorbeeld door het aanleggen van een regen-waterkelder. De eventueel aanwezige ruimte onder een helling naar een onder-grondse parkeerkelder is een kansrijke locatie. Is die loze ruimte er niet, dan kan een container (ondergronds of op een verdieping) dezelfde functie uitoefenen.

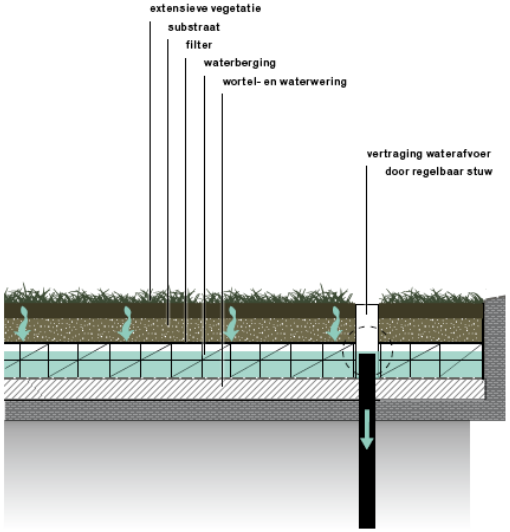
Een voorbeeld van **Water-dak / W-GB2-1** is: Artemis hotel, John M. Keynesplein, Amsterdam (DL1, p. 83).

W-GB2-1
Waterdak



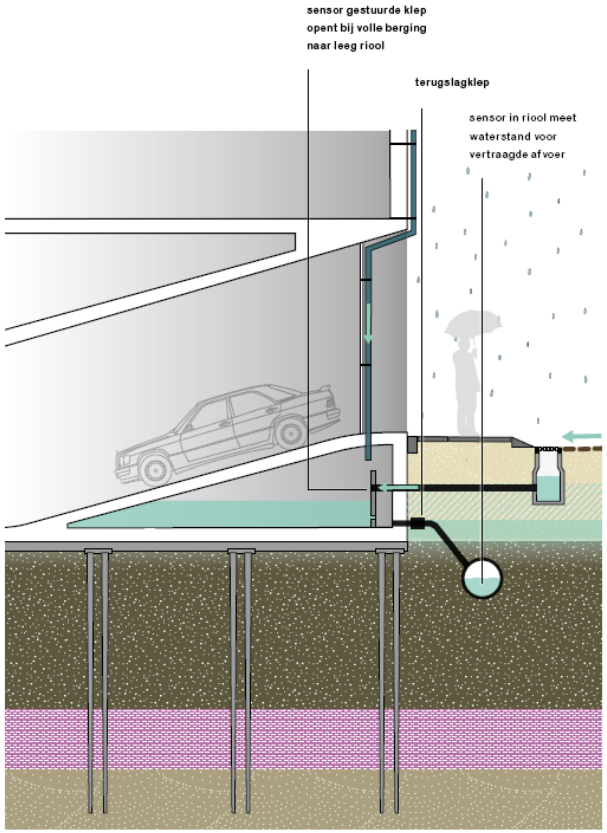
- L -OR1-4
- L -GB3-2
- E -OR2-2
- E -GB1-1
- E -GB1-3
- B -GE1-1
- M-GB3-1

W-GB2-2
Slim waterdak



- L -OR1-1
- L -GB2-2
- F -GB3-1
- E -GE1-4
- E -GE4-1
- E -OR2-2
- E -GB1-1
- B -GE1-1
- M-NE9-6

W-GB2-3
Regenwateropslag in kelder



- L -OR3-3
- L -OR3-4
- L -OR3-5
- M-GB3-1

LEEFMILIEU / GEBIED

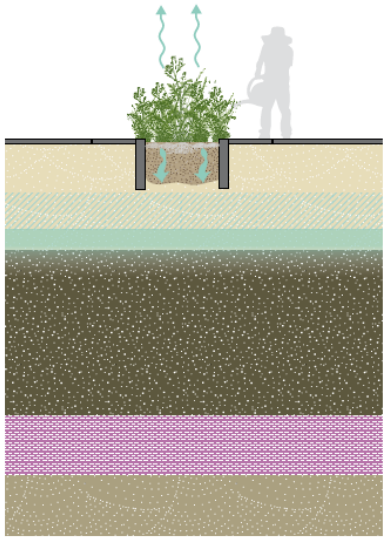
L-GE1

Beperken harde verharding

In steden draagt het grote oppervlak aan harde verharding (beton, asfalt, steen) in hoge mate bij aan het hitte-eilandeffect of 'urban heat island effect' (UHI), waardoor steden op zomerdagen sterk opwarmen. De verharding houdt die warmte lang vast, waardoor straten en pleinen nauwelijks afkoelen gedurende de nacht. De hittestress die hierdoor ontstaat, heeft een negatief effect op de leefkwaliteit op gebiedsniveau. Planten en bomen hebben een verkoelend effect. Ze verlagen de temperatuur doordat ze water verdampen en schaduw leveren. Het verdampen van water zorgt voor verlaging van de luchttemperatuur, schaduw zorgt vooral voor verlaging van de gevoelstemperatuur. Het is mogelijk om hittestress te verminderen door delen van de verharding achterwege te laten of te vervangen door groen. Dergelijke groenstroken zijn redelijk eenvoudig aan te leggen, maar vereisen wel bewatering in droge weken.

Een voorbeeld van vervanging van **Strookverharding door groen / L-GE1-1** is: de herprofilering Wibautstraat, Amsterdam (DL1, p. 149).

L-GE1-1
Strook verharding vervangen door groen



- W-GE2-1
- W-OR1-3
- W-OR2-2
- W-OR2-4
- W-OR4-2
- W-GB4-1
- F -NE3-4
- M -GE4-3
- M -NE5-4

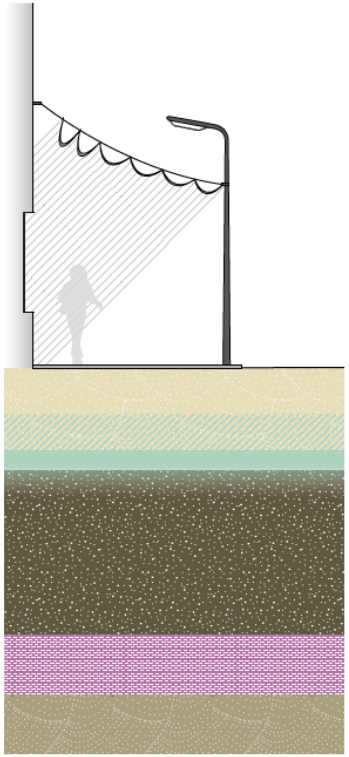
L-NE1

Beschaduwen (water)weg

In de stad is het met name het netwerk van straten, wegen en waterroutes waar zich veel bewoners en passanten bevinden.
Op hete zomerdagen kan hittestress vooral op deze routes, die meestal verhard zijn (zie Beperken harde verharding / L-GE1), een probleem vormen voor oudere, jonge kinderen, actieve wandelaars, fietsers en joggers. Het beschaduwen van deze routes is daarom belangrijk om een aangename gevoelstemperatuur te creëren.
Het plaatsen van straatbomen of van bomen aan de oever van waterwegen is uiteraard effectief, maar op sommige veelbezochte plekken is er ondergronds onvoldoende doorwortelbare ruimte. Dan kunnen kunstmatige schaduwelementen de gevoelstemperatuur lokaal verlagen; bijvoorbeeld door schaduwdoeken boven het trottoir.

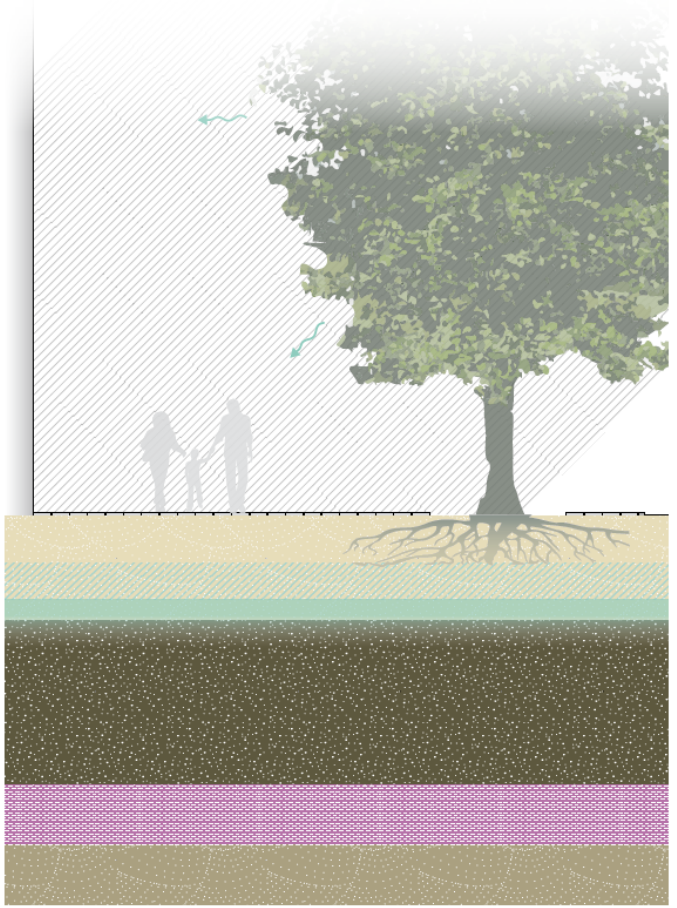
Een voorbeeld van **Boom in straat / L-NE1-2** is: Bert Haanstrakade, Amsterdam.

