

# The Quay To Nature Extension

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How design can extend temporary nature on Amsterdam quay walls while benefitting Amsterdam citizens wellbeing

M.C.E. Koumans (1026988)

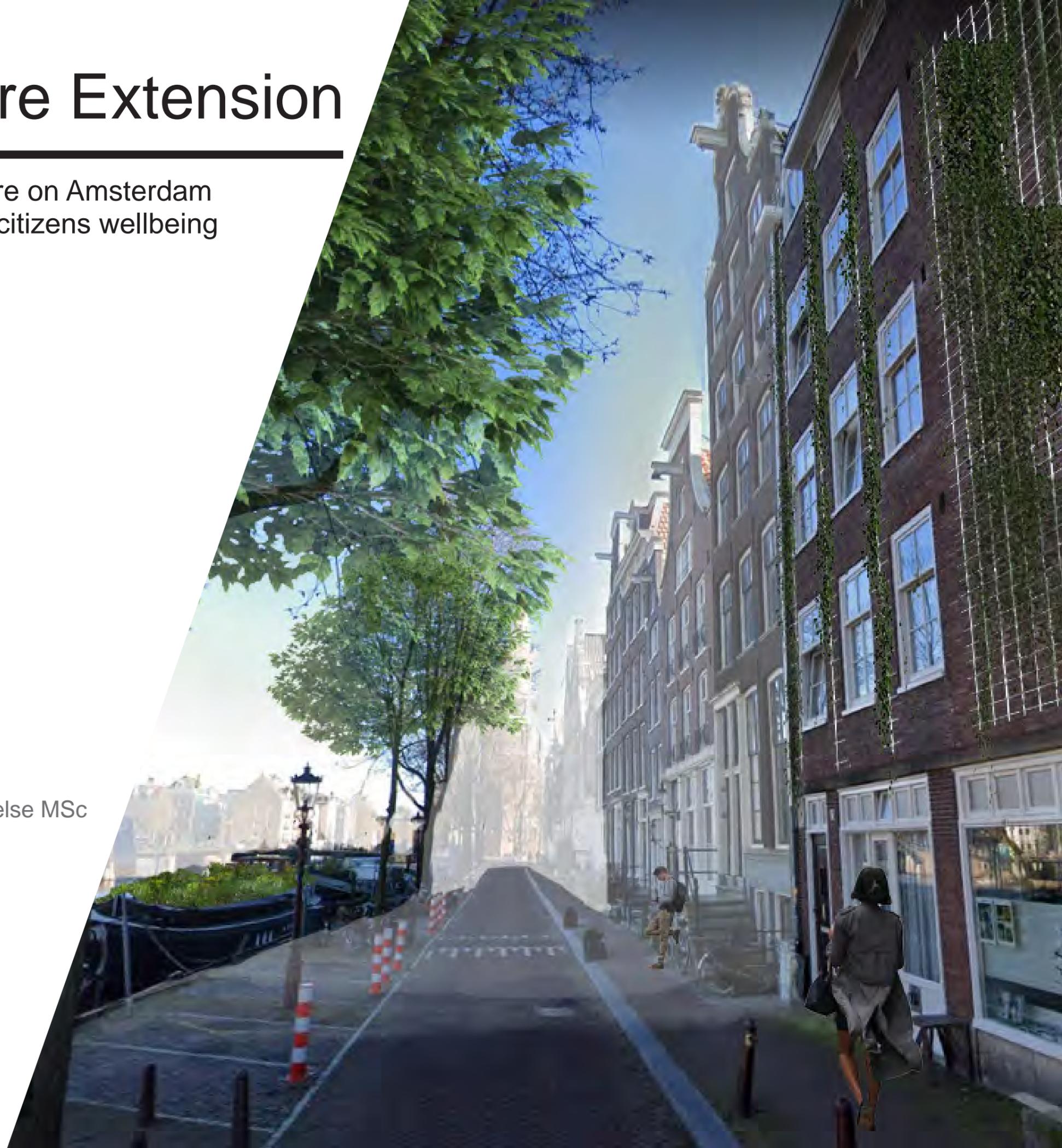
BSc Thesis Landscape Architecture (LAR81812)

Tutor: Sitong Luo

Coordinator and contact person: ir. Gabriëlle Bartelse MSc

Examiner: ir. Gabriëlle Bartelse MSc

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BSc Landscape Architecture and Spatial Planning  
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Author: Maria Christina Elisabeth Koumans

Reg. no.: 1026988

Tutor: Sitong Luo

Coordinator and contact person: ir. Gabriëlle Bartelse MSc

Examiner: ir. Gabriëlle Bartelse MSc

# Abstract

Because of the unstable and deteriorating state of the Amsterdam quay walls, temporary safety measures are being taken. Within these temporary safety measures the municipality of Amsterdam is developing temporary nature. This development can benefit Amsterdam citizens' wellbeing. Yet, there is no clear plan on what will happen to the temporary nature when the temporary safety measures will disappear.

This BSc thesis is a research on how the temporary nature can be extended on the Amsterdam quay walls while benefitting Amsterdam citizens' wellbeing.

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This is done, according to the the research through design method.

On the one hand, this research exists out of a literature study and analysis of the site on different scale levels. On the other hand, this research consists of design, based upon design guidelines, criteria and evaluation, based on a chosen theoretical framework. These two sides of the research will constantly switch back and forth until tree most optimized designs are found for the testbed locations.

The outcome of the evaluation on these designs can help giving an impression on the impact of this on bigger scale.

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Eventually the products of the research through design will be used to answer the research question and hopefully realize the objective of this BSc thesis.

# Introduction

Hundreds of canals have been part of the history and identity of Amsterdam for ages. Unfortunately a big part of the quay walls are in bad shape. Over the next 20 years 200 kilometers of quay wall need to be renewed. Not all quay walls can be renewed at the same time, therefore temporary safety measures are taken (Backerra et al., 2020).

Another problem in Amsterdam is the wellbeing of the citizens, which is affected by a multitude of reasons (Kolokotsa et al., 2020). The city is too crowded with not much personal space for inhabitants, there is a lot of pollution and nature and biodiversity loss, and there is an urban heat island effect.

The temporary safety measures have a prior function of being supportive and do not add social and environmental value to Amsterdam citizens' wellbeing in the first place, nevertheless the municipality of Amsterdam wants to make the quay walls as green and liveable as possible during the temporary safety measures, benefitting the wellbeing of the citizens as much as possible (Backerra et al., 2020).

The temporary nature on the temporary safety measures can improve Amsterdam citizens' wellbeing, but what will happen to all the newly developed nature when eventually the temporary measures will disappear? The municipality says they aim to maintain the newly developed nature as much as possible when the definitive measures will be taken, yet there is no clear information on how this can be done (Backerra et al., 2020).

By combining design and academic research, the expertise of a landscape architect can provide information on this subject and give design guidelines on how to tackle this problem in Amsterdam and maybe even other places.

# Thesis Statement

The objective of this study is to extend the temporary nature on the Amsterdam quay walls while benefiting Amsterdam citizen's wellbeing.

## *Research question*

How can design extend temporary nature on Amsterdam quay walls while benefitting Amsterdam citizens' wellbeing?

- What kinds of temporary nature on the Amsterdam quay walls are there?
- How can nature benefit the wellbeing of Amsterdam's citizens?
- What kind of design principles can be used in order to extend the temporary nature on the Amsterdam quay walls, while benefitting Amsterdam citizens' wellbeing?
- What are the consequence of the detailed design on the Amsterdam citizens' wellbeing on urban scale?

# Methods and Materials

To accomplish my objective, during this BSc thesis the research through design method will be used. This method combines landscape architectural design and academic research. The research questions will be answered by academic research through literature and analysis, but knowledge and evidence will also be gained through design. Therefore there will be a constant interplay between the theoretical framework and designing as shown in figure 1 (Lenzholzer et al., 2017).

The diagram shows that there will be three testbed locations on which the designs will be tested. The designs are based on design guidelines. These guidelines are a result of knowledge obtained from literature and subsequent analysis. Before the design guidelines are used within the designs, they will be evaluated on the determined design goals.

After the three most optimized designs have been realized, these will also be evaluated.

This evaluation will be done according to criteria, again based on knowledge obtained from the literature and analysis. The outcome of the evaluation on the three testbed locations can give an insight on the influence of this research on urban scale level.

Based on all the obtained knowledge through the whole process of research through design, the research question can be answered and the objective can be accomplished.

Several materials will be used within this research. To begin with, literature in the form of for instance scientific research will be used. In addition to that on-site observations in Amsterdam will be made.

Together with GIS information and available maps from the municipality, this will form the base of my analysis. This analysis will be done both on urban and site scale level.

Tools that will be used to execute this research through design are programs such as ArcGis, Adobe Photoshop, Adobe Illustrator, Adobe Indesign and Vectorworks. With these programs maps, visualisations, cross-sections and 3D-models will be made. Also hand-drawing will be a part of that.

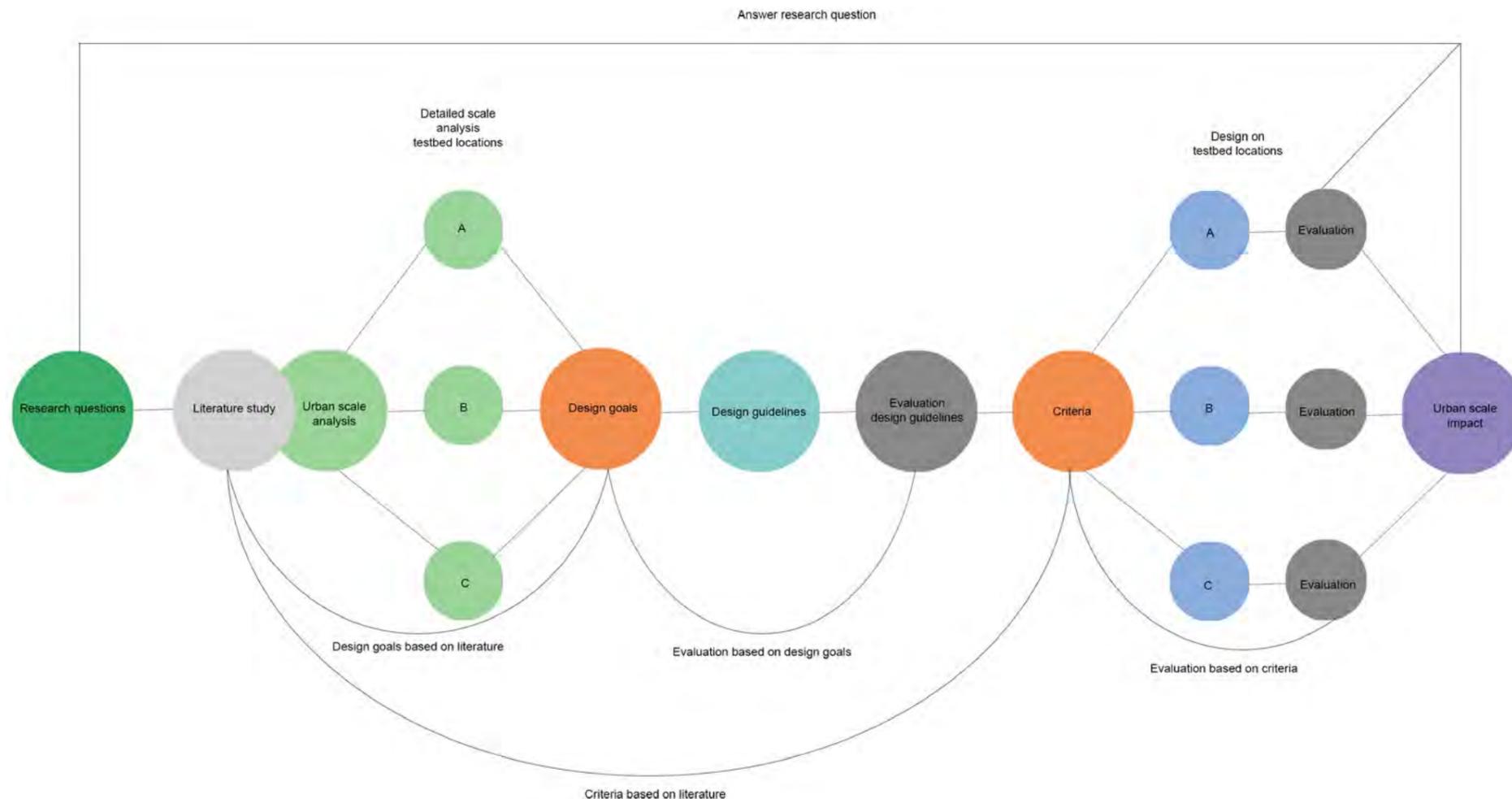


Figure 1: Methods and Materials diagram

# Key Theories

The three following theories are at the basis of this research.

*The Urban Catalyst* theory states that certain elements (tangible or intangible) can be a catalyst when implemented in urban areas, having a positive impact on projects or the city as a whole (Shen, 2013). The research 'Project Urban Catalyst' investigated the potential of temporary uses for long-term urban development. They looked into how temporary uses can be a catalyst, developing positive long-term effects and how they can be successfully incorporated into planning and management of cities (Bengs et al., 2002).

*Cradle to cradle* is a concept that is used a lot on product level, yet it can also be used within garden design and landscaping (Ekeris & Hendriks, 2010). It focusses on creating a circular use of elements, improving the sustainability of an area. Principles have been drawn up on how to apply cradle to cradle within landscape architecture (Boone et al., 2009).

Citizens' wellbeing is vulnerable to various environmental hazards within the city (Kolokotsa et al., 2020). Implementing nature in urban areas has proven to benefit the wellbeing of citizens (Taylor et al., 2017). Nature-based health interventions can facilitate behavioral change through a somewhat structured promotion of nature-based experiences and, in doing so, promote improved physical, mental and social health and wellbeing (Shanahan et al., 2019).

# Analysis

## Urban Scale Analysis

In order to decide what locations are suitable for use as a testbed location for the extension of temporary nature, first an analysis was done on the whole old city centre of Amsterdam. Areas where the physical or mental wellbeing of citizen's is critique were investigated. Additionally, different types and densities of temporary nature development were investigated.

When looking for areas with an environment that influences citizens' wellbeing negatively, the environmental factors influencing citizens' wellbeing must be established, since it has been shown that peoples's feelings and life evaluations depend on different factors in their surroundings (Krekel & MacKerron, 2020).

Take for instance air pollution. An environmental stressor such as air pollution is associated with respiratory and cardiovascular disease and heightened stress levels. This is often in relation with noise pollution, since air pollution is likely to be high where there is also greater traffic noise (Krekel & MacKerron, 2020).

In addition to noise and air pollution, urban living contains more potential hazards that are associated with health risks. It has been shown that infectious diseases are more likely to thrive in crowded living conditions that can be found in urban areas (Bai et al., 2012). Besides, living in these crowded areas does not only effect peoples physical health, but also their mental health, for instance leading to higher levels of stress (Taylor et al., 2017).

Yet, of all the health risks that can be found within cities, climate change related health risks, such as heat stress, are considered as one of the biggest health risks in the 21st century (Bai et al., 2012). The urban heat island is a well-known phenomenon whereby urban areas are generally warmer than surrounding suburban and rural areas.

