

Nature Inclusive Design

A tool for degraded urban areas and climate change mitigation.

Faculty of Architecture and the Built Environment, TU Delft

Building Technology

Master Thesis
Faculty of Architecture and the Built Environment, TU Delft
M.Sc. Architecture, Urbanism and the Building Sciences

Building Technology Track

Title:
Nature Inclusive Design : a tool for degraded urban areas and climate change mitigation.

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05 November 2022

Delft, The Netherlands

Acknowledgements

I would like to start this section by reminding myself, simply, that this is a work of self-resilience, overcoming tough times, and aspiring for a brighter future.

I'm proud and eternally in debt to my parents for always supporting me no matter the distance, this journey has a piece of you all, with endless love. Sandra, Moisés, and Rodrigo (Chico is also included) you all are in my mind every day.

To my mentors for all the knowledge transmitted and the inspiring insights, always pushing and encouraging me to produce and challenge myself, and also the patience for comprehending all the conditions that I've been through and being flexible in those terms. Denise and Andy, I'm grateful.

My friends and all the life I've built up here in the Netherlands, I enjoyed all the moments and the outcome is happiness.

We move forward
G.Ferreira 04.11.22 - Rotterdam

abstract

At a fast pace, the urbanization level is increasing worldwide and the projections indicate that 2/3 of the population will be living in urban environments by 2050. This implies many concerns, more population and urbanization, nowadays, are directly translated to more consumption counting to the inflated orb that lingers all the climate changes matter. The Built environment is directly connected to most of the damage caused by global warming, counting at least 1/3 of the total emissions.

Urbanization brings a series of problems that make the subject more complex and a sensitive topic that accelerates the global warming effect is the devastation and the conflict of the urban, opposing and dominating the green and blue territories. Recent research has analyzed and noted that the overall quality, and quantity of nature, encompassing fauna and flora are decreasing worldwide. In the Netherlands, since urbanization started to take place and dominate the lands, nature has reduced to approximately 15% of its original state, and with that, a chain of reaction emerges. Humans, by making nature grey, are leading to a general complete problem that confines the entire earth's balance in terms of ecology: fewer species, and less variety of flora, conducting to other kinds of crisis, such as food, air, water, and weather.

Recent efforts are displaying that the urban lands, apart from being the human biotope, should encompass and blend with the natural environment. For that is necessary to change current scenarios and also consider bringing nature into the design process, which can cause a myriad of benefits and revert the damage that has already been placed. Simply balancing and offering more space for fauna and flora in the cities, the biodiversity can take its path of growing again, not only that, but combining a set of strategies could likewise be used to improve the life quality in the cities, managing weather and lessening the weather stress, and by that, mitigating the effects of the climate changes.

keywords: nature inclusive design, nature based solutions, sustainable development

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1 . FAMILIARIZING

01.01 – THEME

Nature Inclusive Design: a tool for degraded urban areas and climate change mitigation strategy.

01.02 - RESEARCH PROBLEM

The current concern with climatic conditions, the exacerbated growth of the world population, and the environmental impacts caused by the uncontrolled advances of the economy have been producing high levels of pollution and scarcity of natural resources and decreasing overall biodiversity, which directly influences negatively the ecology systems around the planet. At the same time, Rotterdam municipality calculates the challenge to build 50.000 homes by 2040, which translates to even more urbanization, accelerated consumption, and expanding the greyish layers in natural areas.

The buildings sector, which plays a big role, is one of the biggest causes of impacts in relation to the usage of resources, as well as the constant operating expenses, the petrification of lands, converted into cities is impacting directly the biodiversity balance on earth.

Biodiversity is a vital support of all life forms on earth, including us, humans. In Rotterdam, the biodiversity levels are in a critical scene. Since dense urbanization started, biodiversity in the city has declined. The metropolis is too noisy and bright, the air is becoming more contaminated and the soil is drying up, which also high chance of salinization, provoked by flooding, hence fauna and flora, are suffering the consequences of a less nourishing place. In other words, the city is constructing too much while nature is being neglected.

At the same time, the technological advances of our society and research on the ecological fields are allowing Architects, Urban planners, and Building technologists to balance this situation and perhaps revert this reality. By incorporating nature into the built environment, as a tool for mitigating impacts. As we will see throughout this work, is it possible to explore the strategies (some of them have already been explored) from nature-based solutions, using strategies to give space to fauna and flora, and at the same time achieving societal and environmental challenges.

``The position of that urban quality of life can be designed for plants, animals, and humans to prosper together. It will require calibration of new spatial solutions.``

Maaïke van Stiphout (2019)

01.03 OVERALL OBJECTIVES

Thus, this work will be based precisely on the approach of Nature Inclusive Design methodology application, with greater emphasis on increasing the nature value of degraded/areas of opportunity. This research highlights the main strategies that can be applied for specific circumstances, which enable existing buildings structures, and places, to be altered, being part of and representing the advancement of the design approach, which encompasses nature as a norm.