L-NE1-1
Schaduwdoek in straat



- W-NE1-2
- W-NE1-3
- W-OR4-2

L-NE1-2
Boom in straat



- W-NE1-2
- W-NE1-3
- W-OR1-4
- W-OR4-2
- M -NE3-4
- M -OR3-4

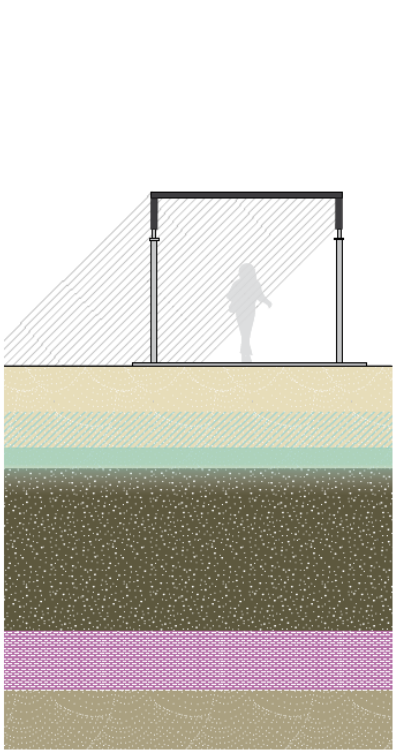
L-OR1

Schaduw door overkapping/groen

In straten, op pleinen, parkeerterreinen of in parken zijn er diverse manieren om hittestress te verminderen. Het basisprincipe is om schaduw te creëren en daarmee de gevoelstemperatuur te verlagen op plekken of looproutes waar mensen zich eventueel kunnen terugtrekken als de rest van de openbare ruimte te warm wordt. Die schaduw kan met kunstmatige middelen worden gemaakt, bijvoorbeeld met een vaste overkapping of flexibele overdekkingen. Het voordeel van een overkapping met getint glas is dat de ruimte eronder op grijze dagen toch aangenaam licht blijft.
Schaduw door groen is vaak effectiever, omdat bomen niet alleen schaduw geven, maar door verdamping de luchttemperatuur ook actief koelt. Boomgroepen hebben het meest effect. Door ze in gevarieerde soorten aan te planten, creëert zo'n groep daarbij verschillende gradiënten van schaduw, zodat mensen iets te kiezen hebben. Een groen alternatief voor bomen is een begroeide pergola boven een looproute, of een schuine groene wand, bijvoorbeeld bij een zitje.

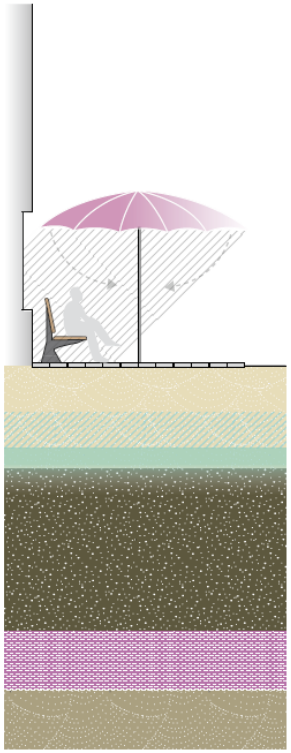
Een voorbeeld van **Vaste overkapping wandelroute / L-OR1-1** is: Stationsplein, Utrecht Centraal.

L-OR1-1
Vaste overkapping wandelroute

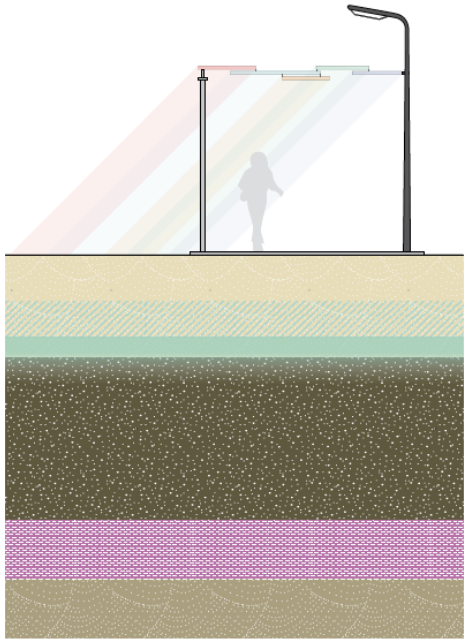


- W-NE1-2
- W-KA1-1
- F-GB1-2
- F-GB1-3
- E-GB1-1

L-OR1-2
Flexibele overdekking

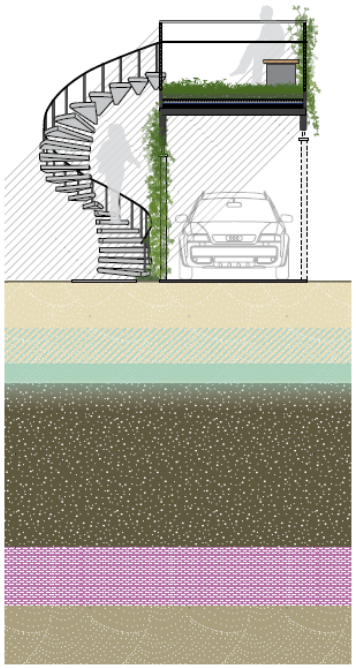


L-OR1-3
Vast gekleurd glasdak



- F-GB1-1
- F-GB1-2
- F-GB1-3
- E-GB1-1

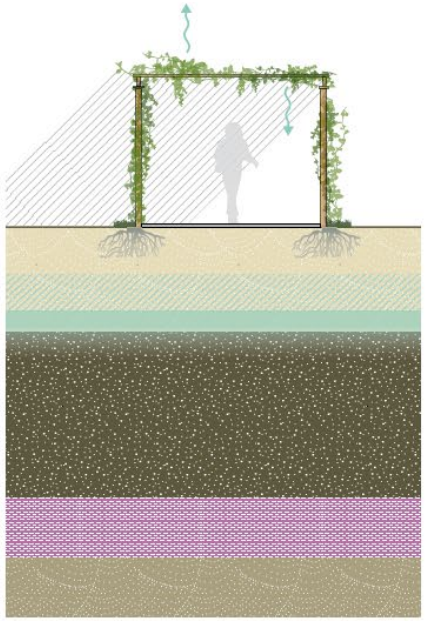
L-OR1-4
Overdekking parkeerplaats



- W-GB1-1
- W-GB1-2
- W-GB1-3
- W-GB2-1
- F-GB3-3
- E-OR3-1
- E-OR3-2
- E-GB1-1
- M-GB3-1

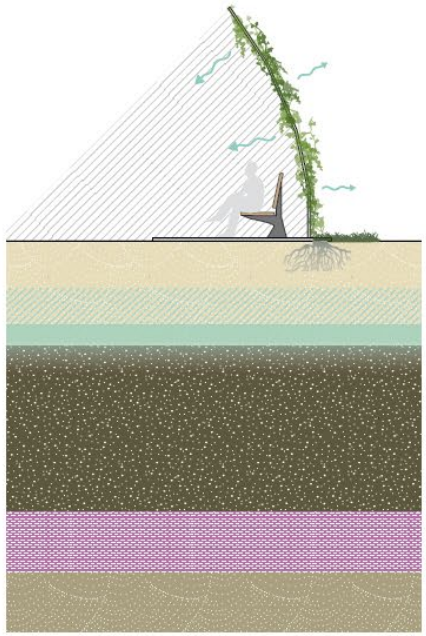
LEEFMILIEU / OPENBARE RUIMTE

L-OR1-7
Pergola



- W-OR3-1
- W-OR3-4
- W-OR3-5
- W-KA1-1
- F-GB1-2
- F-GB1-3
- M-NE6-2

L-OR1-8
Groene wandafscheiding



- W-KA1-3

L-OR1-9
Schaduwgradiënten door variatie in bomen

- W-NE2-1
- W-OR2-2
- W-OR3-1
- W-OR3-4
- W-OR3-5
- F-NE1-2

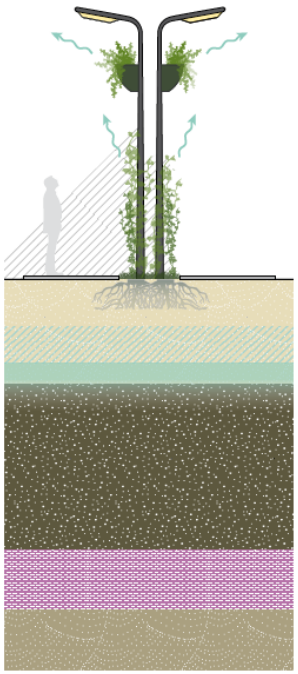
L-OR3

Verkoeling door verdamping

In de maatregel Schaduw door overkapping/groen (L-OR1) was het actief koelend effect van groen door verdamping een bijkomend pluspunt. In deze maatregel komen uitwerkingen aan bod waarbij verkoeling in de openbare ruimte door verdamping juist het hoofddoel is. Daarbij is onderscheid te maken tussen passieve koeling (verdamping) en actieve koeling. Uitwerkingen uit de eerste categorie zijn bijvoorbeeld vijvers met veel groen aan de oevers die veel water kunnen verdampen. Ook lichtmasten met groene klimplanten en plantenbakken verdampen water. Onder uitwerkingen uit de tweede categorie vallen maaiveldobjecten waarin water onder druk wordt gesproeid of verneveld. Denk aan kunstmatige watervalletjes, fonteinen en watermuren (afstromend water langs een muur). De meest intensieve vorm zijn waternevelinstallaties waarin mensen in een loopcorridor worden gekoeld door een fijne nevel van waterdruppels. Een tussenvorm tussen passief en actief koelen is het natsproeien van straten, waar de verharding wordt gekoeld door water, dat vervolgens verdampt.

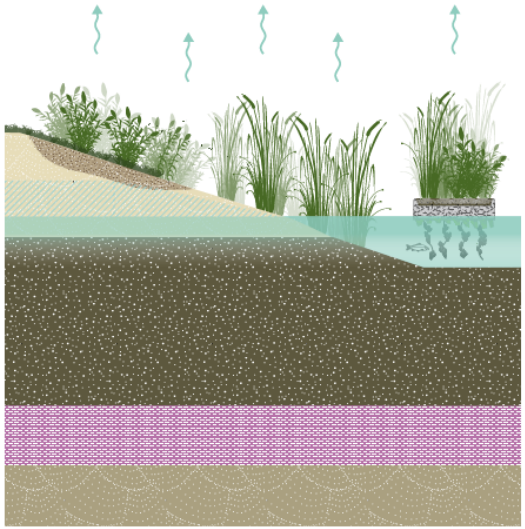
Een voorbeeld van **Fontein / L-OR3-7** is: de fontein in Rijksmuseumtuinen, Amsterdam.