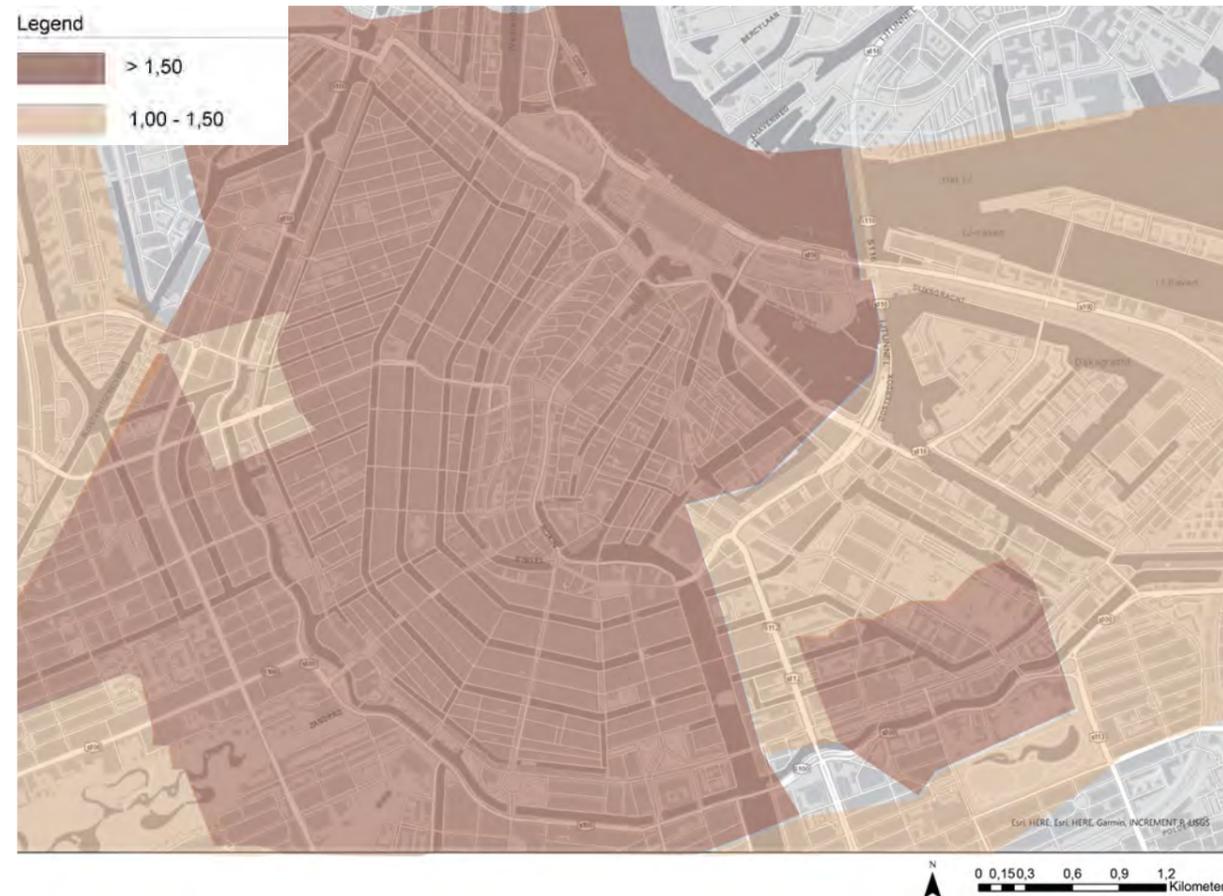


Figure 2: Floor Space Index (Atlas van de Regio, n.d.)

Studies have shown increased health risks in urban populations compared to rural or suburban populations in hot weather (Heaviside et al., 2017).

The municipality of Amsterdam (Maps Amsterdam, n.d.) and the Planbureau voor de Leefomgeving (Atlas van de Regio, n.d.) provide data on these environmental hazards. In order to map the crowdedness of the area, an analysis on the Floor Space Index, the busyness of the roads and the walkability has been done.

The Floor Space Index shows the density of buildings at neighborhood level (Atlas van de Regio, n.d.). As seen in figure 2 a big part of the old city centre of Amsterdam has a high density of buildings. Yet, the largest part of the city even has an extreme density, encompassing for instance the Amsterdam canal belt. The traffic forecast, seen in figure 3, shows the prognosis on how busy the different roads are, based on how much they are being used by traffic (Maps Amsterdam, n.d.). As can be seen on the map, high traffic density is not only limited to the largest roads at the edge of the city.

The roads along the canals are also small, yet busy traffic hotspots.

The map on the walkability, figure 4, of the city center is based on obstacles on the road, such as terraces or street furniture, its width and the amount of passers-by (Maps Amsterdam, n.d.).

The different colors show the different experience of crowdedness experienced by pedestrians when walking through the city.

These three maps combined, give a quick impression on the crowdedness of Amsterdam in general. Figure 5 shows the hotspots within Amsterdam where this overcrowding can be found. It shows a lot of overcrowding is found within the old city centre and especially along the canals.



Figure 3: Traffic forecast (Maps Amsterdam, n.d.)



Figure 4: Walkability (Maps Amsterdam, n.d.)

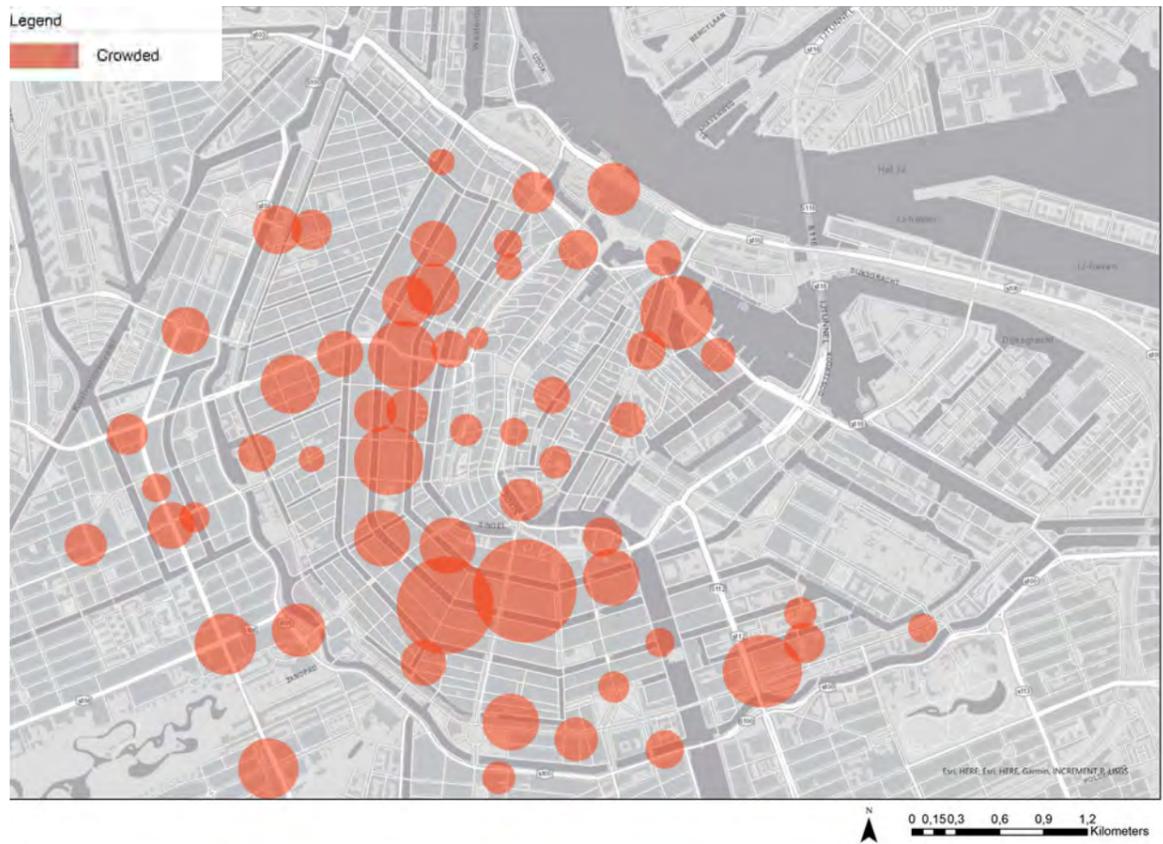


Figure 5: Crowdedness



Figure 6: Urban heat island effect (Maps Amsterdam, n.d.)

When looking on national scale, the whole city of Amsterdam can be diagnosed as an urban heat island (Atlas van de Regio, n.d.). Yet, when looking closely, a distinction can be made between different intensities of heat stress within the old city center as shown in figure 6 (Maps Amsterdam, n.d.).

The map on environmental health risk, figure 7, shows the estimated influence of noise and air pollution on people's health (Atlas van de Regio, n.d.). As stated above, it can indeed be noted that the biggest part of noise and air pollution takes place along the roads. When combining the map on traffic forecast and the environmental health risks map a conclusion can be made on where traffic is high, noise and air pollution is high.

The combination of all the data from the maps above gives us an indication on which areas within the old city center of Amsterdam are most likely to have an environment that effects the wellbeing of the citizens negatively.

The identified locations, shown in figure 8, are overcrowded, air polluted, loud and hot. Therefore the environment of these areas can be seen as harmful for the wellbeing of Amsterdam citizens.



Figure 7: Noise and air pollution (Atlas van de Regio, n.d.)

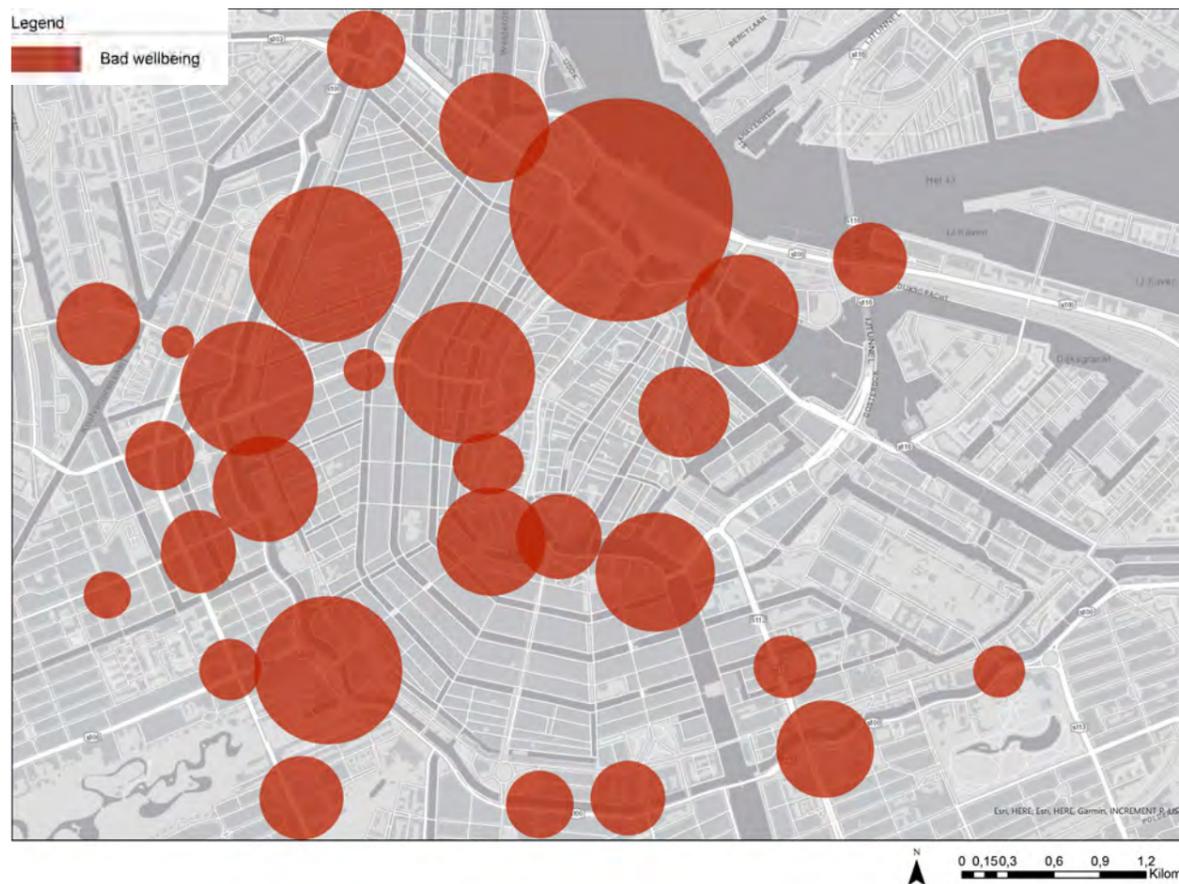


Figure 8: Bad wellbeing



Figure 9: Green areas (Atlas van de Regio, n.d.)

The municipality of Amsterdam has already stated that by implementing nature onto the temporary measures, they want to improve the wellbeing of the citizens (Baccerra et al., 2020). Heaviside et al. (2017) indeed state that there is the potential for nature to support human wellbeing in urban environments.

Evidence shows that nature benefits physical health (for instance lower prevalence of high blood pressure, lung complaints and allergies), mental health (for example lower prevalence of depression and anxiety) and social wellbeing outcomes for people who spend time in nature (Shanahan et al., 2019).

This will be explained in more detail later on in this research, when it will be investigated how nature can be spatially implemented on-site in order to benefit citizens' wellbeing.

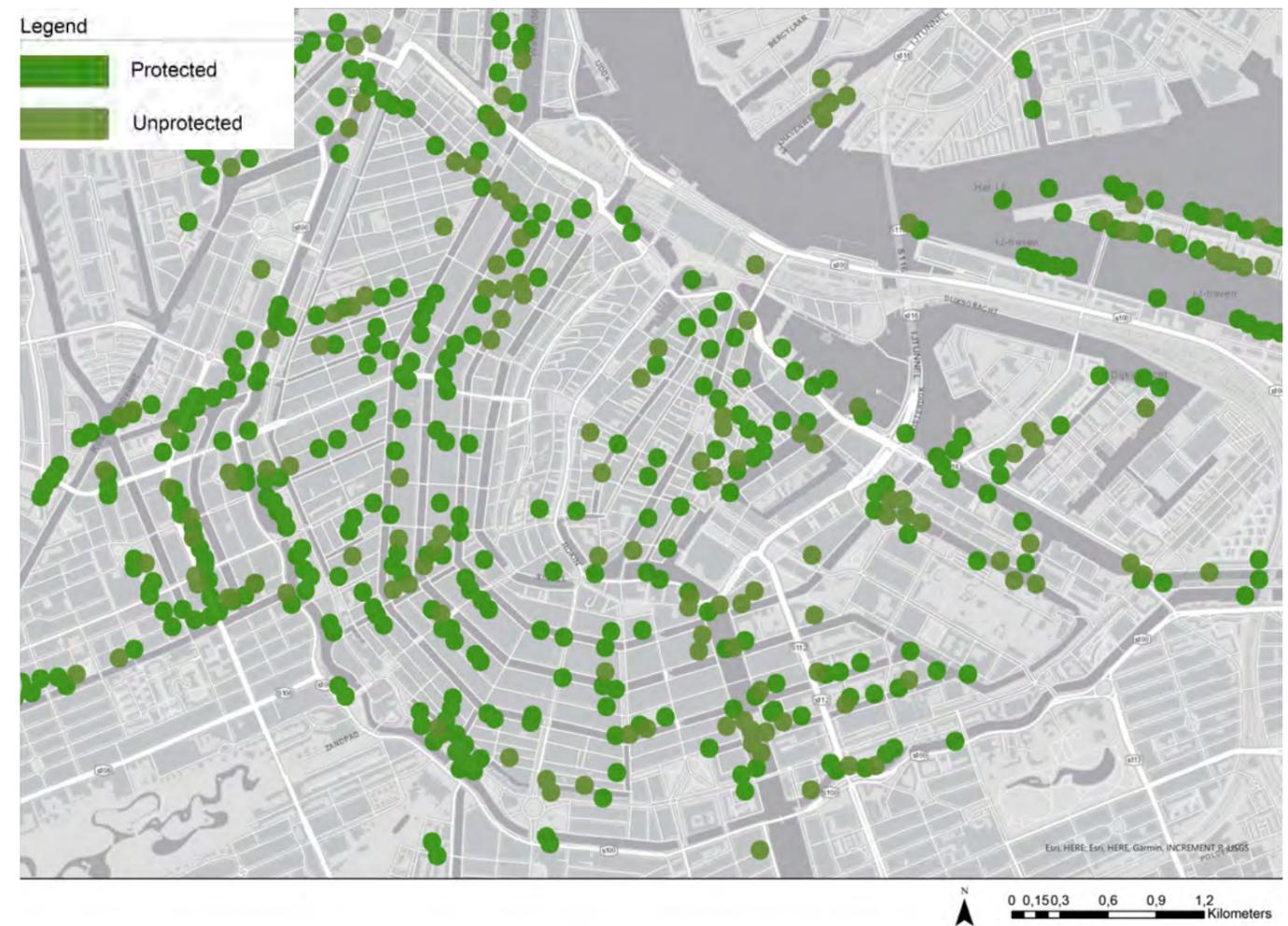


Figure 10: Quay wall vegetation (Maps Amsterdam, n.d.).