Designing with nature does not translate only to greening roofs, for a change, but indeed giving space and conditions for fauna and flora to develop along with the blocky environment, bringing also other benefits, such as better wheater management.

The Nature Based Solutions (NBS) methodology aims to tackle and approach the current global issues, which are highlighted by the #ODS17 (Sustainable Development Goals) of the UN (United Nations). Therefore, Architecture and the design considering the NBS utilized as a strategic object/tool to reduce the consumption of resources and balance ecosystems, becomes a topic of relevance and growing significance, as the future will depend on the union of knowledge and technology to sufficiently meet global needs in a bearable way, seeking greater efficiency with less possible environmental impacts.

In this research, the Rotterdam Stadhavens will be used as the areas of opportunities, and the application site for the methodology for this study. These sites are marked in the new zoning plans as areas on transformation and should be highlighted as engaging mechanisms, promoting environmentally affable concepts, therefore the M4H is the area chosen to be analyzed.

01.04 OBJECTIVES

Analyze areas of opportunities, utilizing the Nature Based Solutions (NBS) and Nature Inclusive Design (NID) methodologies. Scanning through degraded and transformation areas as a canvas for exploration of 3 main topics :

1.Increasement and restoration of the nature value in the built environment through nature-based solutions. Translating the variety of every living form, including water, landforms, and soil.

2.Enhance NID and NBS as standard for a design approach; Utilize the methodology to experiment in a testing field (M4H) as a tool to mitigate climate change stormwater control.

3.Improving ecological relationships in urban areas through the mixture of different methods, such as materiality and urban strategies.

01.05 Research questions:

How Nature-based solutions (NBS) can help to redevelop, and add nature value while responding to climate change and societal demands to the current M4H area in Rotterdam?

Sub-Questions:

- *How existent urban structures can be integrated with nature-inclusive design, in order to improve health quality and biodiversity?*
- *How can architecture and design strategies help to maintain, and improve urban biodiversity + ecosystems in big centers?*
- *How can nature be introduced into architecture to improve urban life quality and biodiversity, creating new habitats and conditions for fauna and flora?*
- *Is it possible to have the built environment co-existing in symbiosis with the natural territory, for a finer urban future?*
- *How NBS combined within the design process, could help to achieve climate requests and create a stormproof M4H.*

01.03 Reseach Boundaries

1.this research intends to explore and apply the NBS methodology to a selected area as a canvas for exploration.

The focus is on applying preliminary global strategies that would serve to respond to the demands after introductory analysis of the object on the scope, in this case exploring M4H.

2.The analyses are limited to existing repository content around the object of study, such as meteorology reports, and documents provided by the Rotterdam municipality, such as stormwater predictions, current levels of heat stress, flooding, and biodiversity levels.

3.The research is limited to applying strategies that are listed in the literature and case studies, the overall design is preliminary, and explores global answers in order to tackle the current problems of the area.

4.The design takes partially into consideration some further plans of the area of application, such as zoning and further masterplan for the M4H (Delva planning for instance), however, the overall objective is to utilize the area as a sandbox where the current data can be utilized as a base for the experimentations.

5.When approaching some existing buildings, and interventions that would follow, the design is limited to the material available in terms of technical drawings, however, the focus is the application of the strategies on those as methodology exploration.

01.06

Research relevance - scientific and social

the Nature Based Solutions (NBS), are presently being approached by many governments as strategies to meet and achieve climate agendas, not only that, NBS has been proved its power with a myriad of possibilities for the ones that are designing with it, and it is a powerful tool that can range from simple strategies with low budget and time investment to more complex ones, but all of them leading to an advantageous collection of goals. In the Netherlands scenario, more specifically in Rotterdam, the subject is considered to be a highlighted topic by the municipality. The latest plans regarding zoning and also weather management, as the masterplans, areas in transformation, and new investments are consistently encircling NBS, as a standard design approach to answering both societal and climate demands.

Thus, is clear that the more the topic is practiced and developed, the more application and expansion it will have.

In the scientific field, while the green and blue environments are more inserted into the urban terrain, new connections start to arise in the ecology linkages and maturation. The exploration of this topic more deeply while it is brought more into the spotlights of designers, can help the more precise predictions on how fauna and flora can develop in certain conditions, as new biotopes are created so as the expansion of species, a variety of nature and etc. Adding to that, those strategies once placed have a real impact on wheater management, and this is a priceless tool for the scientific field, while new studies can be lifted in other to improve overall life quality so as nature value.

For the graduation studio - This research is one exploration and application of the methodology that has been approached in the academia, especially in TU Delft, it also intends to solidify the school procedure on research methodology of analyzing and applying strategies, experimenting, collecting results and reflecting, reevaluating, improving procedures. The importance of utilizing NBS as a standard strategy for design can help Building Technologists and architects to perform higher results in terms of environmental qualities, such as fewer emissions, less consumption, and neutral and environmentally friendly buildings. Not only that but also in terms of materialities and gadgets/strategies that can be affixed to the design in order to improve building qualities.