L-OR3-1
Mast vergroenen



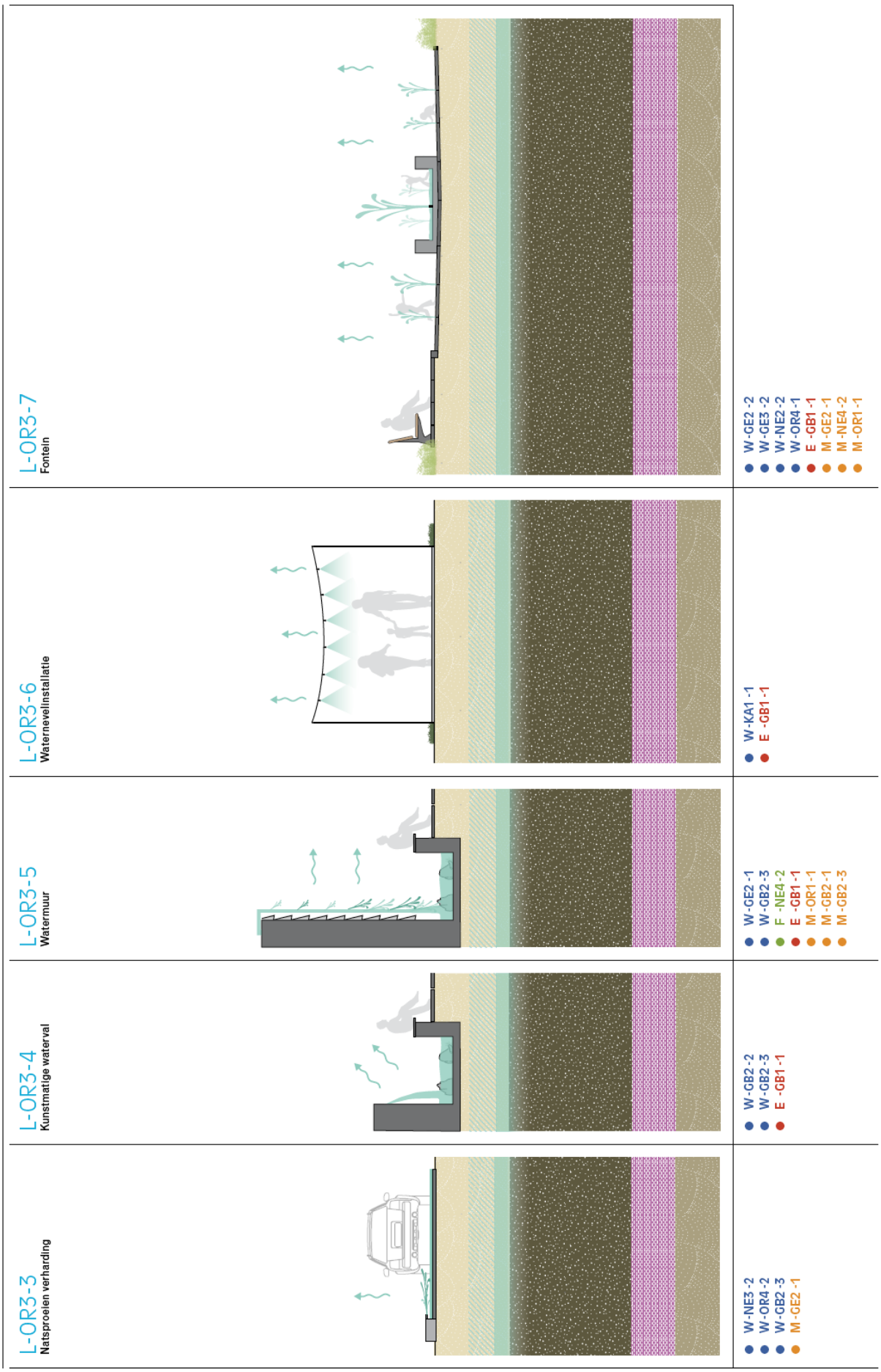
- B -OR3 -3

L-OR3-2
Groene vijver



- W-GE1 -2
- W-GE2 -1
- W-GE2 -2
- W-GE3 -1
- F -NE1 -2
- F -NE1 -3

A.



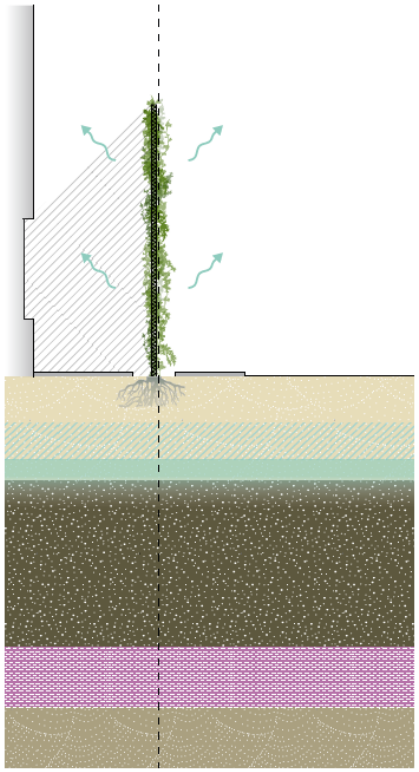
LEEFMILIEU / OPENBARE RUIMTE

L-KA3

Groene erfafscheiding

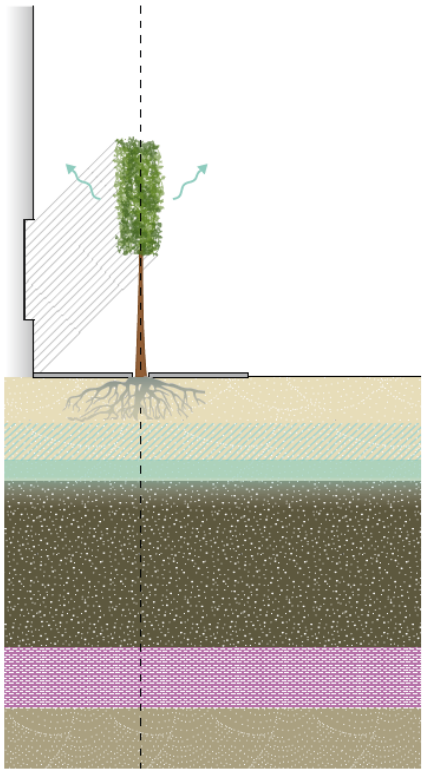
Tussen gebouw en erf-afscheiding kan het in de zomer erg heet worden, omdat gevels en bestrating langs de gevel de hele dag door de zon worden geblakerd en die warmte 's avonds langdurig blijven uitstralen. Dat heeft bij-voorbeeld tot gevolg dat het openen van ramen minder effectief is om de woning te koelen, omdat er een 'gordijn' van warme lucht rond het gebouw hangt. Groen in de vorm van een begroeide schutting, leibomen langs de gevel of een hoge haag zorgt voor meer schaduw en verkoeling door het verlagen van de gevoels-temperatuur langs de gevel, waar in elk geval de lagere etages profijt van hebben.

L-KA3-1
Begroeide schutting

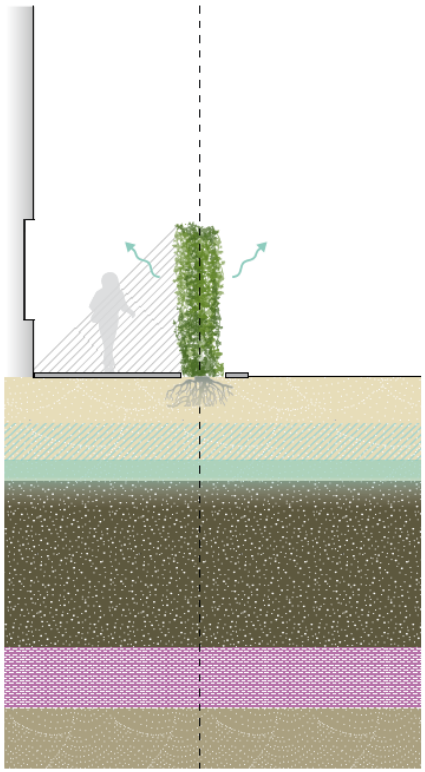


- W-OR1-3
- W-OR2-4
- W-OR3-1
- M-GB3-1

L-KA3-2
Leiboom voor gevel



L-KA3-3
Haag of struik

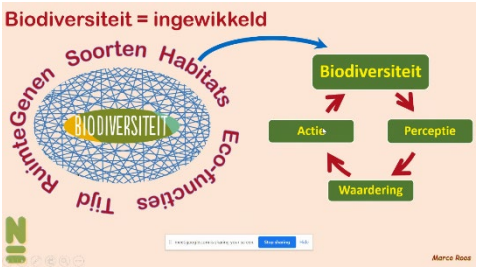


- W-OR2-4

A.5 Interview notes

Notes taken from feedback sessions with Marco Roos (Naturalis):

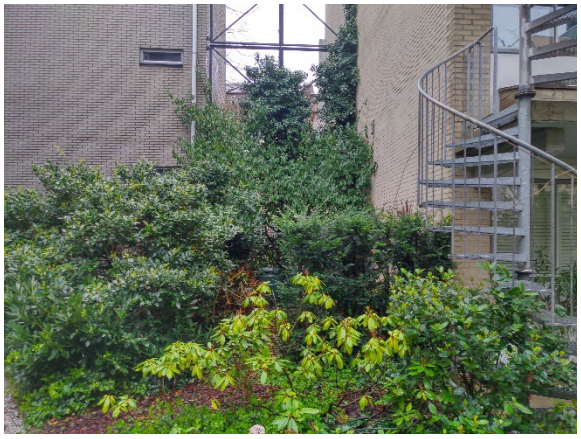
- Biodiversity is often used as a buzzword: actual effective implementation is much more than putting a tree in a public space.
    - Example: The Valley building in Amsterdam by MVRDV. Mostly unsustainable, dependable greenery that needs external watering and feeding in order to thrive.
    - A shift of perspective on what biodiversity entails is needed. Biodiversity is not necessarily pleasant, green, or aesthetic. For example, mosquitoes are as essential as bees.
    - Problem lies in current way of designing and maintaining greenery. Plants (e.g. trees on the side of the road) have fixed positions, no leeway allowed, which drives up maintenance costs. Monogamy in plant choice (e.g. all trees are the same species, oftentimes monogenetic) also causes disease and even more maintenance. Exotic species (e.g. the trees are originally from another continent) also means more maintenance. The need for immediate aesthetic throughout all seasons also limits plant diversity and creates even more monogamy in the ecosystem.
    - Plants are often seen as part of the aesthetic, but not as part of a complex ecological system.
- Nature cannot be designed for nor excluded from the design. It will always be there, in its desired form or not. What can be designed is a baseline that features favourable conditions for local plants to thrive and create a diverse flexible ecosystem that can take on draughts and heavy rainfall.
- Biodiversity is not exclusive from user experience, but should be combined
    - Both nature and people benefit from connections, this should be used as an opportunity to combine the two.
    - People must be educated about what biodiversity entails. Are colourful flowers really seen as equal to stinging nettles and weeds? If the perception changes, so does the appreciation, which sets to action, causing more biodiversity and more appreciation, like a positive feedback loop.
    - Small but simple implementations (e.g. a bowl of water, some deadwood or less weeding) already have big impacts.
- Good implementation of biodiversity on green roofs means the following:
    - A nutrient-poor substrate is, counter-intuitively, better for biodiversity. If the soil is too rich in nutrients, there is less diversity in plants, but biomass also accumulates which is dangerous for the construction.
    - Grass should be prevented, because then there is need for mowing. Sedum is maintenance free.
    - At the edges of the roof, there should be a boundary of maintenance heavy plants, to ensure safety.
    - Nutrient poor vegetation is good for both plants and insects. It does mean less lush greenery, but dune landscapes show how that kind of nature can still be aesthetically pleasing.
    - The focus of the design should be on different options rather than aesthetics.