Furthermore, research shows that the lack of green areas within an urban environment damages citizens' wellbeing even more (Krekel & MacKerron, 2020).

Currently, the majority of nature in the city at the moment can be found in the shape of (small) parks or patches of green, private gardens, trees and quay wall vegetation (Atlas van de Regio, n.d.).

Figure 9 shows these (small) parks and patches of green, private gardens and trees (Atlas van de Regio, n.d.).

As visible, several areas within the inner city center have a big lack of green areas, which may affect the wellbeing of the citizens living there negatively.

Figure 10 shows where protected and unprotected types of wall plants can be found (Maps Amsterdam, n.d.). The majority of the quay wall vegetation is unprotected. Yet, the vegetation is spread all over the city.



Figure 11: Temporary safety measures quay walls (Maps Amsterdam, n.d.).

As stated above, 200 km of quay wall needs to be renewed. Almost 40 different locations require renovations.

The locations where the temporary measures can be currently found are visible in figure 11.

In figure A, which can be found in the appendix, the different types of measurements are connected to the different locations.

The municipality is already working on developing temporary nature on some of the locations or has announced the type of temporary nature that can be suitable to develop on each type of temporary safety measure (Backerra et al., 2020).

An impression of the different possibilities on temporary safety measures and temporary nature development is given in figures 12 until 15.

In figure 12, temporary safety measures at Ouderzijds Achterburgwal in the shape of steel sheet piles are visible. These steel constructions are filled up with sand, on which in cooperation with De Vlinderstichting, so called idylls are planted. The idylls consist of indigenous flowers and plants (De Vlinderstichting, 2019).



Figure 12: Ouderzijds Achterburgwal



Figure 13: Heerengracht



Figure 14: Lijnbaansgracht



Figure 15: Singel

Figure 13 shows the quay wall at the Heerengracht. On this location flowers are planted on the tree pits.

At the Lijnbaansgracht, figure 14, again idylls within steel sheet pile constructions are visible. In addition to that, the old parking spots have been temporarily transformed into small community gardens, since no cars are allowed to enter the street.

Another way of preventing cars from parking near the quay walls is to place big flowerboxes on existing parking spots. These can be found at a lot of locations within Amsterdam. Figure 15, shows the flowerboxes on the Singel.

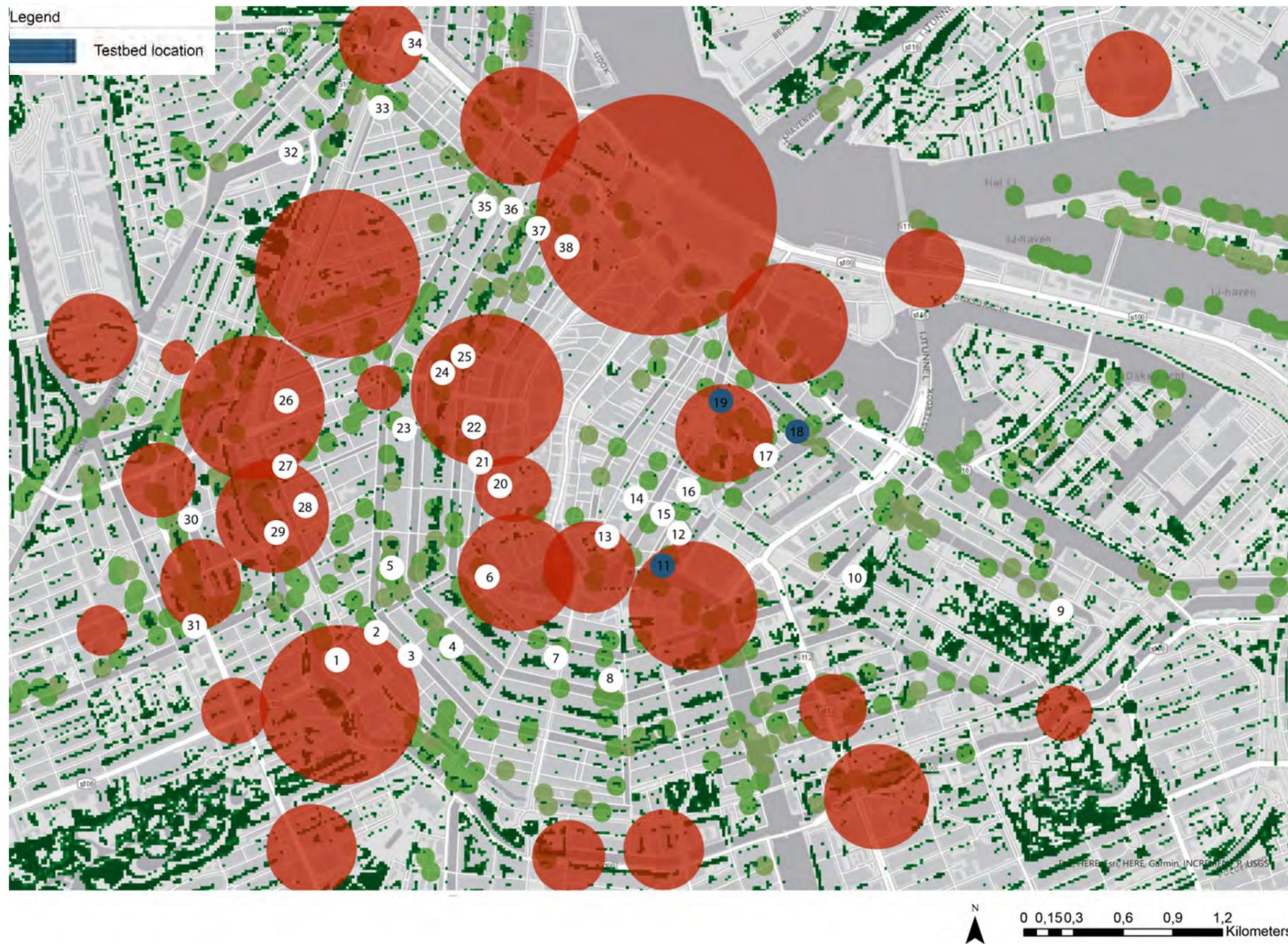


Figure 16: Testbed locations choice

Combining the information on what areas within Amsterdam have a bad influence on the wellbeing of citizens', what areas in particular have a lack of nature and the different insights on temporary safety measures and their potential to help develop temporary nature, three testbed locations were selected as shown in figure 16.

The following locations were chosen to serve as a testbed location:

- 11 Groenburgwal
- 19 Geldersekaade
- 18 Waalseilandgracht

All three of these locations are located within an area that was found to have a bad environment for the wellbeing of the citizens'. So there is a lot of crowdedness, heat, noise, air pollution and lack of green. Besides that the three locations contain different temporary safety measures. Therefore, different temporary nature will be realized on this locations which will bring different challenges and opportunities when designing the area in order to extend this nature.

More information on the type of temporary safety measures and the (possible) temporary nature that can or is developed at the three locations will be given in the site scale analysis.

## Site Scale Analysis

The second part of analysis will be on the three chosen locations at site scale. Within this analysis a closer look is taken at the temporary safety measures and the temporary nature that (might) come with that. In addition to that, the parking spots and their parking pressure is investigated. Also (private) gardens, trees and quay wall vegetation are established. Finally, not only the age of the houses was taken into consideration. Also the present houseboats are mapped, as for the appropriateness of green roofs on houseboats and houses in general. This appropriateness is based on the age of the houses and the shape of the roofs; the houses can not be old and the roofs need to be flat (Verantwoorden subsidie Groene daken en gevels 2020-2022, n.d.).

### Geldersekade

Looking at the available parking spots and the parking pressure at the Geldersekade, it is noticeable that there is a lot of parking pressure on both sides of the canal and it is apparently hard to park your car in this area. Yet, this does not apply to the east side of the canal. Further on, some trees and small patches of green can be found along the canal and in the backyards of citizens' houses. Yet, the biggest contribution of green in this area comes from the temple garden, situated on the westside of the canal, and the school yard, situated on the east side of the canal. Even though there are a lot of houses with different ages, many possibilities present themselves for green roofs. One of these possibilities is also the houseboat that can be found in this area. There even is an already existing house with a green roof (figure 17). The temporary safety measure can be found on both sides of the Geldersekade. It consists out of steel pile sheets. These pile sheets have been filled with sand to relieve the pressure from the quay wall. In order to prevent having citizens look at piles of sand for several years, within this steel construction idylls have been realised (figure 18). Besides the fact that the idylls have a positive impact on the environment and thus the people, they also help insects. Since the idylls consist of native flowers, they have a positive impact on the biodiversity of the area (De Vlinderstichting, 2019).



Figure 17: Site scale analysis Geldersekade (Data en informatie, n.d.)

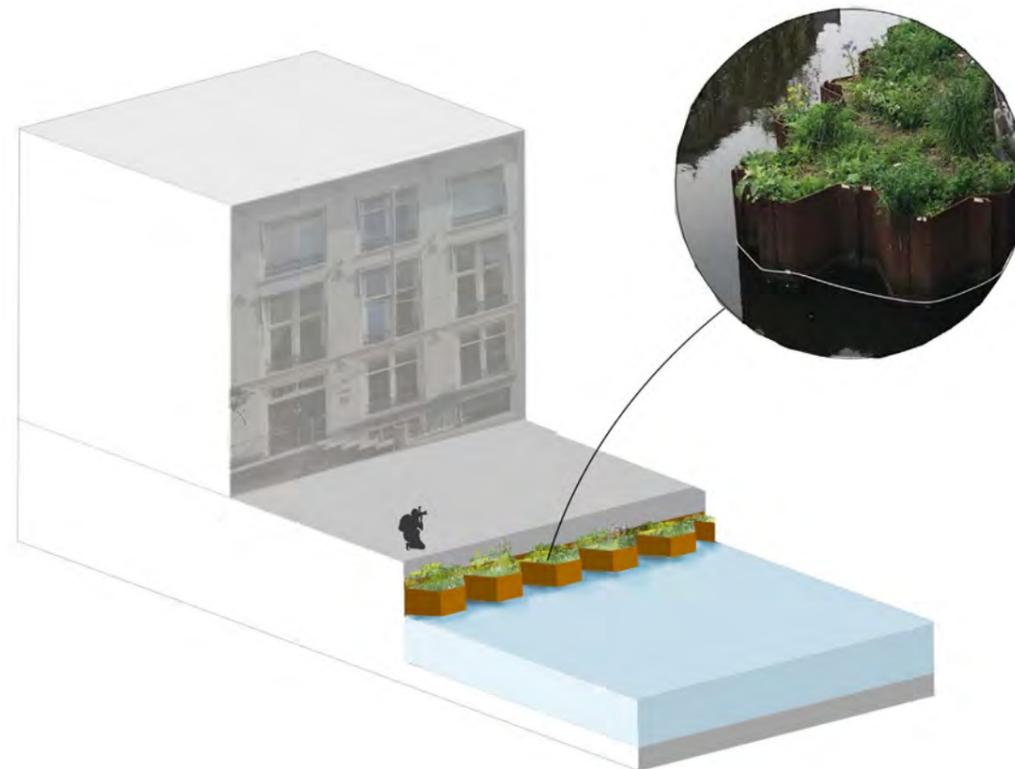


Figure 18: Temporary measures Geldersekade

## Groenburgwal

At Groenburgwal the same type of site scale analysis has been done. Same as the Geldersekaade, the parking pressure at Groenburgwal is unequally distributed in the area. One side of the canal has a high parking pressure, the other side a negligible parking pressure. Trees can almost only be found at the sides of the canal. Other green in this area consist only out of small private gardens. Again houseboats can be found, in this case three (figure 19).

The temporary safety measure here are the steel pipes reaching from the west side of the canal upon the east side of the canal. This type of temporary safety measure is often used at relatively small canals that need renovation (Backerra et al., 2020).

On top of these steel pipes, the municipality of Amsterdam aims to grow nature. These climbing plants will grow on steel rasters that can be easily removed and transported towards other places (Backerra et al., 2020).

Since the water traffic has been stemmed due to the steel pipes across the canal, this can also give opportunities for other types of temporary nature development. For instance floatlands can be realised (figure 20). These plants on boxes are easily to grow and can also be easily transported towards other locations without falling apart, in contrast to other waterplant constructions, such as kokosmatten or rijshout (Backerra et al., 2020).



Figure 19: Site scale analysis Groenburgwal (Data en informatie, n.d.)

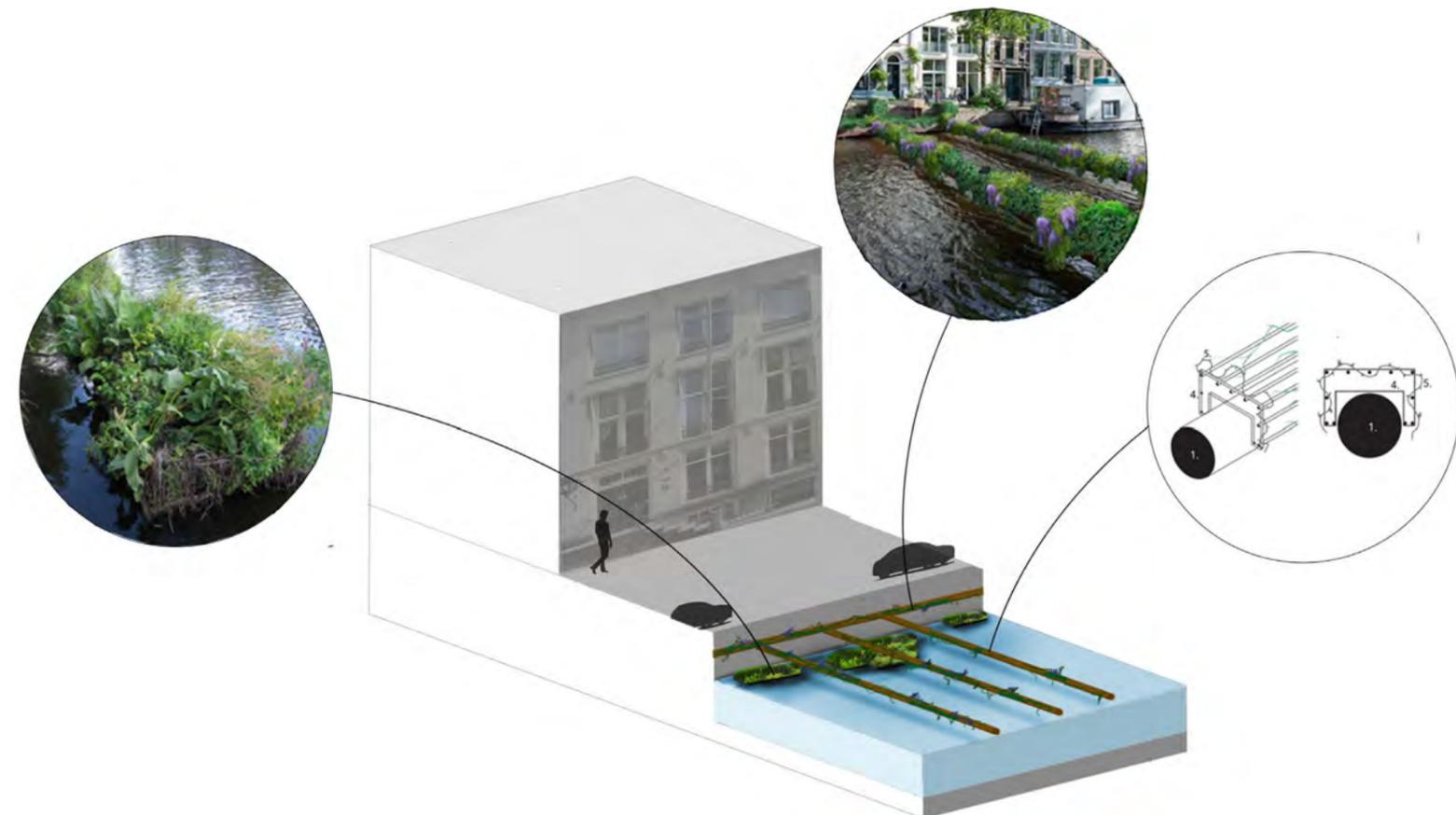


Figure 20: Temporary measures Groenburgwal

## Waalseilandgracht

The last site scale analysis has been done on the Waalseilandgracht. This being a slightly bigger site than the other two locations.