01.07 Research methodology

The method of research is divided into 4 main topics and further split into more subdivisions within the topics: (Note that in the booklet the numbering sequence is different to organize the topics more closely)

- 1- Theory phase - literature review
- 2- Case studies
- 3- Analysis and Design phase
- 4 - Conclusion and reflections

1- The theory phase

is the collection and brief of theory, focused on understanding what is the main literature around the topic, what are the different aspects of the Nature Inclusive Design (NIC), and Nature Based Solutions (NBS) methodology, and what strategies are more suitable to every application.

- 01.1 . Problematizing, why do the architecture and built environment have a relevant role in this scenario?
- 01.2 . Biodiversity affected
- 01.3. Ecology panorama
- 01.4 Building with Nature
- 01.5. nature based solutions
- 01.6. City as an ecosystem
- 01.7 Nature approach for cities
- 01.8 Theoretical framework (NBS)
- 01.9 Overall benefits from NBS

2- Case studies

collection of projects, interventions, and studies where the theory is applied. Other inputs can be collected too and validated, for instance, strategies that have been used in other to increase biodiversity and offer habitat for animals and insects. Also between the projects selected, the intention is to bring different scales, ranging a greater scope of systems applied.

- 02.1 . Primary school for sciences and biodiversity
- 02.2 . De ceuvel
- 02.3. One central park

3- Analysis and Design phase -

an overall look over the area of study (M4H, Rotterdam), examining the background data, and passing through an investigation to identify potential weaknesses that could be worked out by NBS.

03.1 . Why Rotterdam and Port area?

03.2 . Area of study

03.3. Area analysis (buildings and preexistences)

03.4. climate impacts (heat stress, drought, flood)

03.5. biodiversity in Rotterdam

03.6. use of land and soil quality

03.7. Interventions

This subphase, collects the inputs from the analysis phase and applies strategies accordingly to methodology and also explores possibilities listed in the case studies (such as materiality or techniques), in this step, the idea is to show what are the problems in the area, and which solutions can best fit in order to achieve the expected results, following the objectives of the research.

03.7. interventions objectives and parameters

03.8. intervention x analysis

03.9. green corridor

03.8. intervention x analysis

03.9. green corridor project

03.10. situations interventions (sections, plans, details)

03.11. building physics - building intervention validation

04. Conclusions and reflections

In this phase, an overview of the final outcome is reflected and commented on. An overall improvement of the area is expected in terms of nature value, ecology, and storm weather control. The results can be discussed by proposing ``now x then`` material, exploring and detailing what outcomes should be expected by placing these interventions.