Other interviews and feedback sessions:

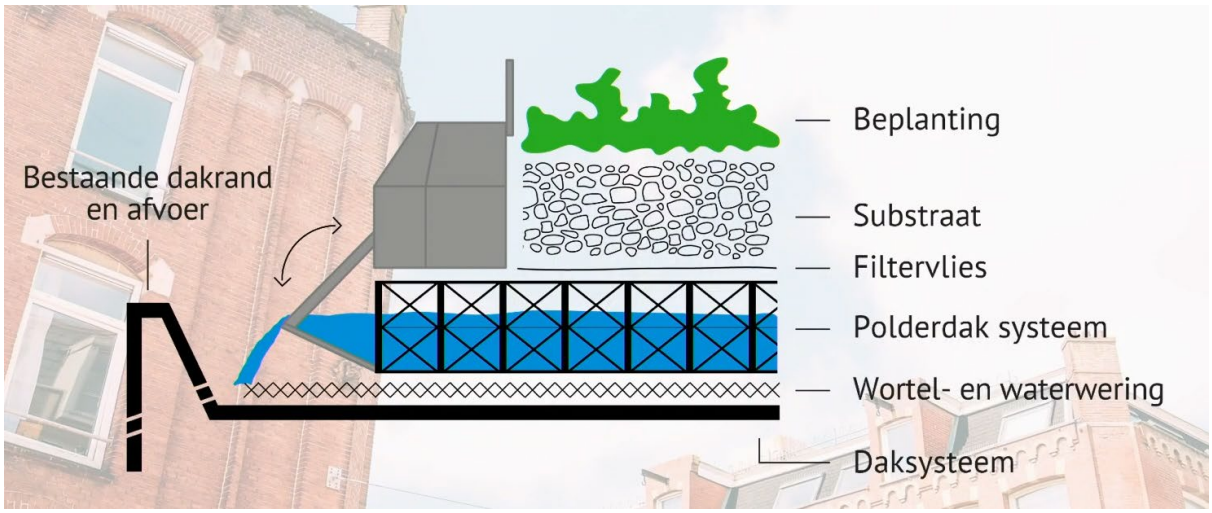
- Mirjam Koevoet, expert on sustainable area development, heat stress and rainfall
    - In the Netherlands, there is a 12% increase in deaths of susceptible people due to heat alone. The decrease in work productivity also has economic consequences. From scientific research, it turns out that the current waterways in Amsterdam contribute little to decreasing heat. Heat can be effectively decreased using ventilation, greenery, and creation of shades in the public space.
    - On the area of rainfall, the municipality of Amsterdam has a legally binding minimum of 60 mm per hour of rainfall to be captured on a building for all new developments in order to combat excess water runoff and overburdened sewers. This is the bare minimum. 120 mm per hour is considered climate change resistant. Using the principles of holding, storing, and releasing water, this can be achieved.
- Jan Henk Tigelaar, director of Rooftop Revolutions
    - Rooftop Revolution is one of the main leaders in changing the roof landscape, with a focus on greenery and sustainability. Multifunctionality is of major importance: not just solar panels or rooftop terraces, but also greenery.
    - To achieve this, they work with different stakeholders: residents, owners of office buildings, and social housing. Each design is based on a context, there is no standard solution easily fitted on every one of these buildings. The focus is on green, yet sometimes the wishes revolve mostly around aesthetics. The most important reason for anyone to work together with Rooftop Revolutions is climate adaptation, which biodiversity is often seen as a part of.
- Fanny Ruth, part of 3W Real Estate, the developer of the renovation of Amsterdamse Poort
    - The current designs show different green hubs in the centre of buildings, connected using the air (birds and flying insects). The decision has been made that this is the most feasible way of connecting the ecological network, so that is why there are no physical connections.
    - 3W has seen different results from participation session than the thesis, claiming that not everyone wants more greenery. The main reason for this is that residents in social housing often do not have the time to care for the public space.
    - There is need for a certain flexibility in design: it is important not to force users into a certain way of living. If users are allowed to try something new out, chances of success increase as appreciation is being built up.
    - The Amsterdamse Poort already features connectivity on a 3D level, however this causes some problems regarding safety. Since the walkways are all publicly accessibly throughout the day and night, they are hotspots for criminal activity and hence unwanted and unsafe. The new design removes this connectivity.
- Ruwan Aluvihare, architect for the city of Amsterdam and pioneer of accessible green roofs
    - Around 30 years ago, in an apartment building in Amsterdam, a green roof was built. With only 250 kg/m2 as maximum capacity, resulting in around 25 cm of substrate above a protective layer and artificial ground water layer, an accessible green roof is realized that looks just like a small park.
    - The rooftop park design was originally meant to consist of sedum alone. This new design shows how, with long-term investment and expertise, even without the currently assumed necessary support, an accessible green roof can be realized.
    - There are some aspects that could be improved. The locations of plants are still very much part of a fixed design. The acacia trees planted are growing too large, and because they are not located

underneath a supporting pillar, must be heavily pruned or simply cut down. The garden features a sprinkler system, making it dependable on an external water source. Still, this green roof shows much more is possible on a small layer of substrate than originally thought.



- Jorine Noordman, part of the municipality of Amsterdam and expert on nature inclusive developments
    - The city of Amsterdam already tries to create incentive for developing and building in a nature inclusive way. It does this using a point system, setting a minimum of points necessary for the development to take place. Developers can earn points by including nature inclusive properties, e.g. a green roof or nestling opportunities. However, it is important to implement this in a diverse way and prevent everyone using the same cheap but effective measures (e.g. nestling opportunities for bats), which misses the point.
    - One pitfall is to constantly renovate buildings and public space, creating nuisance for residents and costly projects. This should be preventable by designing the public space in a sustainable manner, however it is impossible to predict the future, and there will always be unforeseen consequences that affect the public space and creates different needs (e.g. how the corona crisis affected offices).
    - Native plants may sound like an easy fix for designs, however it is not as straight-forward as one might think. Plants, like humans, have different genes and families, and it is very difficult to find the right plants with the right genes for the local area at plantations. Because of the increased awareness, the demand for these plants also increases, straining those plantations and driving up costs. The knowledge for these plant choices also simply is not available for most developers and designers, even the ones that try to create sustainable solutions.
    - The core of the problem is short-term thinking: people want lush greenery as soon as the building is done. This results in plantations working overtime and high maintenance costs. If designers can work with seeds taken from the local area, the resulting greenery will over time become much more native and so sustainable.
- Sacha Stolp, innovation engineer at the municipality of Amsterdam
    - Biodiversity and people do not go well together. They should be separated so that people can not disturb the peace necessary for nature to thrive.
    - Allowing people to access the roof means lots of intensive maintenance and safety issues. This is often not worth the investment. It would be best to keep the functionality of people and nature strictly separated.

- Roofs are great places for storing rainwater, combining blue (water storage) roofs with green and yellow (solar panels) roofs. This is much more feasible than making it accessible to users (red roof).
- One example of this is Project Resilio, which makes use of a smart system that detects when rainfall will occur and empties water storages accordingly to catch excess rainwater during heavy storms. Pilots of this are already developed and it is clear that there is a lot that needs to be figured out for this to be effectively implemented on other roofs.



- Neumine Marshall, chairman of a residents committee in the Bijlmer area
  - The green spaces are used extensively. There are various places where residents can garden themselves, especially where there are flats (and therefore no private gardens). They are just really used. The courtyard gardens, especially when the weather is nice, are actually used by all age groups. There are young families whose children play there, there are older people who come together. There are also gardens where you can grow your own vegetables. That is very popular.
  - The people, generally the elderly, really know a lot about various plants and everything else in terms of flora and fauna. That is because the Surinamese community is very large here, and there is of course the rainforest and a lot of nature. The Surinamese people in particular are aware of plants, vegetables, and that they also love the diversity in itself.
  - If the roof garden is located on a house, then only make it accessible to the residents concerned. Roof gardens located on the retail properties can generally remain open. However, with a specific registration system so that it can be traced who has been where and when. With a possibility to grow vegetables and fruit because that is really a must here. Everyone wants an edible garden in Southeast. People love colour here.
  - People love art, but then it is important that it comes from someone who is originally from Zuidoost. It is also important, just like in the Nelson Mandela Park, it must have a black power philosophy. A reflection of the people who actually live here.
  - People like to constantly emphasize that we live in poverty all the time. Of course, there is poverty and there are people with social assistance benefits, but there are also plenty of people with good jobs and a good income. It is emphasized that we live in poverty here and that is very unfortunate.
  - People are really willing to take care of their gardens. The vegetable gardens and municipal gardens are so incredibly popular. As long as residents are informed that it is their garden and they are allowed to do what they want and that they can/should maintain it, people will do it. They just need to know. To

some extent, the municipality can provide a number of gardening supplies. If there's one thing people love here it's gardening.