Just as can be seen with the Groenburgwal, the parking-pressure at Waalseilandgracht is partly high and partly low. As regards the present green within this area, there are many trees along the canal. Also bigger private gardens can be found, and again a school yard.

What is remarkable about this location is the enormous presence of houseboats. A lot of these houseboats have the potential to transform their roofs into green roofs. One of the houseboats even already has a green roof, just as two of the buildings that can be found in the area (figure 21).

A design has been made on the temporary safety measures and the possibility to develop temporary nature. The design consists out of steel rasters with climbing plants growing on top of it. Again these rasters will be easy to remove and transport towards any other location. On the edge of the quay wall, boxes with small plants will be realized (Ontwerp afwerking veiligheidsconstructies Waalseilandsgracht, 2021).

Because of the fact that it is forbidden for cars to park along the canal, the parking spots have been emptied. Local citizens have taken this opportunity to develop their own temporary community gardens along the canal. Pots with plants, picnic tables, trays with wetlands and small vegetable gardens can be found here at the moment (figure 22). Unfortunately, the municipality has indicated that these 'pop-up' community gardens need to immediately disappear after the renovations on the quay walls are done, since they think the parking spots will be needed again (Gemeente Amsterdam, Programma Bruggen en Kademuren, 2021).



Figure 21: Site scale analysis Waalseilandgracht (Data en informatie, n.d.)

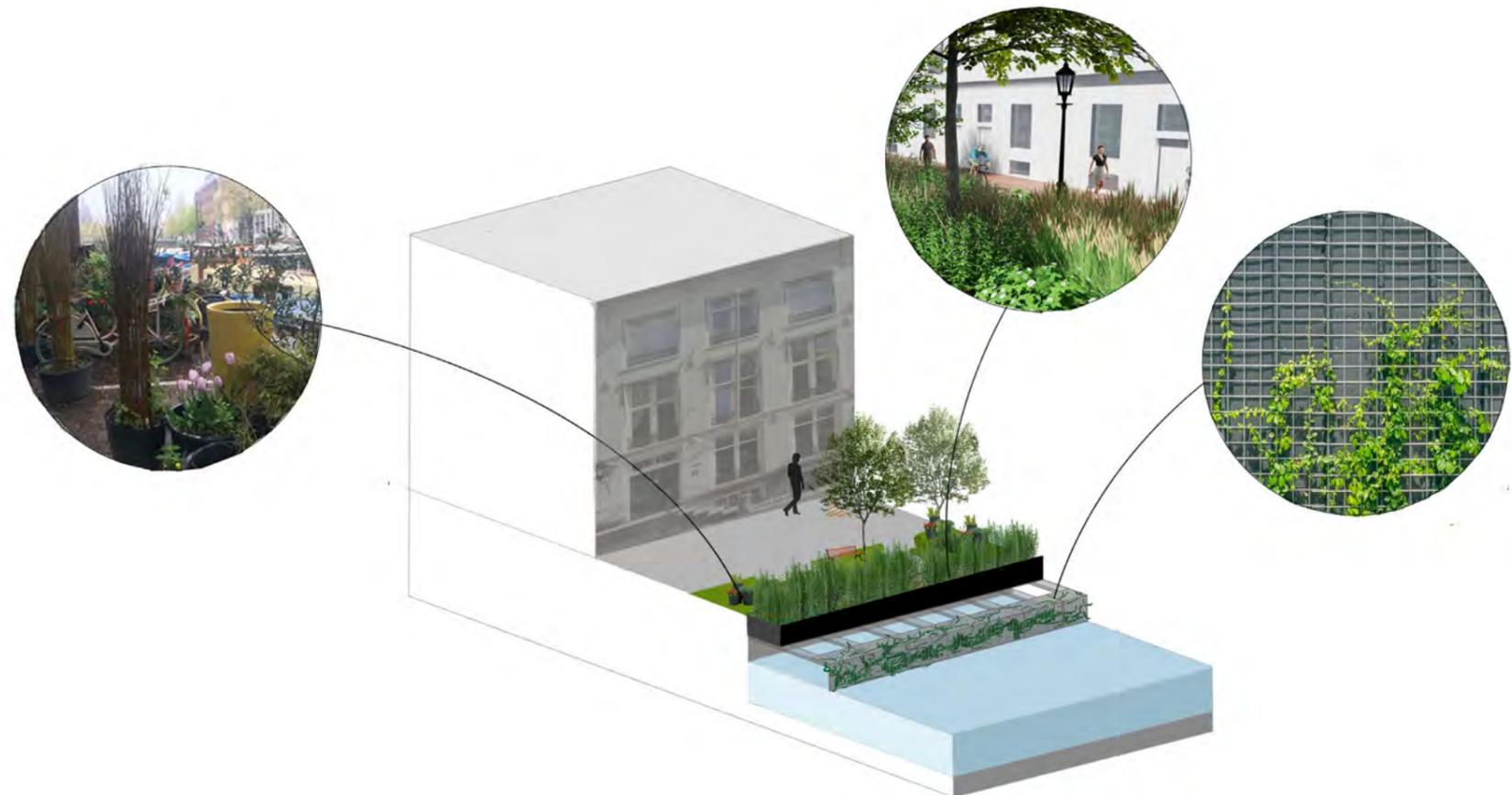


Figure 22: Temporary measures Waalseilandgracht

## Design Goals

In order to develop a design that will answer the research question and hopefully will help realize the objective, design guidelines will be set up. The goals are based on the fact that they will add to extending the temporary nature and improving Amsterdam citizens' wellbeing. The details about these guidelines will be explained later on, but the goals that the designs need to satisfy and will eventually be used to evaluate the design guidelines are the following:

- The existing green needs to be reused (Ekeris & Hendriks, 2010);
- The green areas need to be visible from houses or the streets (Taylor et al., 2017);
- The nature needs to be public (Taylor et al., 2017);
- The nature needs to be easy accessible (Taylor et al., 2017);
- There needs to be residents participation on the nature development (Aalbers & Sehested, 2018);
- The nature needs to cool down the environment, reduce noise pollution and improve the air quality;
- The location needs to be suitable for the extension of the type of nature.

## Criteria

The following criteria are set up to eventually evaluate the most optimized designs in order to see how this research responds to the research question, and if it will realize the objective:

- The temporary nature is extended;
- The wellbeing of Amsterdam citizens is improved.

# Design Guidelines

In order to eventually make a design per location, different guidelines need to be drawn up. These guidelines are made in such a way, that the already existing temporary nature can be extended.

## *Green roofs houseboats (figure 23)*

In the city center of Amsterdam a lot of houseboats can be found. The roofs of these houseboats are very visible from the streets, yet not aesthetically pleasing. When walking or biking past the canals all you see is black or grey roofs. Some of these roofs are already green and the municipality does promote this movement.

Vegetated (green) roofs are one form of alternative land cover that has shown the potential to provide a variety of benefits in urban areas (Carter & Butler, 2008). The municipality will subsidize projects of planting green on the roofs of houseboats. Therefore, the roofs must be appropriate for the realization of the roofs (they need to be strong enough and flat) and the roofs need to stay for at least five years. At least 30 square meter needs to be realized in order to get subsidized, but you can also work together with for instance your neighbors in order to achieve this amount (Verantwoorden subsidie Groene daken en gevels 2020-2022, n.d.). The plants that can be used are small plants, flowers and herbs, and sedum (Carter & Butler, 2008).

Positive effects of these green roofs on houseboats will be that they will be visually pleasing, which will for instance help with stress relief by spectators and eventually will improve citizens' wellbeing (Rooftoprevolution, n.d.). In addition to that, the roofs will improve biodiversity, hold fine dust and water and will isolate the houses. Temperature reductions were found on green rooftops when compared to an asphalt surface (Carter and Butler, 2008). Therefore, there will be less air pollution and less heat island effect, which also contributes to the improvement of the wellbeing of citizens.

## *Green roofs houses (figure 24)*

Besides only realizing green roofs on houseboats, the roofs on houses can also be transformed into green roofs. Again the municipality will subsidize the realization against the same requirements stated above (Verantwoorden subsidie Groene daken en gevels 2020-2022, n.d.). The roofs, again, must be strong enough and flat.

There are different types of green roofs that can be realized. For instance the modular green roof system. This system consists of multiple singular blocks containing different types of vegetation such as sedum but also small plants and flowers (Carter and Butler, 2008). Another type of green roof contains wetlands, using waterplants. Both green roofs will help improve the air quality, but studies have shown that constructed wetland roofs maintain more stable temperature profiles than terrestrial systems because of their slow heat transfer and high heat storage capacity (Song et al., 2013).

## *Green facades (figure 25)*

Again, for the realization of green facades, the municipality offers grants (Verantwoorden subsidie Groene daken en gevels 2020-2022, n.d.). When the plants on the facades are not directly connected to the ground, called indirect greening systems, the grant can be of a maximum of 50 euro's per square meter. Applying green facades, can offer multiple benefits on both new and existing buildings and can be a sustainable approach in terms of energy savings, materials used, nutrients and water needed and the efficient preservation of edifices (Perini et al., 2012). Climbing plants can be used in indirect greening systems by applying them on some sort of raster's. This way the facades of the houses will not be damaged, they can even protect them from acid rain damage or environmental influences such as sun (Köhler, 2008), but to be sure and to not change the image of the old canal houses, you can choose to apply the green facades on newly build houses only. Eventually, through the use of green facades, again, the biodiversity, air quality and heat island effect can be improved. Whereas also the facades being visible for passers-by influences the mental wellbeing of citizens positively (Perini et al., 2012).

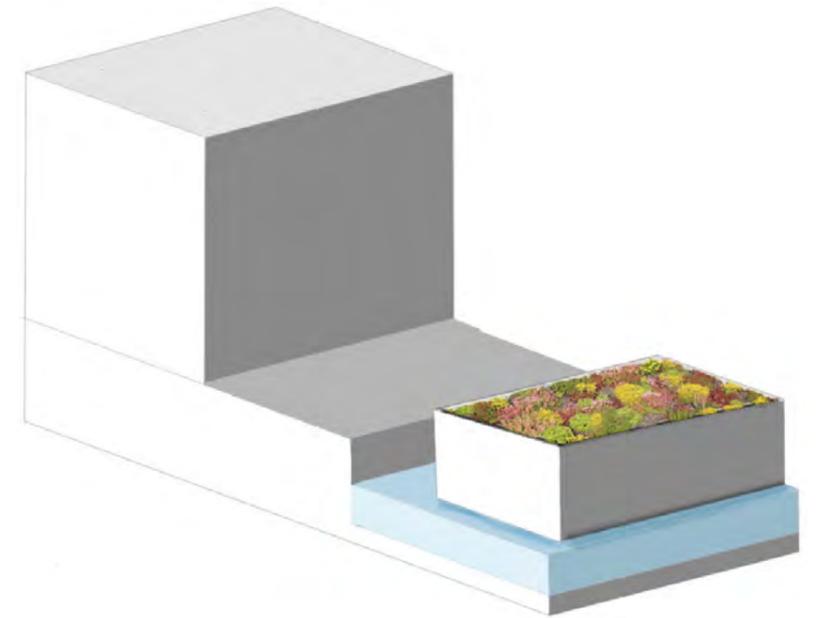


Figure 23: Green roofs houseboats

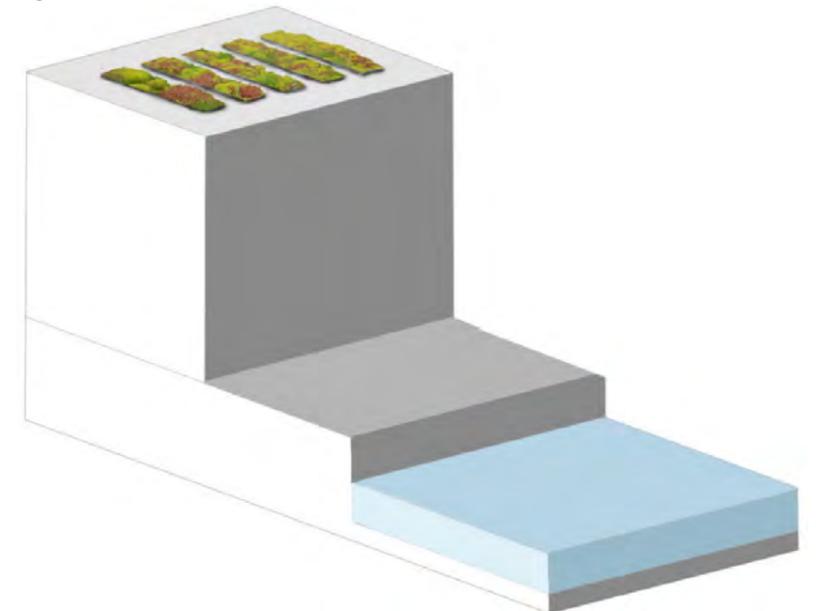


Figure 24: Green roofs houses

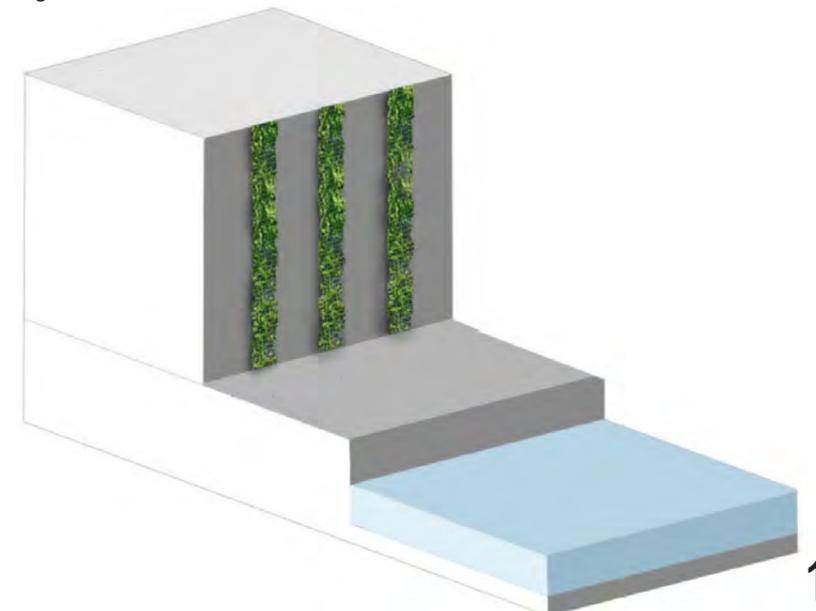


Figure 25: Green facades houses

### *Enlarged tree pits (figure 26)*

The municipality of Amsterdam has indicated that they have this idea of moving flowers, herbs and small plants from Idylles into tree pits (Backerra, M, 2021). It is able to realize plants in tree pits against low costs (Grey et al., 2018). Therefore the idea is there to slightly enlarge all tree pits a little bit to also enlarge their effect on citizens' wellbeing. According to Grey et al. (2018) the small enlargement of tree pits can already have an impact on the positive effect present of nature development. The tree pits can store water, improve biodiversity and air quality and are again nice to look at.