4.01. overview of the final design

4.02. reflection and conclusion, discussion

4.03. further suggestions and developments

4.04. references

1.08 Research methodology and framework

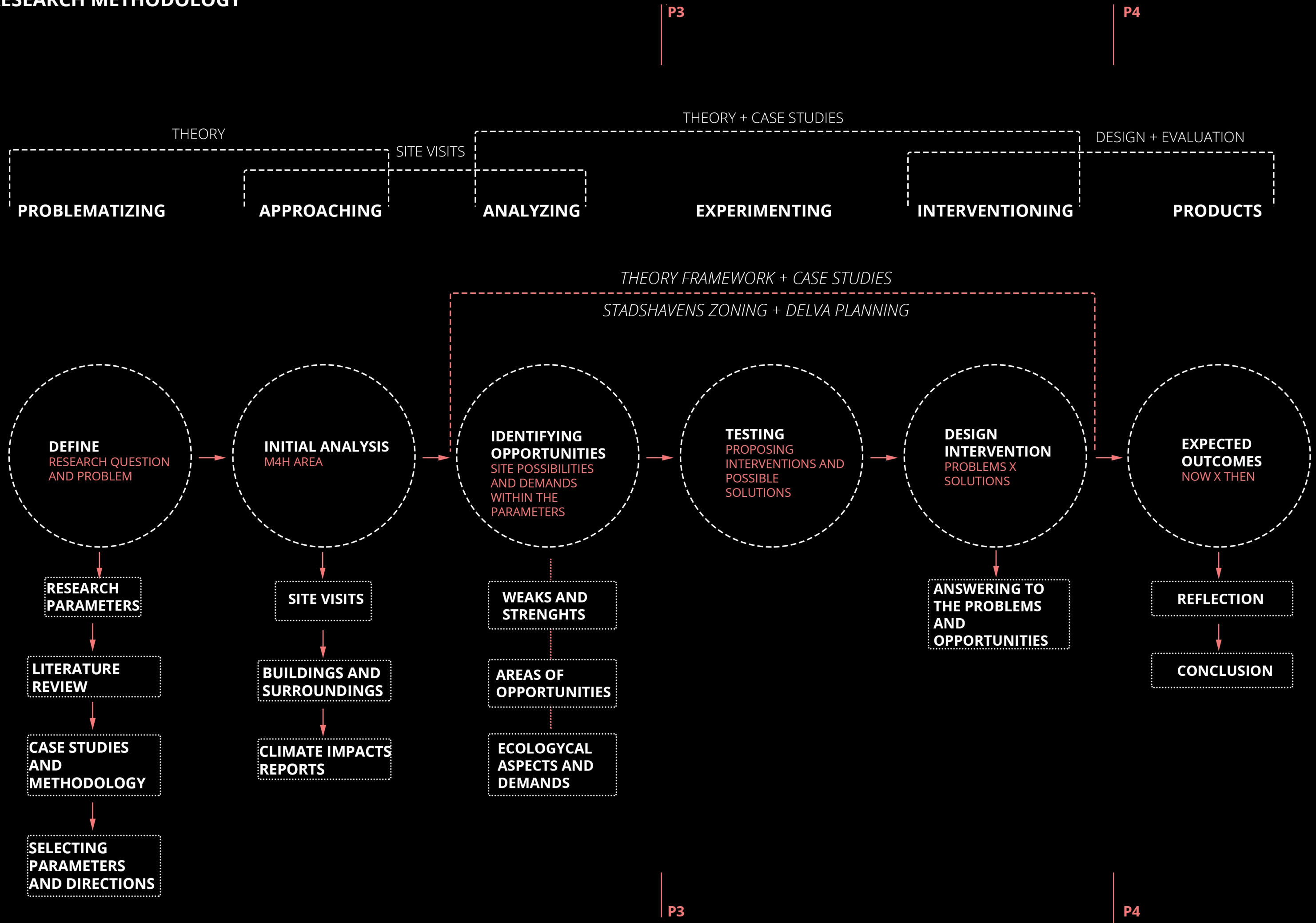
The methodology framework aims to first approach the Research question and problem within the scope of biodiversity. It is stated that urbanization and the built environment are responsible for at least 30% of the overall consumption of energy, which accounts likewise for a huge plot of emissions, contributing to the advancement of climate distress.

The consequences for biodiversity are clear, and it is been observed that the levels are decreasing while the world becomes greyer. This first part plans to clarify what are the impacts for biodiversity and climate. From this point, exploring further the literature, the Nature Inclusive Design is studied from its principles to its applications as a tool to possibly mitigate the stressing scenarios, and methodology focused on the application into the built environment.

In the further stage, having the main theme approached, case studies are explored to recognize the processes that take place in reality, which outcomes were expected and what took place in comparison with what is suggested in the literature. Also, the case studies are good to explore which strategies are more suitable for certain realities, those should serve as north and guide in the intervention phase, referring some actions to the background information that was investigated.

The analysis and design phase comes after the investigation process. the first step is to investigate the zoning plan of the area, the buildings, and pre existences, highlighting important points, and historical buildings. After a climate analysis takes place to understand what are the problems occurring in the area, and also projections for the future. The Intervention then is an answer to venture into those problems from the climate and biodiversity perspective, referring to the method and literature/case studies. After the design/intervention stage, the conclusion and outcomes reflections wrap the research, comparing expected outcomes and other processes.

RESEARCH METHODOLOGY



2 . PROBLEMATIZING

- 02.1 Problematizing
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02.01 -WHY THE ARCHITECTURE AND BUILT ENVIRONMENT HAVE RELEVANT ROLE IN THIS SCENARIO?

The world faces now unpredictable times and is constantly and quickly changing. It has been more difficult to predict weather and prevent catastrophic events, this is mainly caused by the unsteady system we live in nowadays: fast urbanization, increasing population, and the advance from the grey sphere to rural.

climate change

Climate change is a very sensitive topic, and it surely brings several consequences to our lives and to the environment, including fauna and flora. It is mentioned that our whole system and environment are so exposed and dependent on balance, that simple changes such as an increase of 2 degrees in the average temperature, could cause a series of unbalances: floods, a decline of species, permanent lower coral reefs populations, and as a domino effect, one thing leads and push other results, and those are potentialized by the advance of the urbanization, industrialization, excessive consumption, and emissions in the atmosphere. (IPCC, 2022).