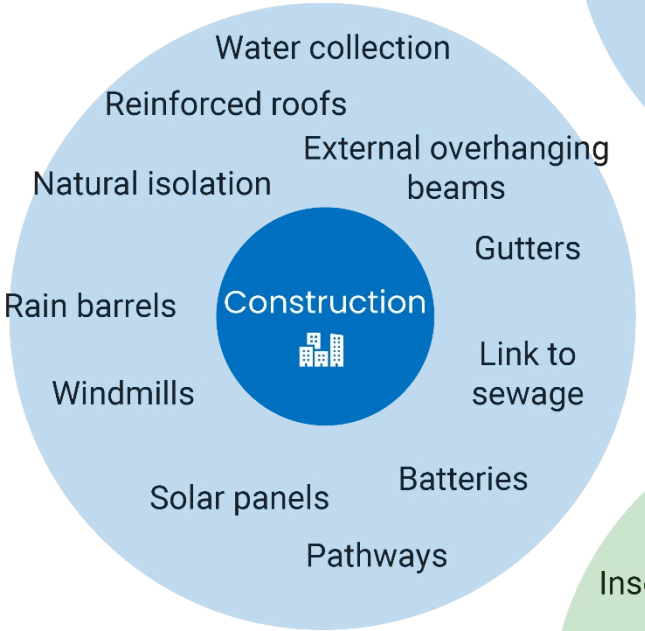
- The Surinamese community is number 1, then you have the African community. Especially the Ghanaian, Nigerian, etc. just go down the list. Then come the Antillean communities, then the Dutch, and from then on come the people with Islamic backgrounds. The Surinamese, African and Caribbean communities in particular are by far the largest.
- People do feel safe in the Amsterdamse Poort, but they no longer find it attractive to shop and live nearby. It would be nice if there were more shops that would benefit us as residents. It is now somewhat touristy. It is nice for the people from the offices to eat here, but the residents themselves are hardly there anymore.
- People would like a bigger H&M, a Primark and a Zara, some other supermarkets. A little more variety so that you no longer have to go to the centre for shopping.
- The Bijlmer is still largely black. Many people come to the Bijlmer to live among your own people. In Zuidoost you actually experience very little racism because everyone is of a different origin.
- Black people have a different way of life. We spend a lot of time outside when the weather is nice, we like music and parties. Now it is never complained about, but that could change. The neighbourhood will be laundered, we will soon no longer be able to be ourselves, the houses will become more expensive, these are things that people are concerned about.
- Trust in the municipality is very low. They feel that they are being left out because the houses being built now have very high prices. In certain situations, you are no longer eligible for an owner-occupied home. The promises made by the district are not fulfilled.

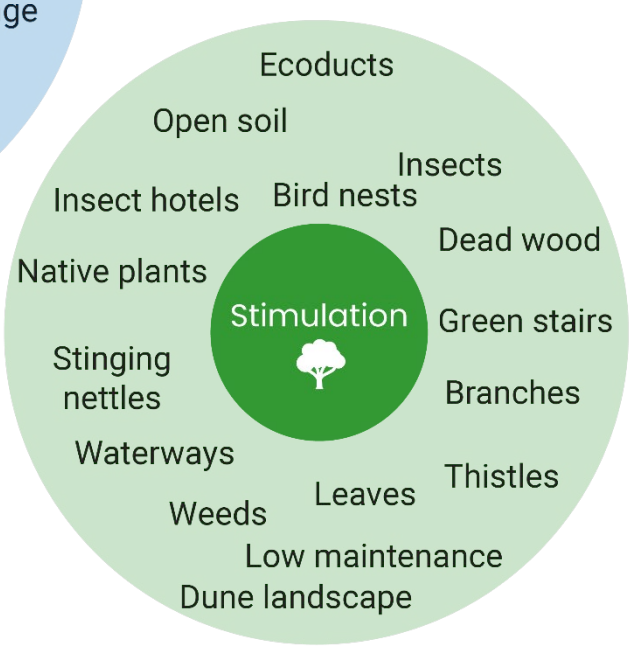
A.6 Ideation mood boards & mind maps

A.


Advertisements
Calling
Letters
Social media
Websites
Emails
Communication
Providing gardening tools
Locks
Apps
Neighbourhood house
Questionnaires
Surveys


Stairs
Escalators
Elevators
Ramps
Overpass
Fencing
Accessibility
Locks
Entrances
Exits
Shop locations ("plinten")
Cycling roads


Water collection
Reinforced roofs
External overhanging beams
Natural isolation
Gutters
Rain barrels
Construction
Link to sewage
Windmills
Batteries
Solar panels
Pathways


Ecoducts
Open soil
Insects
Insect hotels
Bird nests
Dead wood
Native plants
Stimulation
Green stairs
Stinging nettles
Branches
Waterways
Thistles
Leaves
Weeds
Low maintenance
Dune landscape

A.7 Design Dilemmas

"The users should have freedom in giving meaning to the public space"

+ Autonomy

- Chaos

"The environment should have all the space it needs to fully restore."

+ Sustainability

- Unpredictable

"The public space should be efficiently designed and managed."

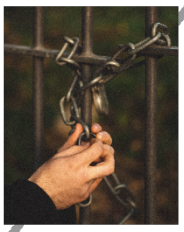
+ Efficiency

- Controling

"I want a safe and peaceful public space suited for my own needs."

+ Social cohesion

- Inaccessible



"I want a nice view and accessible walk-ways for during my lunch breaks."

+ Accessibility

- Uninteractive

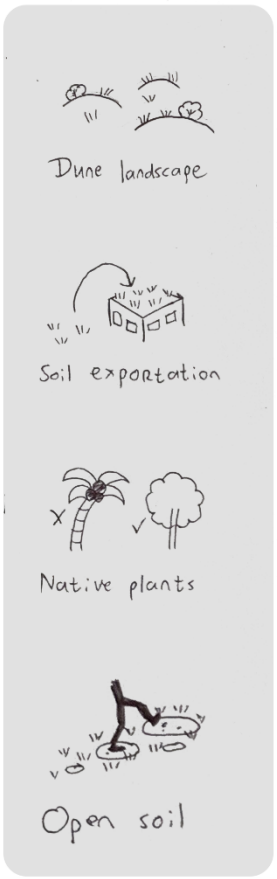
"I want an exciting public space with lots of things to do and experience."