### *Community gardens (figure 27)*

At the moment temporary 'pop-up' community gardens are being organized by the citizens of Amsterdam. Transforming these community gardens into definitive, organized community gardens can have a positive effect on the wellbeing of these citizens. Community gardens give a big opportunity to grow all kinds of nature, while involving local residents, and improve the social cohesion of the area (Veen, 2015). Therefore, community gardens can serve as a public green area, improving citizens' health by relieving stress and also improving the air and temperature quality of the city a little bit.

### *No car zones (figure 28)*

Some of the roads along quay walls have been temporarily transformed into no car zones since the cars are too heavy and otherwise the quay walls would collapse. Because of the no car zone, no parking is needed in those areas, creating more space for for instance nature.

It is likely that in the future there will be less cars within cities, since there will be more focus on for instance public transport (Alessandrini et al., 2015). This will make it easier to develop no car zones and create more space since parking spots will disappear.

When nature will be developed on the old cars spots, the no car zone makes it also more accessible to walk or bike along the nature, which will have a positive effect on the wellbeing on those passers-by (Taylor et al., 2017).

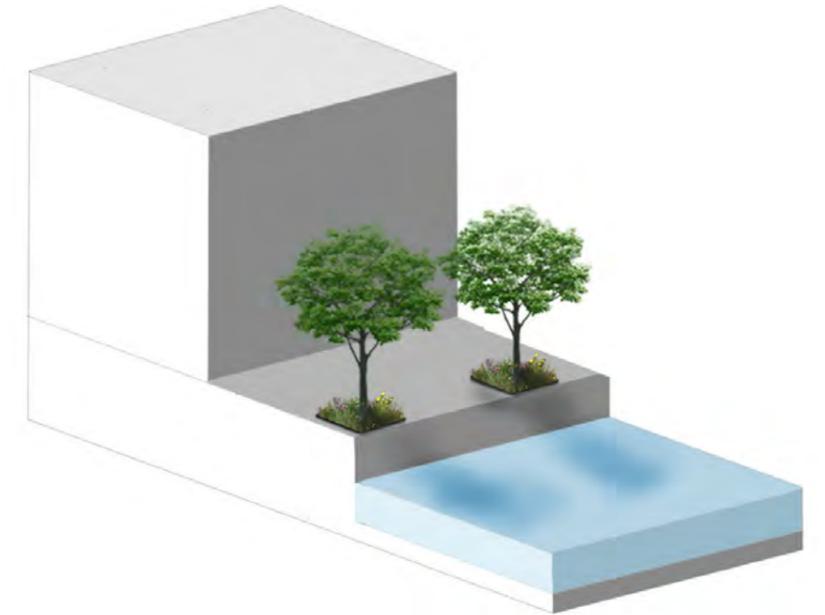


Figure 26: Enlarged tree pits

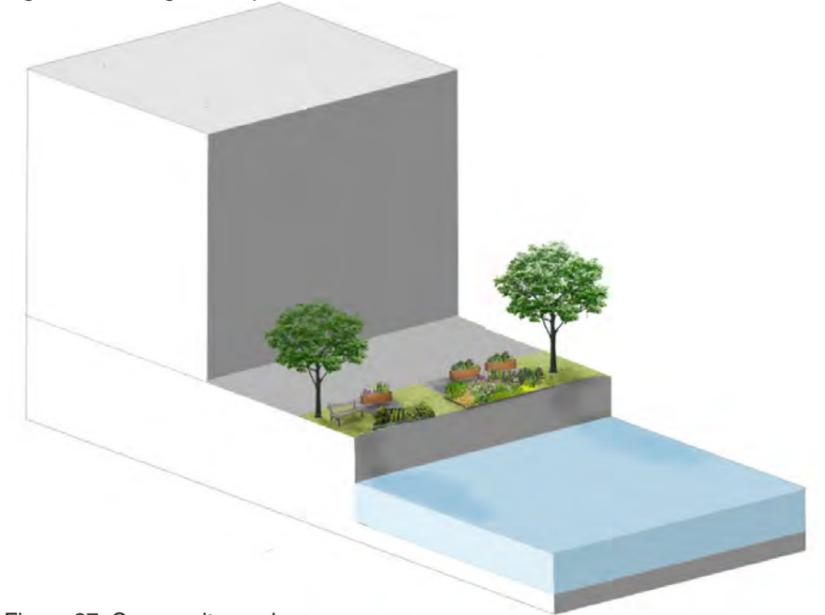


Figure 27: Community gardens

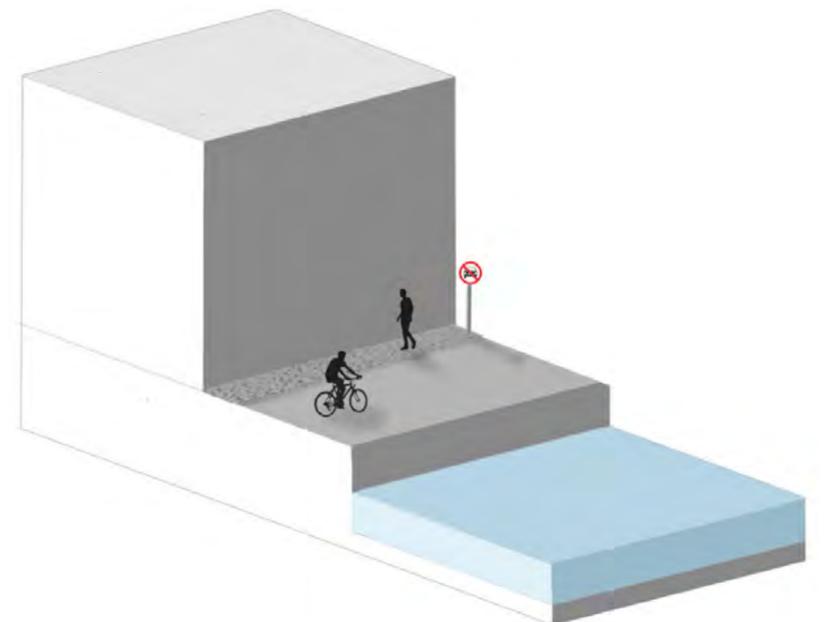


Figure 28: No car zones

### *Floating nature (figure 29)*

Floating nature is a type of nature development that already is being developed within Amsterdam. They consist out of steel constructions on which some sort of waterplants grow (Backerra et al., 2020).

In contrast to other type of nature development on water, floatlands can be easily removed and transported towards other places (Backerra et al., 2020).

The nature that is developed on floating nature can benefit the mental health of citizens, but also adds a lot to benefitting the physical health of citizens. Floatlands can help reduce the urban heat island effect and clear the air of pollution (Shanahan et al., 2019).

### *Private gardens (figure 30)*

Amsterdam being a big city has no space for big private gardens, yet still some small private gardens can be found in the city center.

A movement is going on where citizens are being encouraged to implement more green in their homes and especially their gardens. A lot of gardens are overly paved and suffer from lack of green influence (Stichting Steenbreek: samen van verstening naar vergroening, n.d.).

By transporting temporary nature towards private gardens, these gardens will get way more green. This will have a positive impact on not only the environment, by improving water drainage, air quality and urban heat island effect, but also on people and their mental well-being (Taylor et al., 2017).

### *Quay wall vegetation (figure 31)*

Quay wall vegetation can be developed in many ways. There are species that can grow on the stones, or rasters should be attached to the stones in order to make it possible for certain species to grow on.

Nowadays a lot of research is done on how quay wall vegetation can be developed in the most efficient way. Certain types of cement, bricks or quay wall shapes are being designed in order to make it more easy for vegetation to grow on the quay walls.

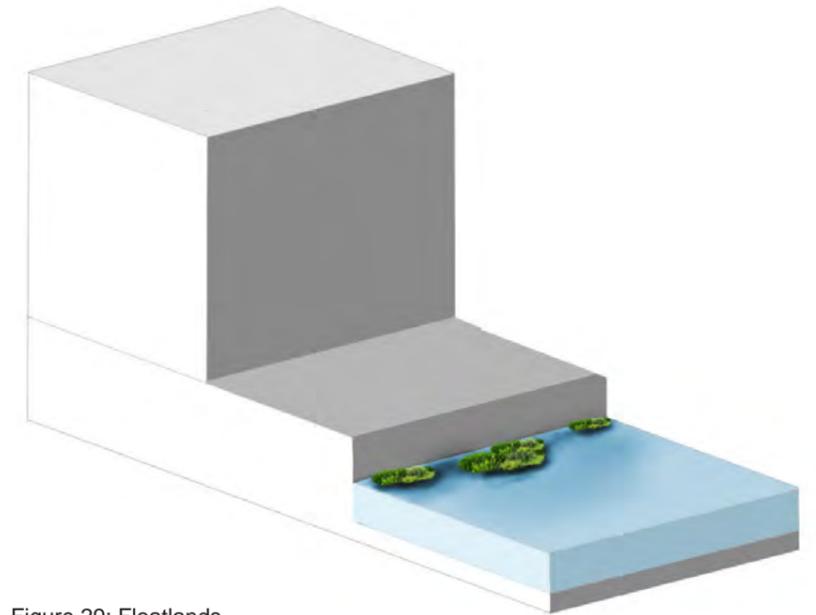


Figure 29: Floatlands

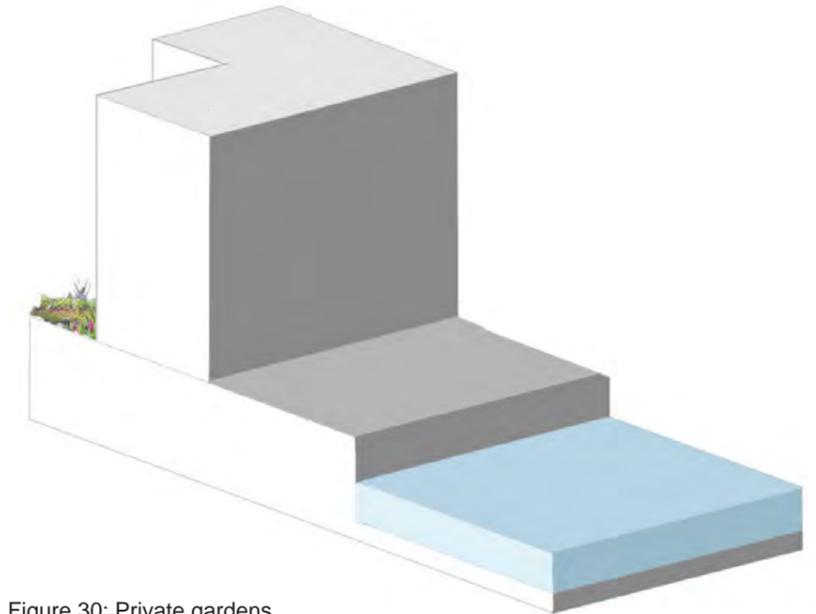


Figure 30: Private gardens

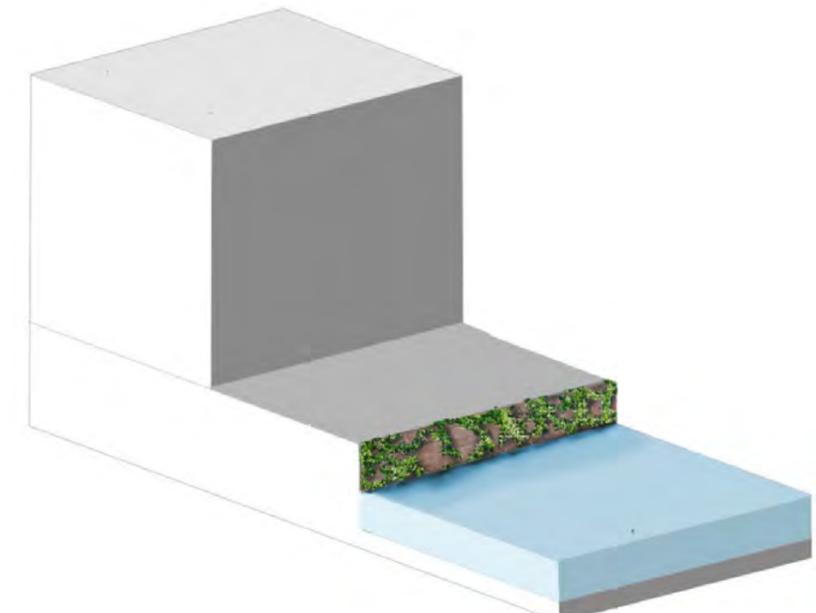


Figure 31: Quay wall vegetation

# Evaluation Design Guidelines

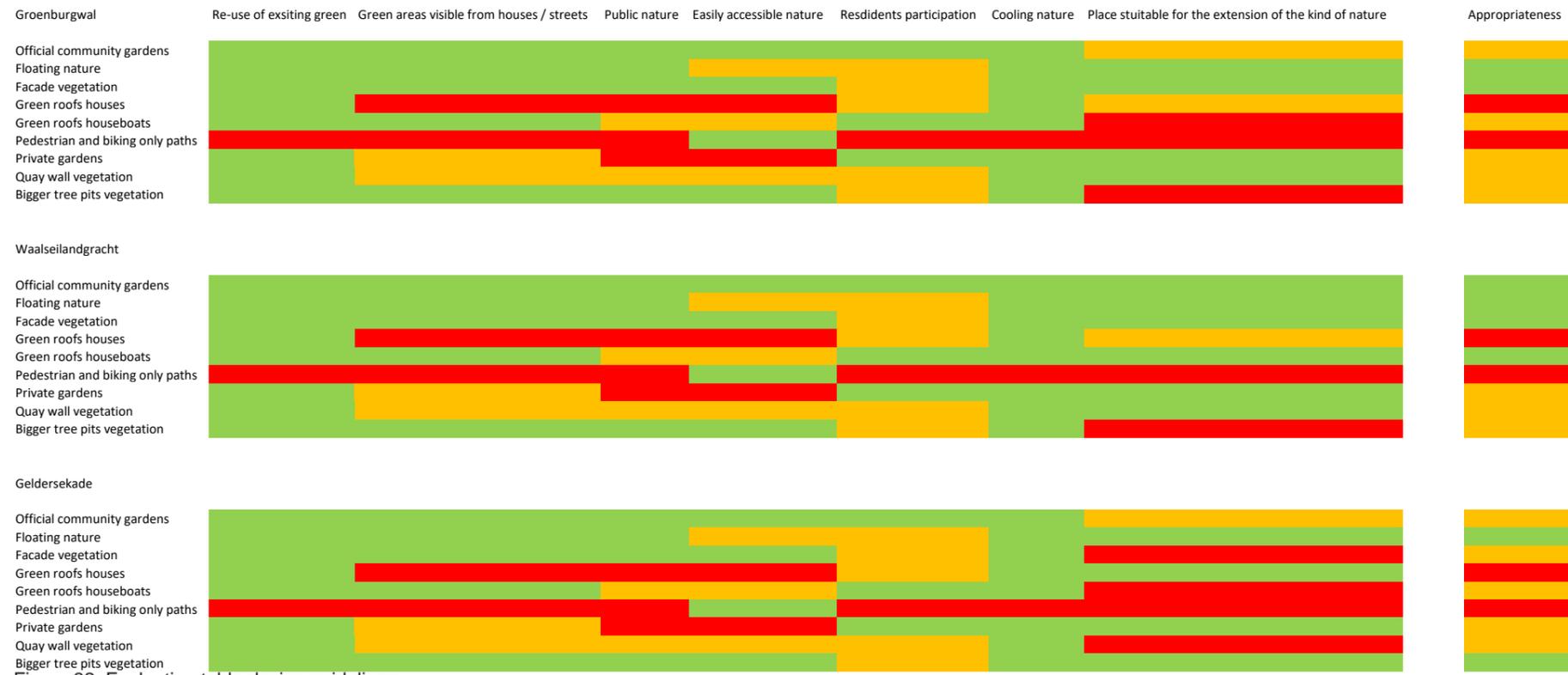


Figure 32: Evaluation table design guidelines

The plants from the idylls can transform into green roofs on the big number of houseboats that can be found at the Waalseilandgracht. Again, this way, all the nature is visible and as easy accessible for people as possible. The last possibility is the realisation of floatlands. There is a lot of space between the houseboats. It will be visible from the streets or from the houseboats and more plants will be reused.