The called grey territory is responsible for a huge parcel of the damage that is collaborating to boost climate acceleration. Accordingly, to the UN report for climate of 2020, buildings are accounting for at least 35% of the total greenhouse emissions, while industry and transportations are with 32% and 23% respectively. It is accounted also that the embodied carbon affects 11% of this whole portion, while the building sector is also accountable for at least a third of this. A reasonable part of this consumption is due to the assembly process, such as cement and material production, likewise burning fossils on buildings for heating, cooling, and other operations.



figure 01 : sao paulo skyline - pure grey density (wikiwand, 2021)

Buildings account for 35%-40% of the total greenhouses emissions

70% of global emissions are attributed by cities

Without changes, emissions of building will double in 2050. (IPCC, 2020)

2.2 BIODIVERSITY AFFECTED

Looking a bit closer, it is described that 70% of the global emissions are attributed to cities, while those only cover 3% of the earth's surface. Over 50% of the world population is gathered now on that 3%. This number is relevant, as we also observe the population and urbanization predictions by the United Nations, where urbanization is projected to be 2/3 of the overall population. (UN DESA, 2018)

With this collection, if nothing changes, the emissions caused by the built environment will at least double by 2050. Hence, with the domino effect, more houses will be required and more energy, translating into more emissions if no actions are taken to change its panorama. (UN DESA, 2018)

As observed in the first chart (figure 2), the world population is fast pacing towards an even more citified society, as the rural population is decreasing.

The effect of urbanization on biodiversity can be noticed in the second chart (figure 3). After the 1900s urbanization starts to run up, and at the same time biodiversity levels start to decrease, consequently, the number of species starts to decline, and hence, its abundance is lowered as humans start to expand their urban centers upon the countrified areas. It is evident that the only solution to balancing this scenario, knowing that urbanization only advances, is to bring balance between those areas, suggesting a co-existing scenario.

biodiversity
decreasing

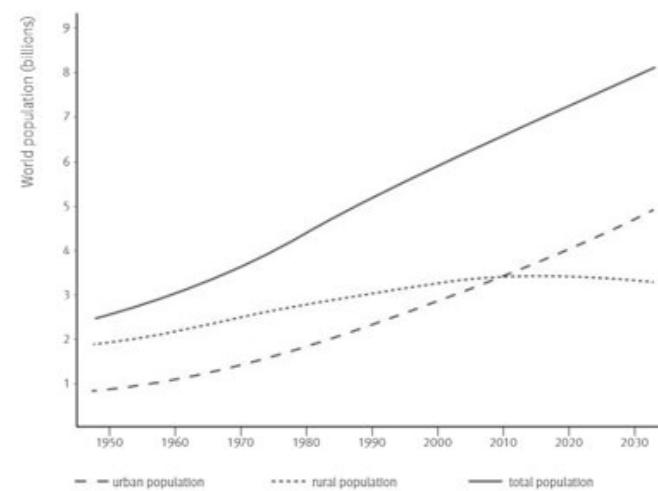


Figure 2: Urban x Rural
Author: Maaïke van Stiphout (2019)

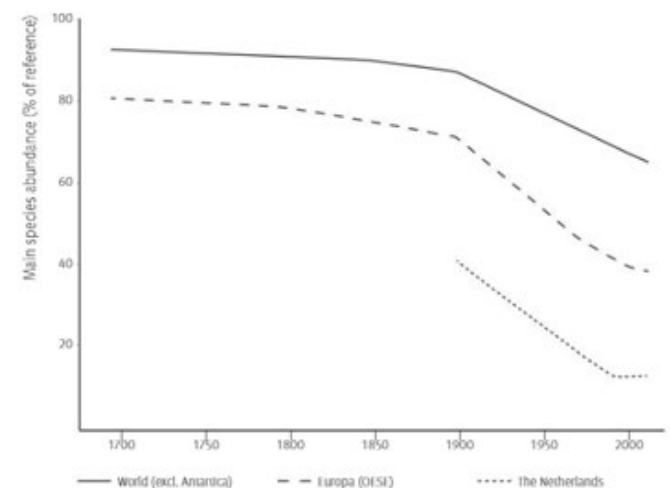


Figure 3: Species abundance
Author: Maaïke van Stiphout (2019)

The overall global levels of biodiversity are declining at a fast pace. In the Netherlands for illustration, it is observed that the biodiversity only declined during the last century, and it seems difficult to revert the scenario altogether, some species have been permanently impacted by that already. The literature indicates that the original quantity and quality of fauna and flora have already decreased by 15% from their original state. Rogge-
ma, R., Tillie, N., & Keffe, G. (2021)