+ Exciting

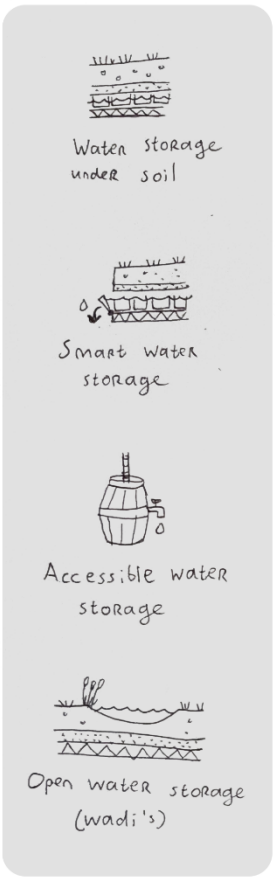
- Busy

A.8 Design Blocks

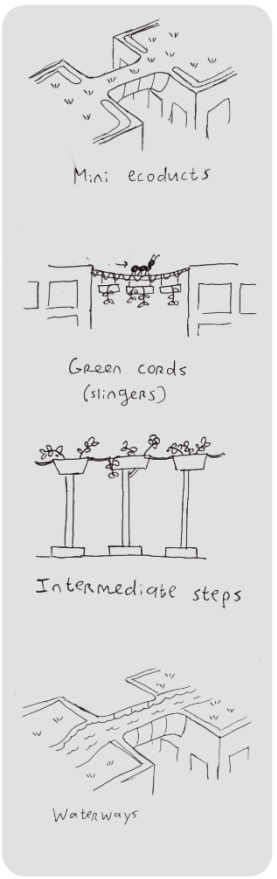
Resilient nature



Water storage & availability



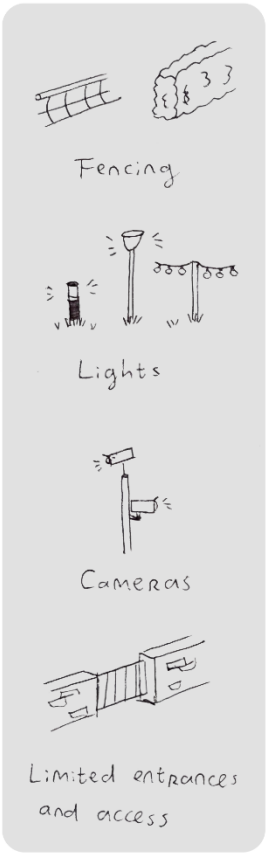
Horizontal connectivity



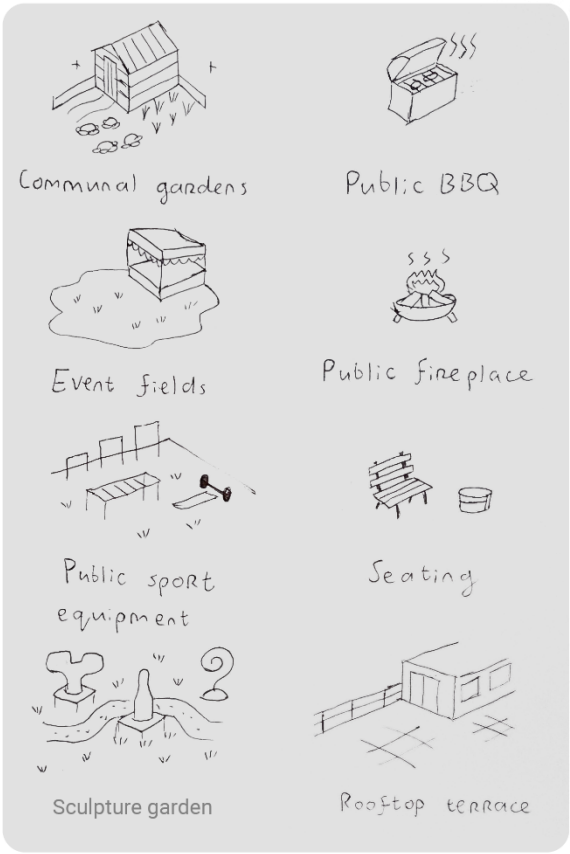
Vertical connectivity

Mobility

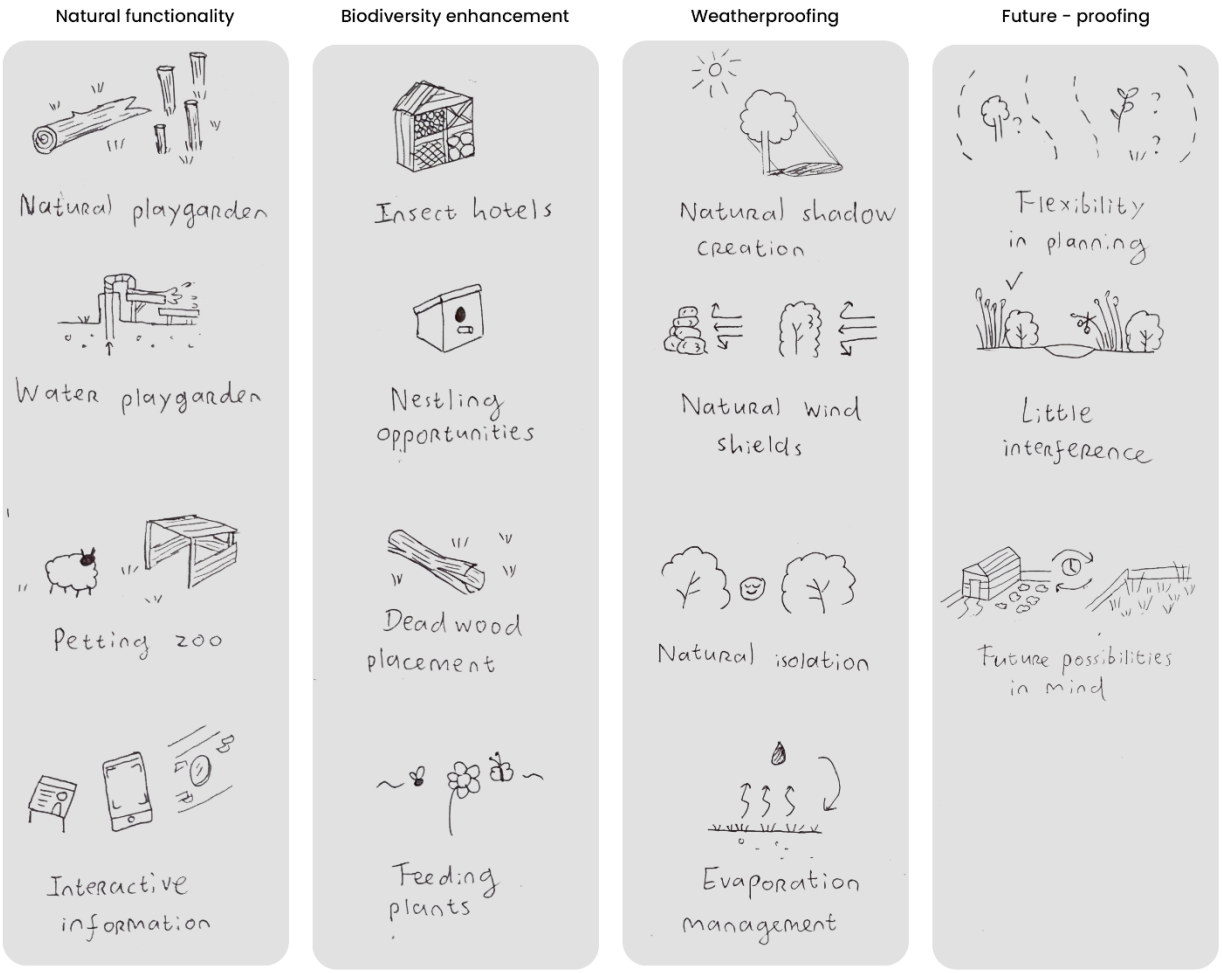
Safety



User functionality



A.


Natural functionality
Natural playgarden
Water playgarden
Petting zoo
Interactive information
Biodiversity enhancement
Insect hotels
Nestling opportunities
Dead wood placement
Feeding plants
Weatherproofing
Natural shadow creation
Natural wind shields
Natural isolation
Evaporation management
Future - proofing
Flexibility in planning
Little interference
Future possibilities in mind

MOBILITY / NETWORK

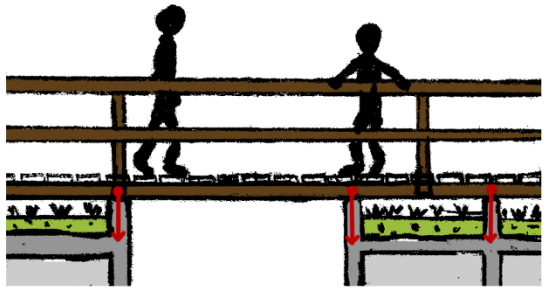
M - NE1

Elevated walkways

elevated walkways, is a way of connecting different pathways on different levels. They are non-intrusive in their construction, using fixed points of contact with the building construction. This property can help in distributing the load of such structures to strong points in the foundation of the building, making roofs visible without them necessarily needing to support people on every spot. They can serve as attraction, providing people with a nice view, while leaving the vegetation alone.

M - NE1 - 1

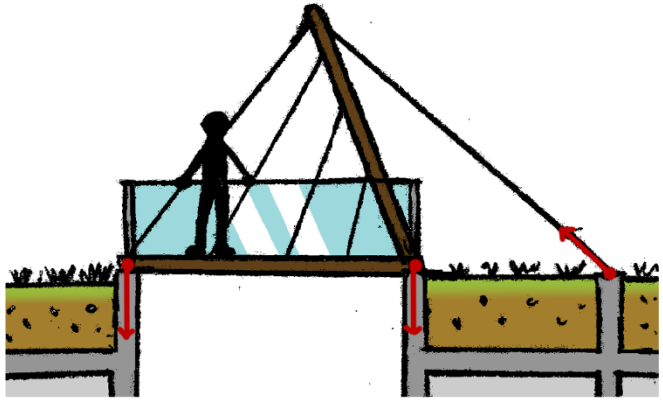
Wooden walkboards above ground



- F - NE2
- W - OR3

M - NE1 - 2

Suspended bridges



- F - NE5
- G - KA1

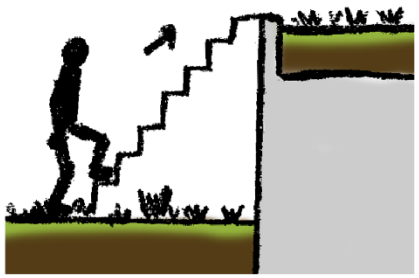
M – KA1

MOBILITY / SITE

Vertical accessibility

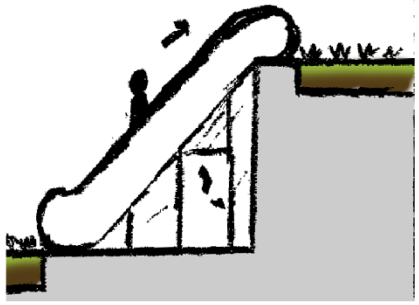
Vertical accessibility focusses on getting users to elevated areas. This is an important aspect for a rooftop park, as it makes them easily accessible in a safe way for a large audience. These vertical connections can be combined with vertically growing greenery so that a natural network is created as well. This adds more functionality to the vertical access point. An example of this can be found in the design proposal

M – KA1 – 1
Stairs

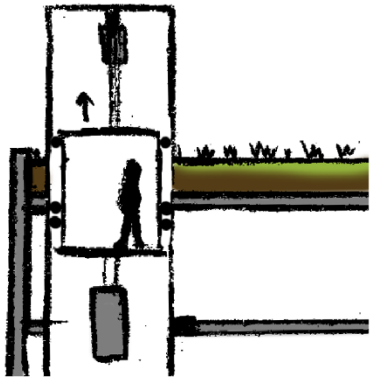


- F - NE2
- F - GB1
- W - KA1
- L - OR3
- G - GB1

M – KA1 – 2
Escalators



M – KA1 – 3
Elevators



- G - GB1

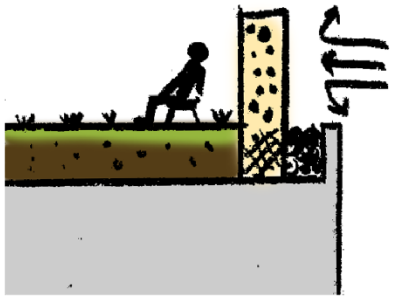
L - KA4

Wind shields

The wind shields are needed on roofs that have no environmental shielding against the wind, to protect both the present vegetation and users. Adding wind shields to the roof increases safety and makes the overall experience more pleasant. The wind shields should become part of the 3D greenery, as they provide great opportunity for the creation of new micro habitats or shelter for small wildlife. They can also act as division between certain areas with different functionalities or goals, for example between busy grass fields and more isolated green hubs.

L - KA4 - 1

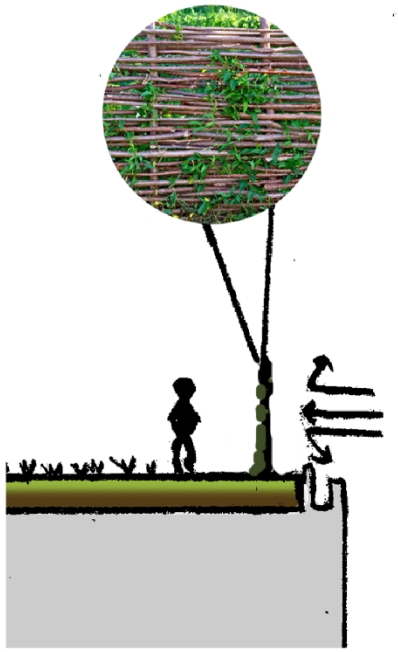
Natural stone (porous) wall



- F - GB1
- F - GB2
- L - OR1
- L - KA3
- G - OR1
- G - GB1

L - KA4 - 2

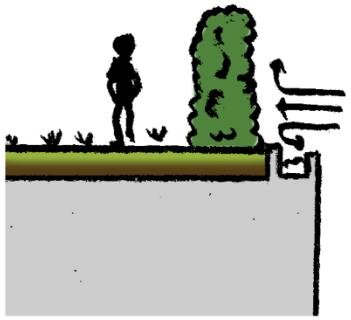
Wooden (willow) fences



- F - GB1
- F - GB2
- L - OR1
- L - KA3
- G - OR1

L - KA4 - 3

Hedges



- F - GB1
- F - GB2
- L - OR1
- L - KA3

FLORA & FAUNA / WHOLE AREA

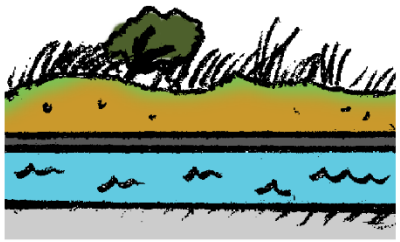
F - GE1

Resilient soil

Resilience means a soil that needs little maintenance to sustain itself and adds to local biodiversity in a sustainable way. A resilient soil can be realised by creating intentionally oligotrophic conditions, meaning that there are little nutrients present in the soil. Although this sounds contradicting, it actually increases local biodiversity as there is no dominant species overtaking all others . It also means that anything that grows on top of such soil will inherently be able to better withstand harsh conditions like draughts. To kickstart healthy soil on top of isolated green roofs, inoculation can be used to create favourable starting conditions.