The fact that the other design guidelines did not seem suitable for the locations is mostly based on the fact that the nature would not be visible from the street or the houses, such as for instance the green roofs on houses. In addition to that some of the guidelines could not be realized on certain locations since the type of nature needed for the design could not be found within the temporary nature on the temporary safety measures. Finally, not all design guidelines required the same amount of participation from the citizens, or were not even accessible at all for these people.

In order to decide which design guidelines will be used within the most optimized design, all design guidelines have been evaluated per location on whether they do, partly do, or do not reach the design goals that have been set up earlier in this thesis report (figure 32).

Eventually a conclusion could be made on which design guidelines will be used at which location in order to extend the temporary nature and improve the wellbeing of the citizens of Amsterdam.

The most suitable design guidelines for Geldersekade are the enlargement of the tree pits and the placement of boxes with plants on private gardens.

The Geldersekade has some spots with low parking pressure and some trees available. Therefore there is room for the enlargement of the tree pits, and since there are plants from idylls to extend which can grow perfectly there and can be seen from the houses and the street, it seems like a good design opportunity.

Another guideline that might work is the transportation from the flowers towards the school yard located there. The plants seem suitable and the public is quite big.

The Groenburgwal is a location where a design with green facades and floatlands would work. The green facades are visible from the streets and can be made from the rasters with climbing plants from the temporary safety measures. The floatlands are already there and can be moved along the sides, towards the quay wall and between the houseboats.

The Waalseilandgracht came out on top as the location with the most opportunities for the design guidelines that were presented. The location is suitable for the realisation of a community garden, since there is already a temporary community garden and the parking pressure is semi-high or semi-low on one side of the quay wall and it asks for participation from the surrounding inhabitants. The location can also have green facades, whereas also the rasters and climbing plants can be reused from the temporary safety measures.

# Designs

## *Geldersekade*

At the Geldersekade the placement of flowerboxes within private green, the enlargement of tree pits and placement of flowers on them, and the realisation of a green roof on the houseboat were appropriate design guidelines.

As visible in figure 33 nature in the shape of plantboxes have been placed at the gardens/squares from the temple and the school in the area.

On the east side of the canal, the enlargement of the tree pits is implemented. Therefore some parking spots will disappear. Yet, on this side of the canal, there is no high parking pressure and other parking spots are close.

The one present houseboat within the area also gives the opportunity to realize a green roof on top of it.

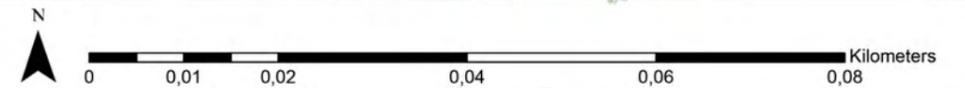
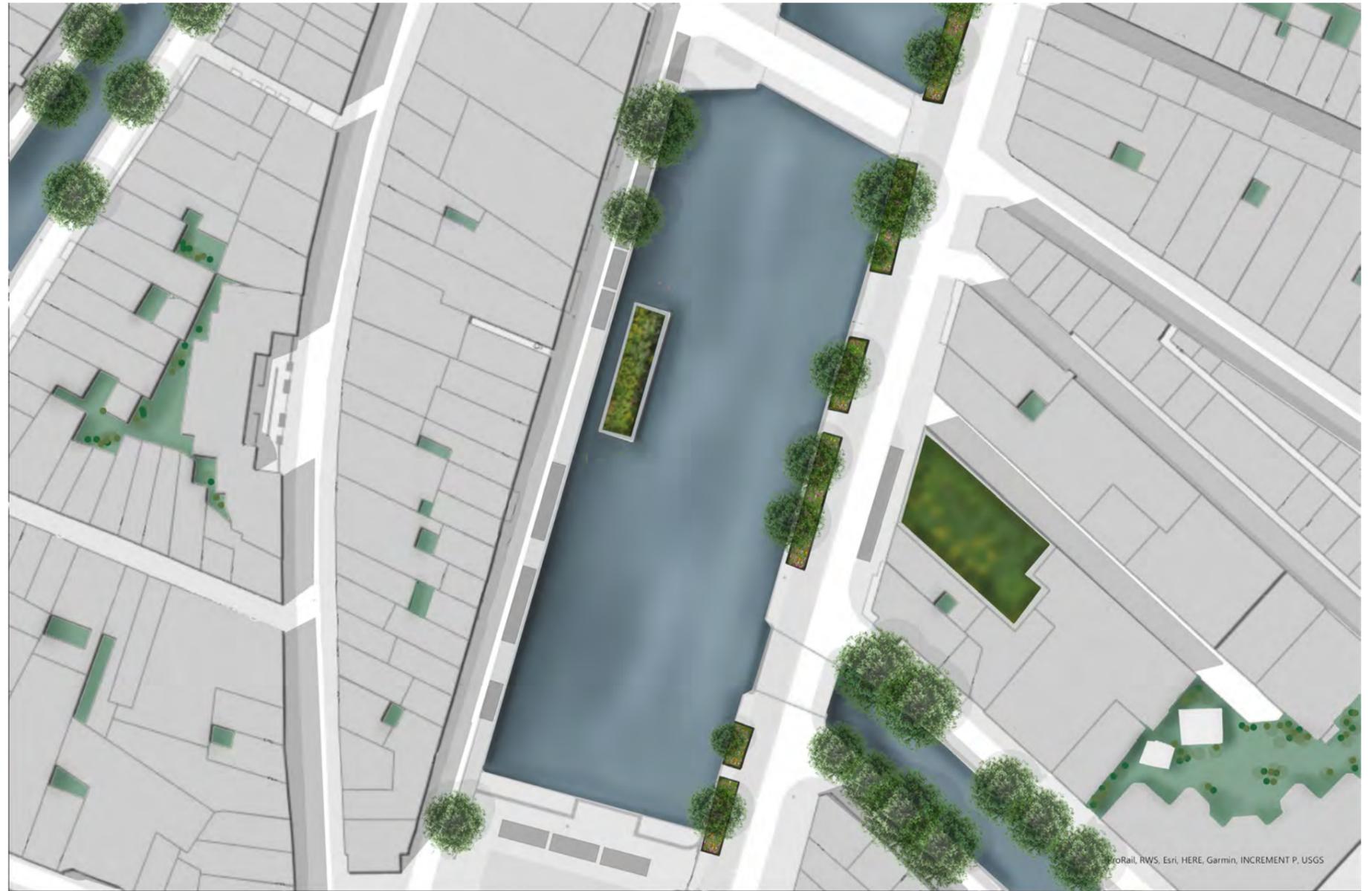


Figure 33: Design Geldersekade

Legend	
	Green roof houseboat
	Enlarged tree pits with green
	Plantboxes with green

Figures 34 and 35 show a top view and a cross section on what the enlargement of the tree pits with plants on it will look like on location. The tree pits will be approximately two till three times as large as the current size of the tree pits. The plants that will be re-used on this tree pits come from the idylls that can currently be found on the steel sheet pile measures.

Figures 36 and 37 show a top view and a cross section on the placement of plantboxes on a school yard, located at Geldersekkade. They are placed on the sides of the square and are very visible to the people passing them. These plants also come from the idylls.

How the green roof on a housboat is constructed will be shown later on when looking at the design on Waalseilandgracht in figures 46 and 47.