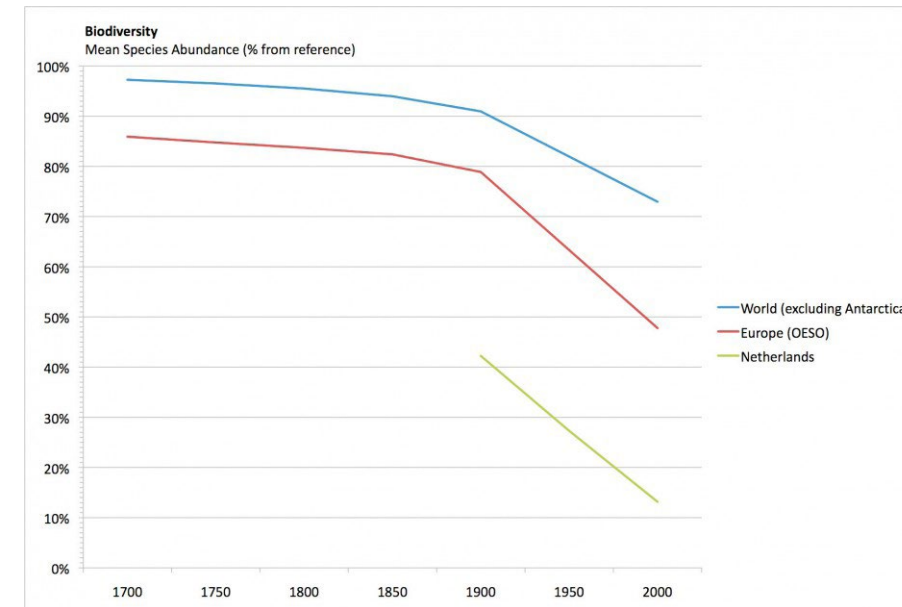


figure 4: Biodiversity mean species abundance between 1700-2000 © PBL, 2010

The Anthropocene is leading to impairments that might not be repaired if effective actions are not taken. the current affinity between humankind and nature is more than ever a dominant exploratory relationship. However, the whole world is dependent on a clear balance between the species. This behavior is leading to a lessening of biodiversity, and this indicates several problems in sequence, as expressed in "The first guide to nature inclusive design" by Maaïke van Stiphout (2019), the world economy is still dependent on rural-based resolutions, and it is clear that is time to change this stance and protect the natural biodiversity, instead of exploring it completely for our benefits.

This should occur in mainly two ways: Balancing the existing grey physical environment and returning and/or introducing natural aspects to it. Also including and considering this inclusion for further developments as a standard and mandatory process of design. It has been proved that cities that are planned with the most prosperous biodiverse ecosystems are health-fuller for their residents and improved life quality, a rich biodiverse city can act as an impact mitigator, preventing and managing unstable weather. Those cities have usually better and more purified O2 and fewer excesses on energy consumption. This can be achieved with the careful ratio of urban expansion that gives space for the natural ecosystem to mature normally, and as a result, the whole physical environment and society collect the benefits

Anthropocene

“Sustainable urbanization the key for successful development of man” (Maaike van Stiphout, 2019)

The Anthropocene then must produce a new relationship with nature, and this relationship should be hovered with caution, Therefore, before plunging into Nature Inclusive Design, we must understand the importance of ecological bonds, and how everything is somehow connected.

2.3 ECOLOGY

According to the Ecological Society of America, ecology can be described as the study that analyses the relationship between every living organism and the physical environment. It's added that those living organisms are living, co-existing, and forming different ecosystems, thus it is of major importance to keep those protected, preventing, improving, and managing the natural environment.

The importance of ecology is highlighted by understanding the interdependence between those living organisms, the maintenance of fresh and clean water and air, and, food production, which is crucial for human development, translating into overall life quality. The study of ecology enhances the basis for nature's well-being and conservation, the variety of species living among themselves is vital to keep the whole ecosystem solid. (ESA, 2022)

ecology

The awareness started to increase when abrupt changes in natural scenarios near urban areas started to occur, for instance, the mutation of marine fauna and flora in wetlands, due to the modification of harbor and bank areas. The pollution and solidification of those sites have a direct impact on the ecosystem that is dependent on them, therefore when a parcel is modified negatively, the ecosystem changes, and the interconnections are affected, and every consequence comes in a chain reaction. The importance of specializing and understanding the ecology and the symbiosis of the living organism has a major influence on the earth's well-being and with a direct and positive impact on our lives. (ESA, 2022)

Through ecological examinations, it was possible to identify that those degraded and modified areas, caused mostly by human influence, such as contaminated waters and banks, could be healed and restored through natural processes. For instance, it has been discovered that swamps and wetlands, near rivers that have suffered from pollutants agents, can be a great asset and a very effective tool to purify and clean polluted water, some species of algae can be used to treat the contamination, as filtering elements. Those findings enriched the possibility of mending damaged ecosystems with natural solutions. Thus, ecology presents itself as a major study that helped humanity to comprehend how to co-exist with other organisms and life forms, in this study, ecology is the topic that brings and walks along the methodology, suggesting those “Nature Designs” interventions that will be further mentioned. (ESA, 2022)

RICH AND BIODIVERSE ENVIRONMENTS:

Comes in 3 pillars
Built environment, human and nature

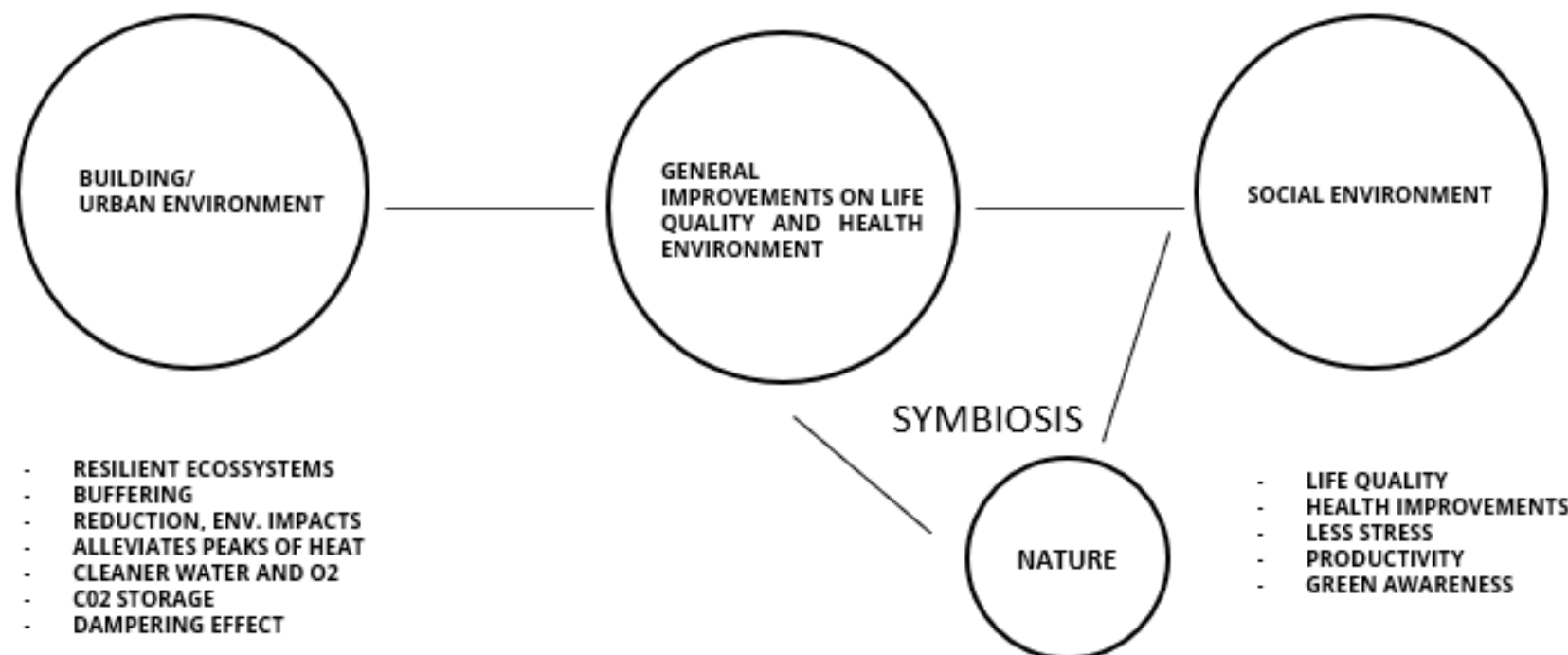


figure 5: Author 2022

2.4 WHAT IS BUILDING WITH NATURE?

Nature inclusive design

The called "Nature inclusive design" can be characterized as a set of strategies that integrate natural processes as a definitive part of the design.

Looking towards sustainable development, encompassing nature as an essential part of the process, means blending and harmonizing settings, rather than prioritizing one, for illustration, as stated in the last edition of Building with Nature (2020), those actions are not only based on being fully green, but in fact, combining green with the existing gray and also blue, hence fulfilling the societal requests, and boosting biodiversity balancing nature. (Erik van Eekelen & Matthijs Bouw, 2020)

If the natural system is in fusing with buildings and urban landscape, and a series of adaptations are made to make this merging possible, where fauna, flora, and humans can profit from what cities are providing, making it exist as a whole unique organism than this can be called Nature Inclusive Design. (Vink, J., Volvaard, P., & de Zwarte, N., 2016)

These series of adaptations can be decoded through the called Nature-Based Solutions (NBS), and those are fundamentally a set of actions, according to the International Union for Conservation of Nature (IUCN, 2020). Those strategies are actions to guard, manage and restore natural or modified ecosystems, improving biodiversity and at the same time providing and addressing societal challenges. Translating, Nature Based Solutions (NBS) are processes that aim to include natural processes into built environments, balancing urban and nature scenarios. In other words, working while encompassing nature as a design method it's a way to mitigate climate consequences, reintroducing, reviving, balancing, and conserving natural ecosystems, co-existing with the built environment.