F - GE1 - 1

Dune landscape (nutrient poor)



- F - GE2
- F - NE2
- F - GB3
- W - GE1
- W - OR3
- W - GB2
- L - GE1
- L - GB2
- G - OR1
- G - OR3
- G - OR4

F - GE1 - 2

Soil inoculation / exportation

- F - GE2
- F - NE3
- F - GB2
- F - GB3
- W - GE1

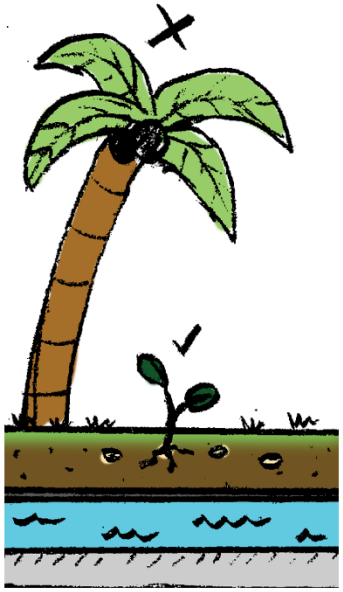
F - GE2

Resilient plants

Thiis measure focuses on the vegetation, which should consist of resilient plants. When designing a green space that is to be beneficial to the local environment, the plants should be part of it and stay alive without much nutrition. This can be best achieved by giving the environment plenty of leeway to grow as it pleases, creating and sustaining itself without need for costly maintenance or planning

F - GE2 - 1

Native plant selection



- F - GE1
- F - NE3
- F - GB2
- F - GB3
- W - GB2

FLORA & FAUNA / NETWORK

F - NE5

Physical connections

This measure focuses on cre-ating a natural network by using connections, be-tween both horizontally and vertically aligned green hubs. These connections create opportunities for both plants, insects, and even small wildlife to trav-erse between green spaces, increasing flexibility and strength of the local ecosystem. The complexity of a connection can range from non-intrusive structures like ropes to stepping-stones or small ecoducts.

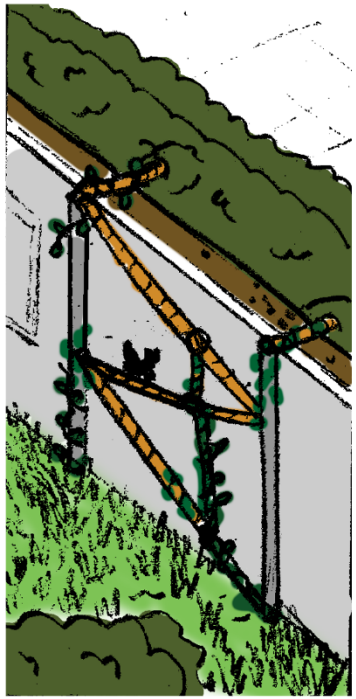
F - NE5 - 1

Cords (horizontal)

- F - NE2
- F - GB3
- M - NE1
- G - KA1

F - NE5 - 2

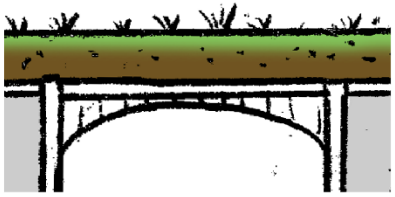
Ropes / net (vertical)



- F - NE2
- F - GB3
- G - OR1
- G - KA1

F - NE5 - 3

Ecoducts

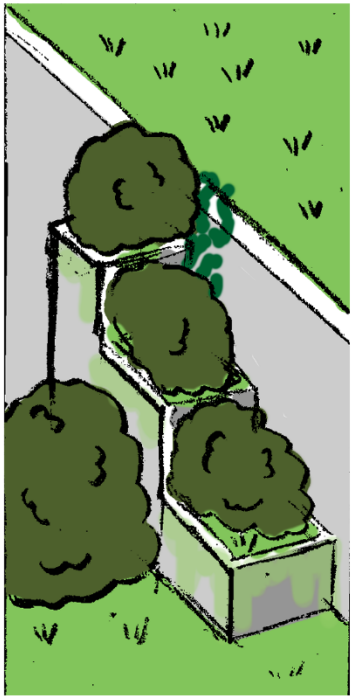


- F - NE2
- F - NE3
- F - GB3
- W - GE1
- M - NE1
- G - KA1

FLORA & FAUNA / NETWORK

F - NE5 - 4

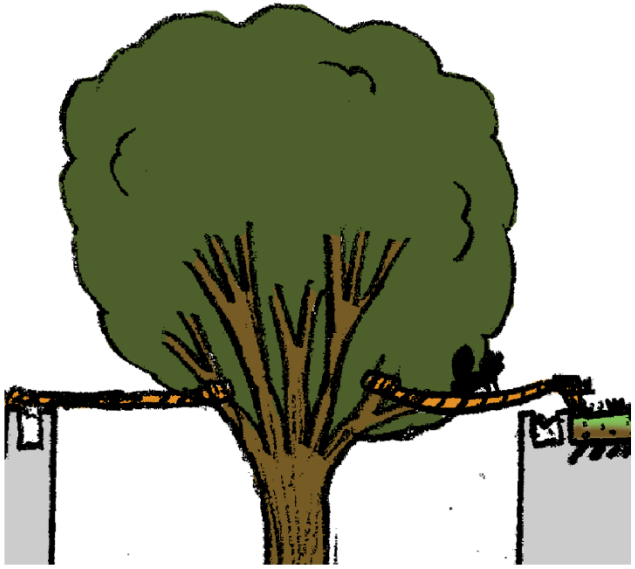
Stepping stones



- F - NE3
- F - GB1
- F - GB3
- M - KA1
- G - OR1
- G - GB1

F - NE5 - 5

Using trees & tree tops



- F - NE2
- F - GB2
- F - GB3
- L - NE1
- L - OR1
- M - NE1
- G - OR1
- G - KA1

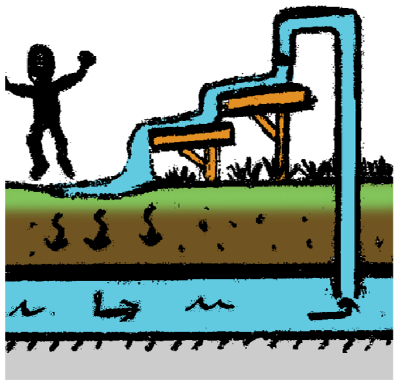
USER FUNCTIONALITY / PUBLIC SPACE

Natural play facilities

As part of 3D greenery, natural play facilities offer great opportunity for recreation and education of younger users. Natural playgrounds are favoured over artificially designed versions as natural ele-ments are better for the development of children into adulthood. For example, water is one of the most interesting natural elements that are part of natural playgrounds, so it is a great opportunity for added user experience. By creating small pathways through densely vegetated areas, children can explore the paths and create their own games that make use of them. By encouraging children to scavenge the perimeter and search for certain insects or flowers, they are active in the natural environment and possibly intrigued by it.

G - OR1 - 1

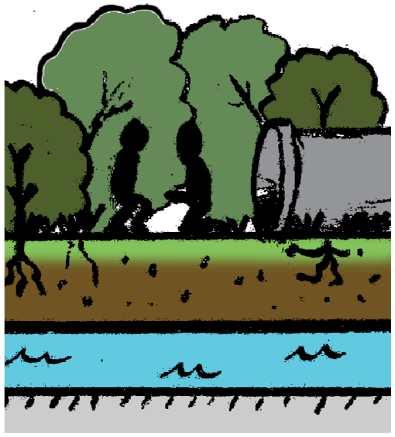
Water playgarden



- F - GE2
- F - GB3
- W - GE1
- W - OR3
- W - GB1
- L - GE1
- G - OR2
- G - OR4
- G - GB1

G - OR1 - 2

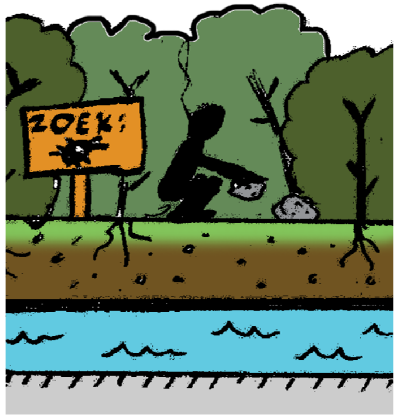
Play forest



- F - NE2
- F - GB2
- W - GE1
- L - GE1
- L - OR1
- L - OR3
- M - NE1
- G - KA1

G - OR1 - 3

Natural scavenger hunt



- F - GE1
- F - GE2
- F - GB3
- W - GE1
- L - OR3
- M - NE1
- G - KA1

USER FUNCTIONALITY / PUBLIC SPACE

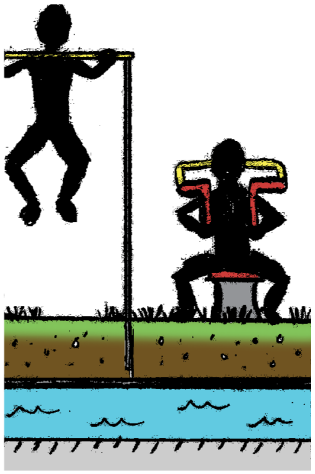
G - OR2

Sport facilities

An important reason for adults to go outside is to exercise, and sport facilitation in the area can aide with this healthy habit. Different equipment can be put together as a circuit to accommodate a full body workout. It can also take the form of a large climbing rack, leaving the exact forms of training up to the users themselves. Having this equipment available for free may lower the bar for local residents that may not be able to go to a fitness centre. Sport fields can give both children and older parties an opportunity to play sports and socialize. The field can be part of a healthy soil if it makes use of real grass, although this does require additional maintenance.