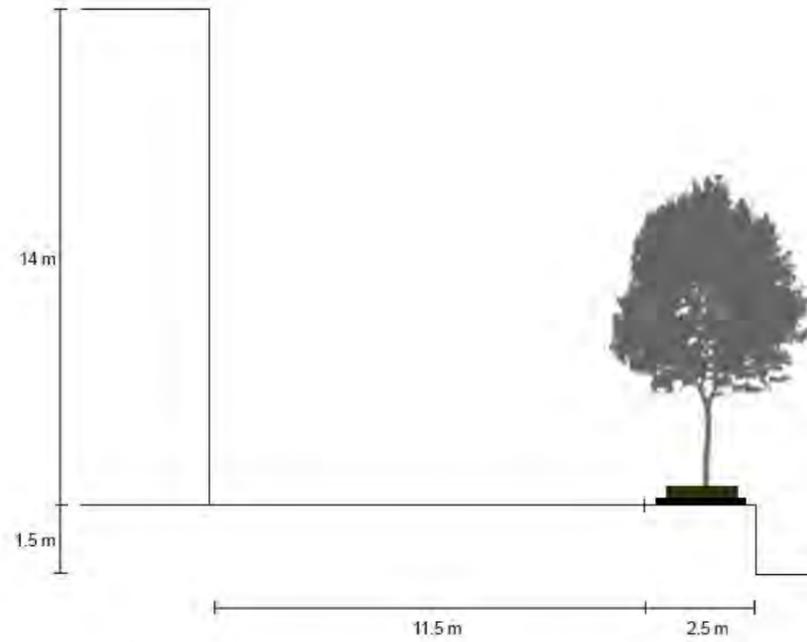


Figure 34: Cross section enlarged tree pits

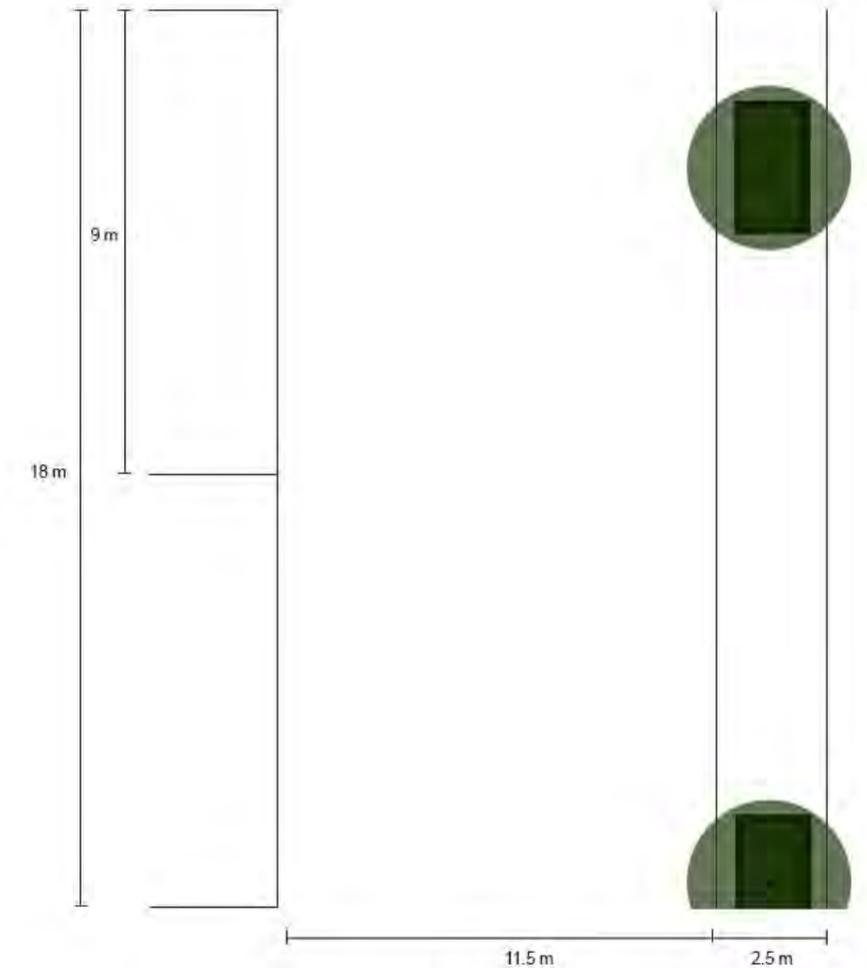


Figure 35: Top view enlarged tree pits

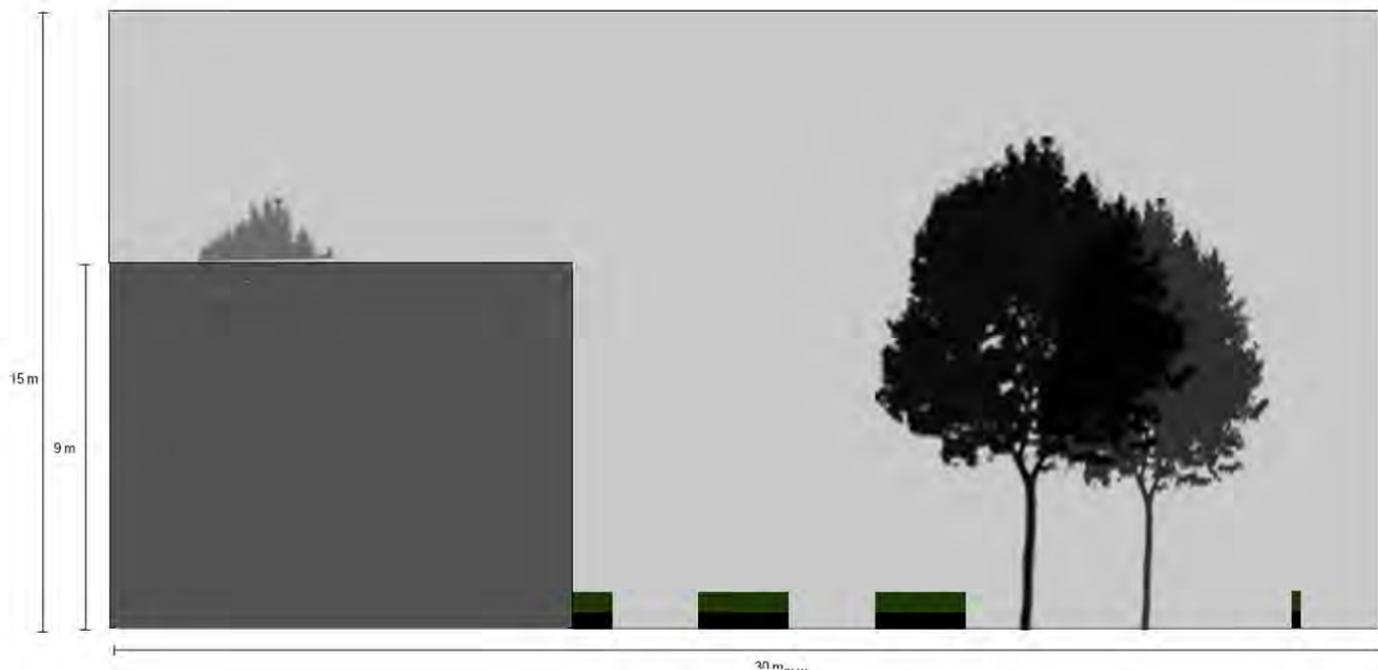


Figure 36: Cross section plant boxes

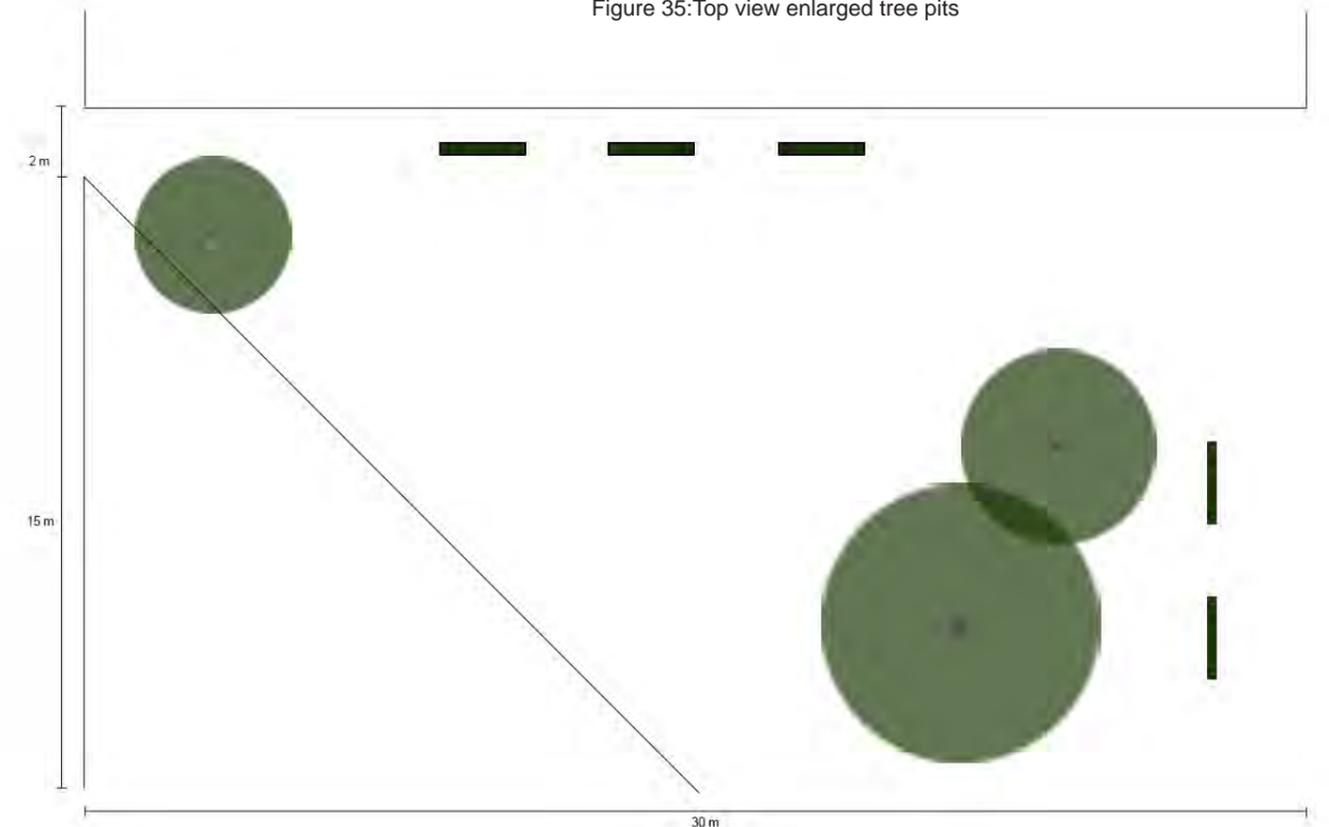


Figure 37: Top view plant boxes

## Groenburgwal

At the Groenburgwal a few locations are suitable for the realization of green facades as seen in figure 38. These buildings are relatively new and have an appropriate, flat surface on which the green facade construction can easily be build.

The other part of the design is the presence of floatlands. These can be found on the water in line with the houseboats. This way the floatlands are very visible for all citizens passing by and do not harm the water traffic.

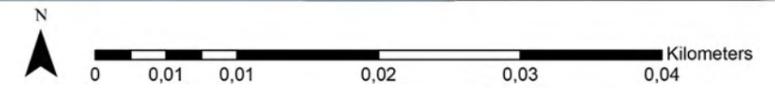


Figure 38: Design Groenburgwal

Legend	
	Green facade house
	Floatlands

Figures 39 and 40 show a top view and a cross section of the green facade. As can be seen, the facades are constructed a few meters above the ground and consist out of multiple strokes that differ in size. The plants and rasters that can be reused originate from the constructions around the temporary safety steel pipes.

Figures 41 and 42 show a top view and a cross section of the floatlands. As visible the floatlands consist out of multiple small boxes, floating between the boats. Since there are currently already floatlands, these can be reused and transported from the area around the bridge towards the sides of the canal.

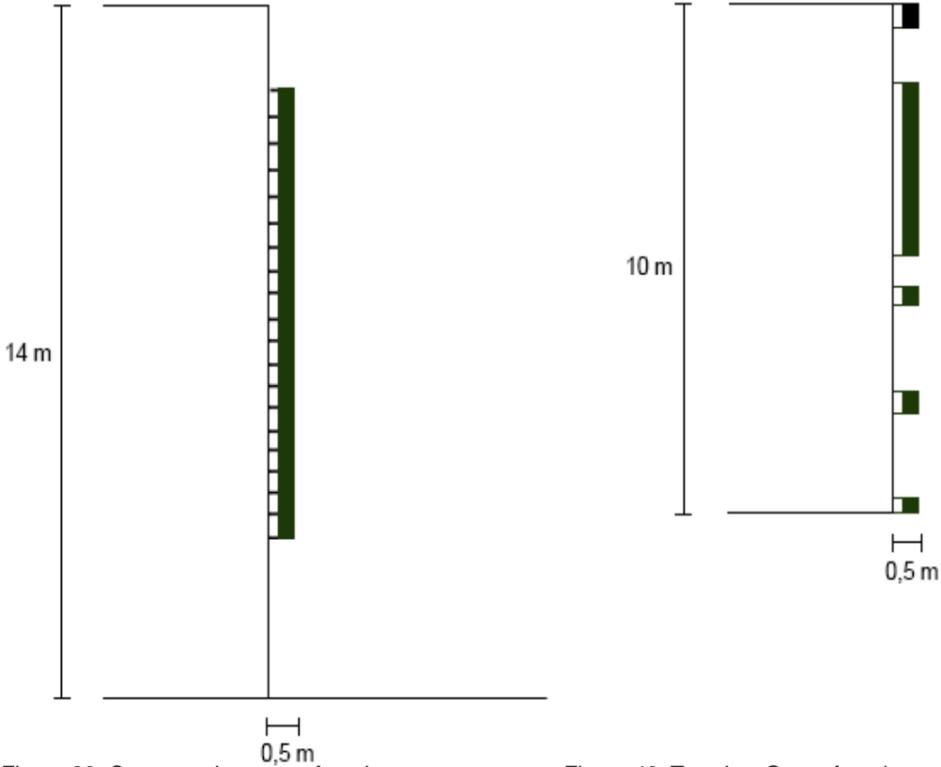


Figure 39: Cross section green facade

Figure 40: Top view Green facade

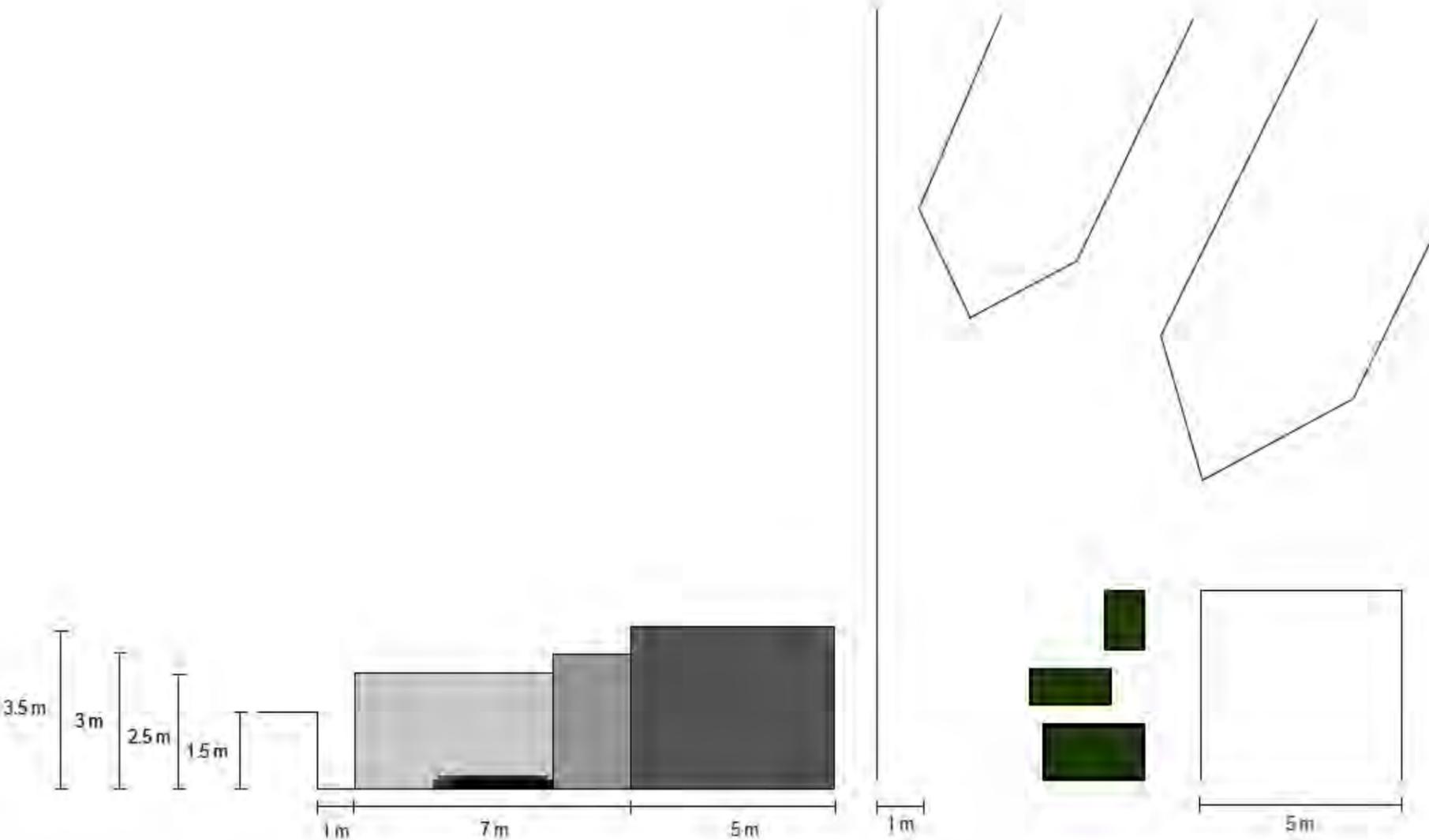


Figure 41: Cross section floatlands

Figure 42: Top view floatlands

## Waalseilandgracht

At Waalseilandgracht there are a lot of design possibilities as seen on figure 43. On all the appropriate houseboats, green roofs can (partly) be realized.

Just as at Geldersekade, at Waalseilandgracht there can be houses with green facades. Also these houses are relatively new and have an appropriate surface on which steel rasters can be attached.

Just as at Groenburgwal, in the area around Waalseilandgracht a school yard can be found on which plantboxes can be placed, again visible to a large number of people.

On the east side of the Waalseilandgracht the temporary community gardens will be transformed into a more definitive community garden. Here the parking pressure is quite low, so there is less need to maintain the current parking spots. Besides that, the people maintain the temporary community gardens at this moment can perhaps do the same for the more definitive community gardens.

Between all the houseboats, just as with the Groenburgwal, floatlands will be realized.



Figure 43: Design Waalseilandgracht

### Legend

	Green roof house
	Green facade house
	Green roof houseboat
	Floatlands
	Community garden
	Plantboxes with green

Figures 44 and 45 show a close-up of the construction of the community garden at Waalseilandgracht. The elements of the community garden can be sourced from the nature being there now at the temporary community gardens and the plantboxes. Also, nature from the other temporary nature can be at use, since the nature of the community gardens is very diverse.

A top view and a cross section of the green roofs on housboats can be seen in figures 46 and 47. The biggest possible surface area will be covered with plants from all of the temporary safety measures.

How the floatlands, the green facades and the plantboxes are constructed has been shown above at the designs on Geldersekade and Groenburgwal in figures 36, 37, 39, 40, 41 and 42.

A more realistic view on the designs is shown in the visuals of figures 48 until 51.

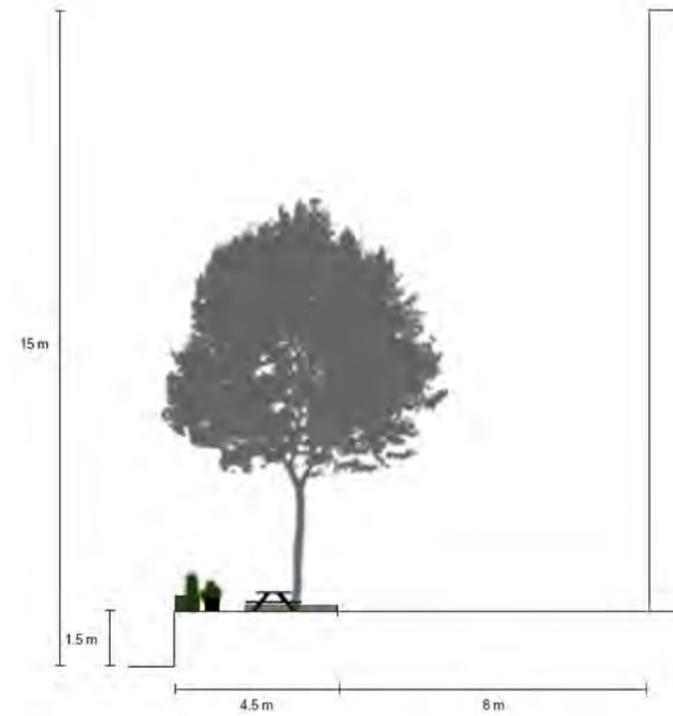


Figure 44: Cross section community gardens

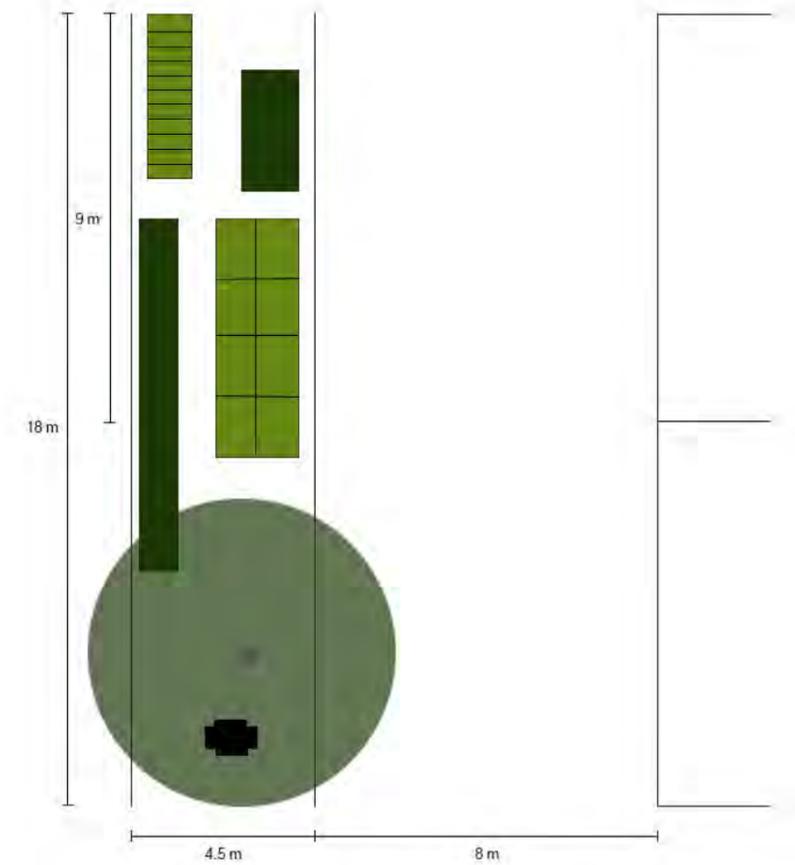


Figure 45: Top view community gardens

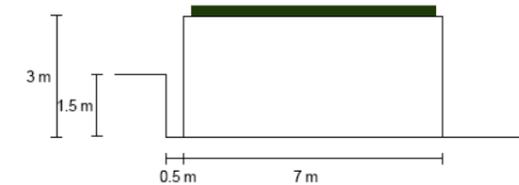


Figure 46: Cross section green roof houseboat

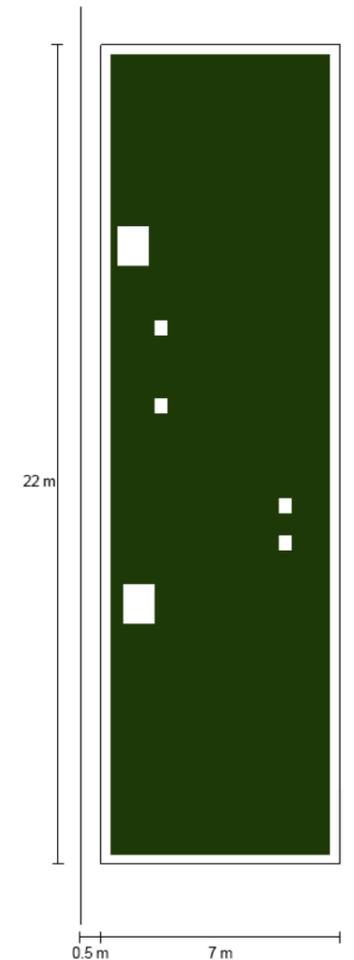


Figure 47: Top view green roof houseboat

# Visuals



Figure 48: Visual green facades and green roofs houseboats



Figure 49: Visual community gardens, green roofs houseboats and floatlands



Figure 50: Visual enlarged tree pits and green roof houseboat



Figure 51: Plant boxes on school yard

# Evaluation Criteria

Now that the three most optimized designs have been made, they can be evaluated based on the criteria mentioned before.

The first part of this evaluation is looking whether the temporary nature present within the area has been extended due to the design.

## *Gelderse kade*

Looking at Gelderse kade, there were only the idylls that had the opportunity to be extended. The location provided three types of possibilities on how this could be done. Therefore, the design will probably extend the temporary nature.

## *Groenburgwal*

At Groenburgwal growth on rasters and wetlands could possibly be extended. Looking at the climbing plants, only a select area of houses seems to be suitable for the realization of green facades. Therefore, the envisioned change achievable by extending the temporary nature is more difficult and lower, since perhaps not all citizens want to cooperate.

The wetlands on the other hand can practically all be extended. They only need to be transported towards another place.

Therefore, the design on Groenburgwal partially succeeded in extending the temporary nature.

## *Waalseilandgracht*

At Waalseilandgracht there are the most appropriate options available on extending the temporary nature. The design succeeded in extending the existing of the climbing plants via placing them on a lot of house facades, transforming a whole quay into a community garden, creating a lot of floatlands, green roofs on houseboats and plantboxes on private gardens.

Therefore the design on Waalseilandgracht did a really good job in extending the temporary nature and simultaneously created more options for developing new nature within the area. This can for instance be done at the community gardens, which can extend even more.

The second part of the evaluation is about the influence of the designs on improving the wellbeing of the citizens.

## *Geldersekade*

At Gelderse kade, there are only the idylls that can have a positive effect on the wellbeing of citizens. Yet these idylls consist out of flowers that will have a positive effect on the biodiversity and the environment in general. This will have a positive effect on the wellbeing of people.

The flowers are very visible for passers-by looking at the tree pits or the green roof of the houseboat. Also a lot of people will visit the school square and therefore will be seen by a lot of people, especially children and parents.

To conclude, the the design on Gelderse kade possibly will have a small effect on the wellbeing of citizens. Even if it is a small effect, this effect will be positive.

## *Groenburgwal*

At Groenbugwal there are two types of extended green that can have a positive effect on the wellbeing of citizens. These are climbing plants and wetlands.

As mentioned before the climbing plants can only grow on a small area within the design. Therefore, although the effect of the nature extension of the climbing plants is possible it maybe is to little in order to have a positive effect on the wellbeing of citizens in general.

There are a lot of floatlands visible, when travelling besides the canal. These floatlands will add to the visible green areas within the area and can help improving the air quality and especially reduce the heat island effect.

To conclude, the design on Groenburgwal has a partially positive effect on the wellbeing of citizens.

## *Waalseilandgracht*

At Waalseilandgracht there are multiple types of green that can have a positive effect on the wellbeing of the citizens. There are a lot of green facades with creepers, there is a community garden, there are floatlands, green roofs on houseboats, and plantboxes on private gardens.

All this extended nature is distinguishly present and visible or accesible for the citizens. For instance the community garden even asks for a serious participation of the locals, benefitting the wellbeing of them even more.

Because of the enormous amount of houseboats being there, the whole appearance of the area will be different after these housboats transformed their roofs into green roofs. This will have a positive impact on the mental wellbeing of the citizens, and in addition to that, the green roofs are very efficient in cleaning the air and reducing the heat island effect.

All in all, we might say that the design on Waalseilandgracht can be seen as the perfect example on how extending temporary nature can benefit the wellbeing of the citizens.

# Influence Urban Scale

The influence of extending the temporary nature of temporary safety measures through design has been investigated on three testbed locations on site scale. Yet, it might be interesting to have a look at what the outcome of this research could mean for the nature extension on a bigger scale; on urban scale.

Figure 52 shows the current situation of all the present green areas.

Figure 53 gives an impression on the situation of the green areas within 20 years, after all the temporary safety measures are gone and there has been an opportunity to extend all the temporary nature that has been realised over those years. It shows a ideal image, where at every location where there were temporary safety measures, all of the temporary nature has been extended and transformed in some sort of more permanent type of nature.

Figure 54 shows the added nature and whether this will be realised within the locations where the wellbeing for citizens is bad. Offcourse adding nature everywhere will help improve the general wellbeing of citizens, yet in some cases perhaps the extension of the nature can really help improve the bad environment into a more livable environment for surrounding inhabitants.

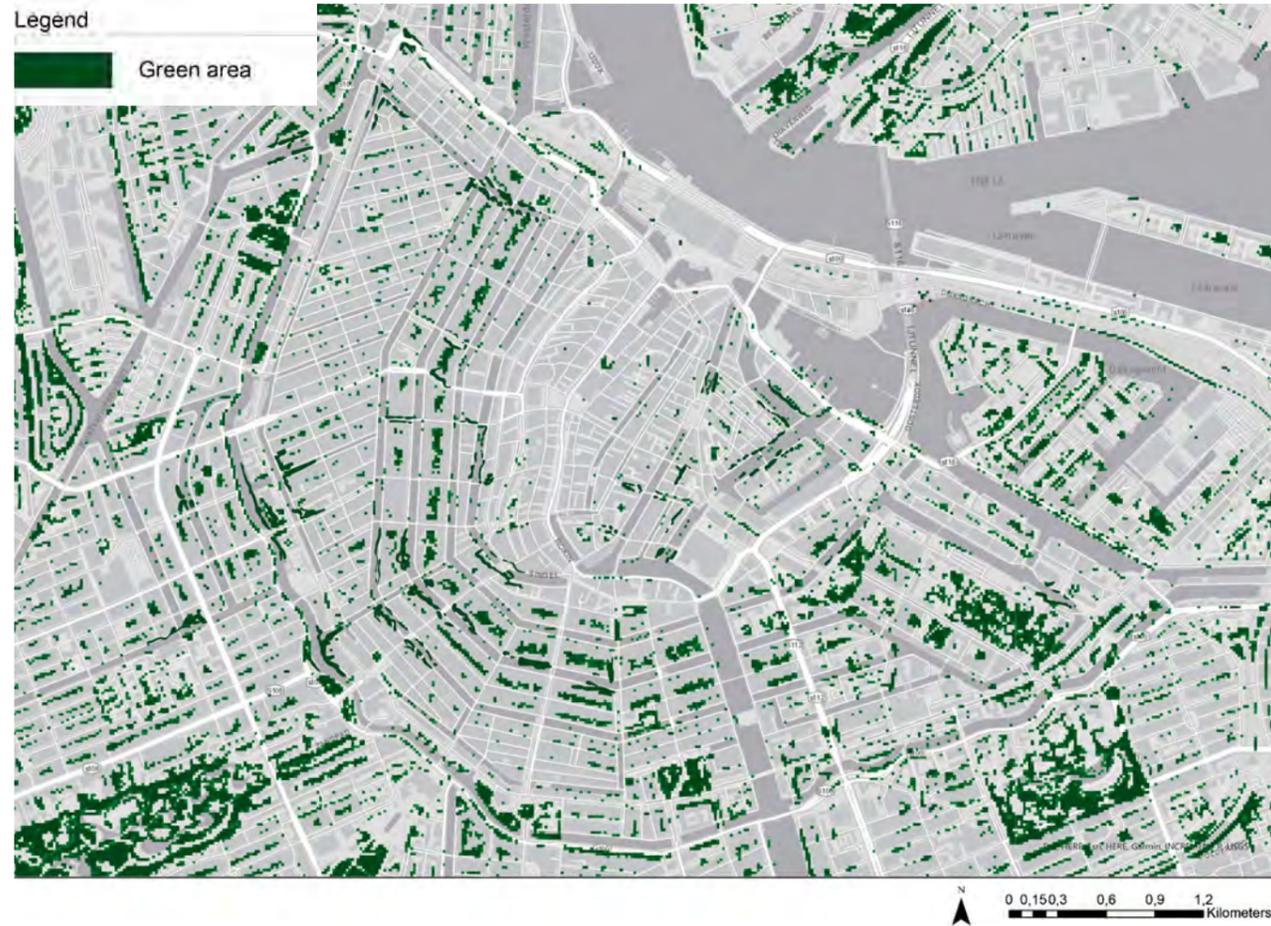


Figure 53: Future green areas



Figure 52: Green areas

Figure 54: Future green areas and bad wellbeing

## Discussion and Conclusion

Looking at the evaluation of the designs and the impact of designing the extension of temporary nature, one may say that the answer to the research question 'How can design extend temporary nature on Amsterdam quay walls while benefitting Amsterdam citizens' wellbeing?' is clear and the objective of this research 'extending the temporary nature while benefitting Amsterdam citizens' wellbeing' can be realized.

Yet, the amount of impact also became clear as the research progressed. Although making a design on the extension of temporary nature is possible and it will have an impact on the Amsterdam citizens' wellbeing, we are talking about extending nature on small scale, resulting in a direct impact that is small and local.

However, as stated by the urban catalyst theory (Shen, 2013) a small element can work as a catalyst and have a positive impact on for instance a city as a whole. It can start a chain reaction and inspire people on a bigger level to pursue and expand the small element. For instance, expanding the temporary nature can also trigger the development of 'new' nature within the city even more.

Especially when the participation of locals is stimulated, using something as an urban catalyst has an even bigger effect (Aalbers & Sehested, 2018). Therefore it is even more important that the participation of people is taken into account in the design, yet this can not always be enforced. For instance with the green roofs on houseboats, green facades on houses and community gardens, this might be a bottleneck.

The designs made for the testbed locations take up space, and especially spaces that are now parking spots. It has been assumed that in the future there will be less cars within a city and therefore it should not be a problem. Yet, maybe this is too optimistic. In that case there are less possibilities on extending the temporary nature while benefitting the wellbeing of citizens, or these possibilities will only occur later on in the future.

Another thing to take into account is the effectiveness of the cradle to cradle theory.

Maybe not all plants are that suited to their new location/function. Perhaps it takes more energy to extend the temporary nature instead of simply creating new green areas.

Extending temporary nature through intelligent design choices can show citizens the potential of preservation of nature within the city while benefitting their wellbeing and can inspire them to do this or even realize more green areas. In addition to that, when the impact and efficacy of design choices has been proven, future designers of temporary nature can take into consideration design choices that would make the transition to extending nature easier.

# Reflection

When I personally reflect on this research, I must say it certainly was a challenge. When I started reading into the subject of quay walls in combination with nature development, I noticed that a lot of research had already been done on nature development in the city and the impact of that on for instance biodiversity or the urban heat island effect.

I also read about the plans of the municipality to develop temporary nature over the next 20 years, saying that after the temporary measures were gone they wanted to maintain as much of that nature as possible. Yet, information on how this could be done could not be found. In the meeting with someone from the municipality at the start from my research, I confronted him with this fact. He confirmed that not much knowledge on that was available, but that they do were very curious on what the possibilities might be and wanted to gain knowledge on the subject.

That is when my research really began. I discovered this knowledge gap that I wanted to solve. Meaning, that I really needed to do my own research in order to gain knowledge on the subject.

The workload of this thesis was, at times, too high, but I already expected that since I am a perfectionist and from my perspective something is never finished. Also it took me some time to find the right approach for my research. The constant zooming in and zooming out, the adjusting of my research questions and constantly improving my work took some time but also made me critical and brought me to the place I am now.

All in all, I am very content with the research that I have done. I feel like I really added knowledge on this topic, which can be a premedation for other research.

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# Appendix

Number	Name	Measurement	(Possible) Temporary nature
1	Leidsekade	No parking	Flowerboxes, plant patches, pop-up community garden
2	Leidsegracht	No cars	Flowerboxes, plant patches, pop-up community garden
3	Prinsengracht	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
4	Keizersgracht	Being watched	x
5	Prinsengracht	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
6	Singel	Moved parking spots	x
7	Herengracht	Steel posts and beams	Raster growing, float lands, floating trees
8	Herengracht	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
9	Entrepotdok	Temporary auxiliary construction	x
10	Nieuwe Herengracht	No parking	Flowerboxes, plant patches, pop-up community garden
11	Groenburgwal	Steel pipes	Raster growing, float lands, floating trees
12	Groenburgwal	No parking, no heavy vehicles	Flowerboxes, plant patches, pop-up community garden
13	Grimburgwal	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
14	Ouderzijds Achterburgwal	No parking	Flowerboxes, plant patches, pop-up community garden
15	Kloverniersburgwal	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
16	Kloverniersburgwal	No parking	Flowerboxes, plant patches, pop-up community garden
17	Recht Boomsloot	New street furniture	Flowerboxes, plant patches, pop-up community garden
18	Waalseilandgracht	No parking, no heavy vehicles, steel sheet piles, move houseboats	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
19	Geldersekade	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
20	Singel	No parking	Flowerboxes, plant patches, pop-up community garden
21	Singel	No parking	Flowerboxes, plant patches, pop-up community garden
22	Herengracht	No parking, no cars, steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
23	Prinsengracht	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
24	Keizersgracht	Steel sheet piles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
25	Leliegracht	Steel sheet piles, no parking, no heavy vehicles	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
26	Lijnbaansgracht	Steel sheet piles, no cars	Idylles, willows, float lands, nature friendly shores, green sheel piles, fluted pendant
27	Lijnbaansgracht	No heavy vehicles	Flowerboxes, plant patches, pop-up community garden
28	Lijnbaansgracht	No cars, no parking	Flowerboxes, plant patches, pop-up community garden
29	Marnixkade	No heavy vehicles	Flowerboxes, plant patches, pop-up community garden
30	Da Costakade	Move houseboats, peoples participation redesign of the street	Flowerboxes, plant patches, pop-up community garden, float lands
31	Jacob van lennekade	No cars, no parking	Flowerboxes, plant patches, pop-up community garden
32	Jacob Catskade	Parallel parking instead of cross parking	x
33	Marnixkade	No parking, steel sheet piles	Idylles, willows, floatlands, nature friendly shores, green sheel piles, fluted pendant
34	Singelgracht	No parking	Flowerboxes, plant patches, pop-up community garden
35	Prinsengracht	No verhicles, no parking	Flowerboxes, plant patches, pop-up community garden
36	Brouwersgracht	No parking	Flowerboxes, plant patches, pop-up community garden
37	Brouwersgracht	No cars, no parking	Flowerboxes, plant patches, pop-up community garden
38	Havengracht	No cars, no parking	Flowerboxes, plant patches, pop-up community garden

Figure A: Table temporary measures inventory