G - OR2 - 1

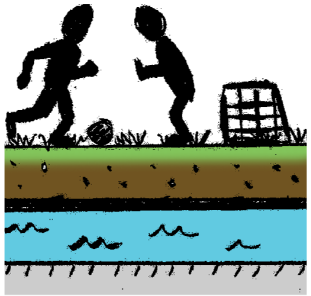
Public sport equipment



- G - OR1

G - OR2 - 2

Play forest



- W - GE1
- L - GE1

G - OR3

Cultural facilities

Public space can also accommodate some cultural functionality, as a way for people to express themselves or come together. This will strengthen their bond with the public space and increases the feeling of a shared responsibility. Sculpture gardens can facilitate actual sculptures, or other forms of art such as graffiti or temporary exhibitions. It can function as an aesthetic attraction both for local residents as well as one-time visitors of the area. It is also non-intrusive to the vegetation nearby. A podium too can be either fully accessible or open for rent in order to create revenue. It can be used by any local cultural incentive, like theatre groups, musicians, or be part of a festival. A proper podium has space for an audience, so a larger open space is a necessary part of the design.

G - OR3 - 1

Art garden

- F - GB2
- F - GB3
- M - NE1
- G - OR4

G - OR3 - 2

Podium

- L - GE1
- L - GB2
- G - OR4

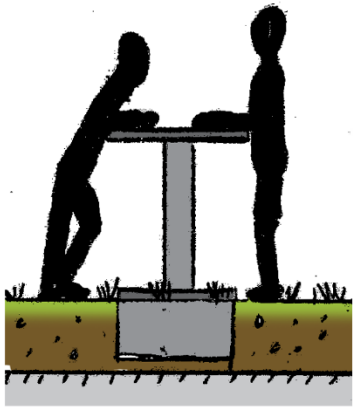
G - OR4

Meeting spaces

Although any public space can essentially be a meeting space, certain attributes can be allocated to aide in this process. This is favourable as it reinforces social cohesion of a neighbourhood which in turn increases the perceived safety. A simple elevated flat surface can facilitate many forms of meetings, such as a quick lunch or chat. It can take the shape of stand-alone objects or be integrated in walls or fencing around the area. This allows for easier interaction between users that they can give shape themselves. A rooftop terrace lets users lean back and enjoy a nice view. Shared gardens iare potentially less effective for the natural environment, but if some of the measures are communicated as advice, it can also serve an educative purpose.

G - OR4 - 1

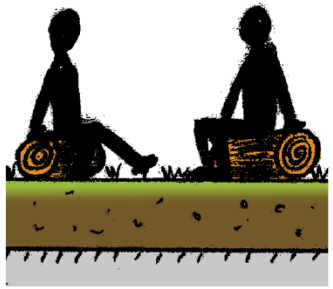
Standing tables



- F - GE1
- G - OR3

G - OR4 - 2

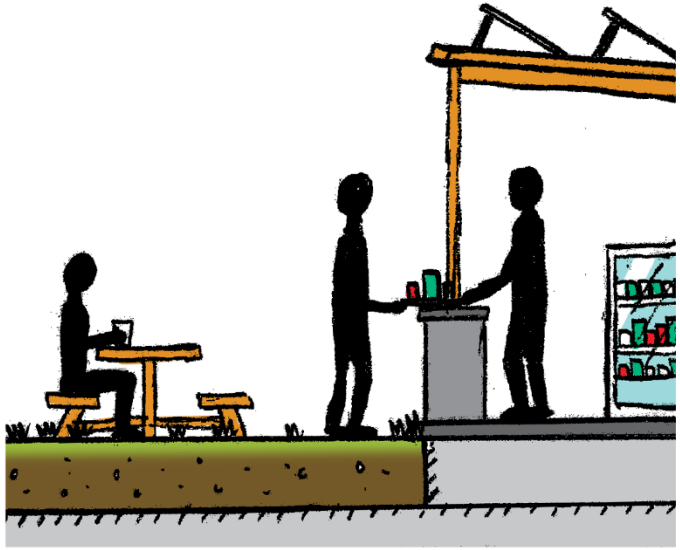
Circling seats



- F - GB2
- G - OR1
- G - OR3

G - OR4 - 3

Green rooftop terrace

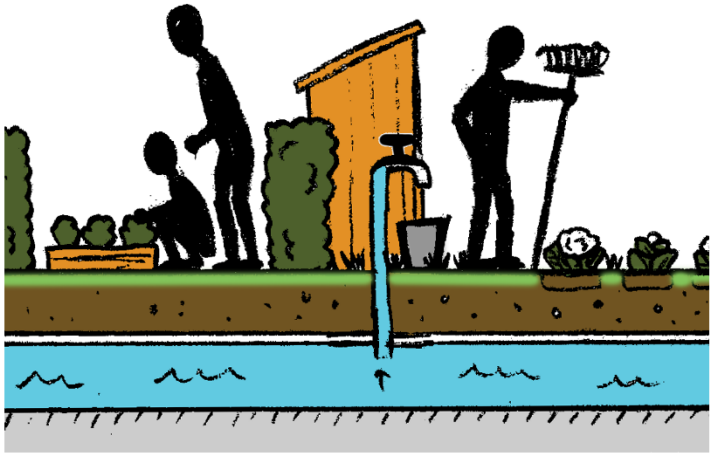


- W - OR3
- W - GB1
- L - GE1
- L - KA3

USER FUNCTIONALITY / PUBLIC SPACE

G - OR4 - 1

Standing tables



- F - GB3
- W - GE1
- W - GB2
- L - KA3
- L - GB2
- G - OR1

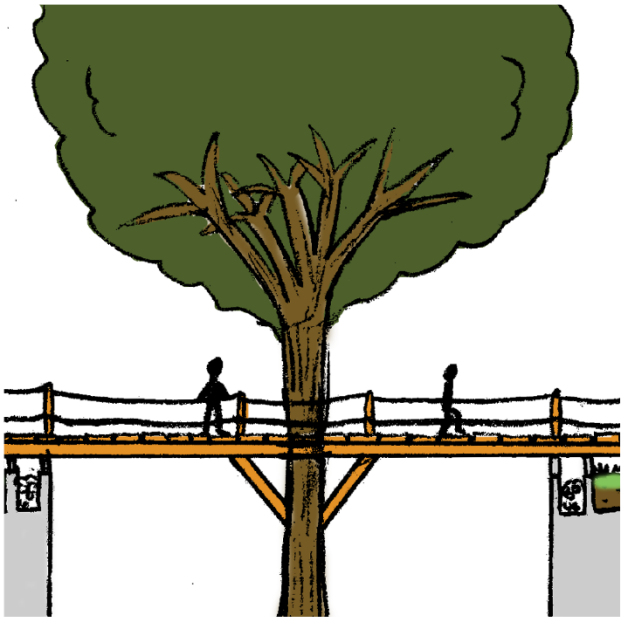
G - KA1

Horizontal connections

The horizontal connections focus on connecting different elevated green hubs with each other in an interesting manner. Routes for example make use of actual trees or artificial poles in between 3D greenery to create an elevated walkway. This type of structure is more exciting than a regular bridge and uses the local natural environment to get from A to B. It can be done in many ways, increasing either the play factor or accessibility of the route. It depends on what the target group is. The view can be accommodated with information panels, making users more aware of what they might be looking at.

G - KA1 - 1

Tree routes



- F - NE2
- F - GB2
- F - GB3
- F - NE5
- W - GE1
- L - NE1
- L - OR1
- L - OR3
- M - NE1
- G - OR1

G - KA1 - 2

Routes with a view

- F - NE5
- F - GB3
- W - GE1
- W - OR3
- L - GE1
- L - GB2
- M - NE1
- M - KA1

USER FUNCTIONALITY / BUILDING

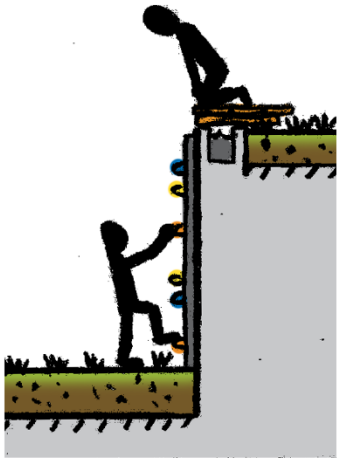
G -GB1

Vertical connections

Another important aspect that is inherently part of 3D greenery are vertical connections. Again, although already mentioned as a measure improving Mobility, there are iterations that focus less on accessibility and more on recreation. The climbing walls are a fun and physical option for able people to get higher up. The climbing walls can be designed traditionally using grips, or using porous rocks. Another option is to use ropes, either in a singular matter or in a certain shape like a web or a rope. This option can also be combined with a natural connection as plants and insects can use the ropes too. A final option is the implementation of slides, allowing mainly children to slide down from higher areas to lower laying ones.

G -GB1 - 1

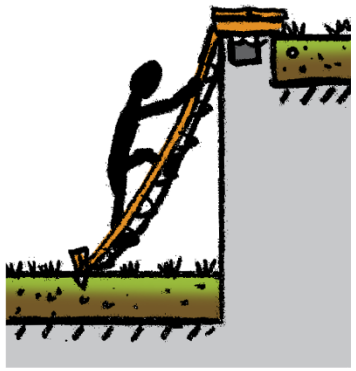
Climbing walls



- F - NE5
- F - GB1
- W - KA1
- L - GB2
- M - KA1
- G - OR1

G - GB1- 2

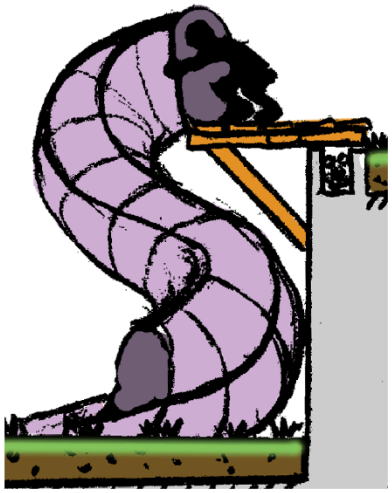
Climbing ropes or net



- F - NE2
- F - NE5
- M - NE1
- M - KA1
- G - OR1

G - GB1- 3

Slides



- M - KA1
- G - OR1