The literature, Is it stated that applying a process of design and methodology can be very useful to mitigate and tackle global warming effects. The strategies start from a method approach (that we will look closer further in this report) and then translated to a set of actions and interventions, that can be described and presented in many ways accordingly to the needs of the specific field that is being analyzed, for instance, vegetation can be integrated into buildings to balance the energy consumption, hence these could expect less energy usage for heating and cooling, at the same time, new habitats can be created while this merging is being settled, providing space for animals to find their ways there. (Maaïke van Stiphout, 2019)

Fewer energy demands could come also with improved water management in the buildings, so as cooling and evaporation systems are optimized, those mainly helped by the plants that could be inserted in the facade, for instance. Greener into buildings also could provide more purified air and better ventilation. It's noted that O₂ production and CO₂ absorptions are increased when nature and plants are implemented on buildings. (Maaïke van Stiphout, 2019)

societal benefits

The society also collects the benefits of having projects more connected to nature, for instance, the clear sight of a calmer environment with plants around, decompressing the ambient, improving the life quality, reducing stress, and making it healthier in general. It's important to consider that also beyond the benefits collected from the application of those strategies, another factor to be considered is the importance of utilizing this as a move towards a more sustainable future, making society accepts and recognize that nature should be inserted in an urban environment, increasing the awareness towards green.



figure 6: Maaïke van Stiphout (2019)

2.5 WHAT ARE NATURE BASED SOLUTIONS?

nature based
solutions

The definition 'Nature-Based solutions' (NBS) was given by the European Union as an umbrella term for several different strategies and actions that encompass nature to improve the built environment, they can be divided and applied in diverse areas, such as green infrastructure, green spaces, restoring ecosystems and services, and ecosystem-based transformation. (Roggema, R., Tillie, N., & Keeffe, G., 2021)

The definition of NBS for the International Union for the Conservation of Nature is:

"Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits..." (IUCN, 2020)



figure 7: Kiwa initiative (2020)

Nature-based solutions are efforts to reform natural ecosystems, the main objective is to tackle and mitigate climate changes and at the same time address societal challenges, as mentioned before. Those actions take benefit based on natural procedures, for instance: the advantages of wetlands: These natural floodplains can control and buffer temperature, they are natural carbon depository mechanisms, important for water circle administration, hence some natural techniques are of great importance also for habitats creation so as weather management.

restore ecos-
systems

Those systems are being debated by governments nowadays as potential climate challenges mitigators, looking towards a more sustainable and enduring future.

The literature describes many different possibilities for interventions and they can vary accordingly to the area of application, scope, and expected outcome, for instance, every dominant ecosystem has a different biotope, which translates to different systems. Coastal areas, for instance, have different needs compared to mountain forest inlands. This research intends to analyze how those interventions can be attached to degraded urban areas, taking into consideration the city biotope.

Generically, those strategies if applied correctly can offer many improvements to the ecosystem. The publications list many different positive effects that could be considered to tackle the global warming effects, so as:

focusing on
cities

- Passive strategies for cooling and evaporation
- water management
- Less energy demand, consumption, and waste
- Better air and ventilation (pandemic-proof)
- Microclimate improvement (heat island effects)
- More O2 production and CO2 absorption
- Life Quality for users
- Healthier and relaxed environment (less stress and diseases)
- Future generation prospects – more aware of the value of nature

When dealing with nature-inclusive projects, the simple and more direct objective is to give space for the natural elements to grow back and develop in symbiosis with the built environment, spontaneously. This is of course, offered to mainly generate improvements for the ecology in general, meaning the whole spectrum of organisms including humans. When applying the strategies to a new area of opportunity, after scanning the conditions as the methodology suggests as we are going to explore further in this research, principles should be considered to resolute the possible problems, to improve and increase the general nature value. (Roggema, R., Tillie, N., & Keeffe, G., 2021)

2.6 CITIES AS AN ECOSYSTEM

The latest IPCC climate report of 2022, is highlighted the importance of cities in the climate change panorama, and this is because they are part of the highest parcel of emissions, in the other hand, cities have room for adjusting and restoring realities within the current configurations.

cities

In the early studies of Ecology, cities were not recognized as biotopes, but in fact, cities are the human habitat. The conception of cities being something apart and separated from the natural was brought in the middle ages (for the European concept) when the cities used to be located between walls, and the external of it only for food production, and the forests were considered dangerous areas. Around the 1900s this idea started to shift, and the importance and beauty of nature started to be assimilated into the semi-urban context. (Vink, J., Vollaard, P., & de Zwarte, N., 2016)

What is curious, is that nature is of course resilient, and the biodiversity in the city can strive as well as in the natural lands. The combination of blocky buildings, big and small, green in between, water, steam, and temperature variation, makes cities a really attractive place for various species. The mixture of hectic areas with more calm spaces provides a whole unique dynamic, that not even the forests can provide, hence cities can also be a space for biodiversity expansion. (Vink, J., Vollaard, P., & de Zwarte, N., 2016)

However, apart from the species of fauna and flora that are already benefiting from the urban environment, the idea is to maximize it so the overall results are more adequate with the harsh future we have to mitigate. In the book Making Urban Nature (2016), to make cities more attractive and improve biodiversity, a series of elements should be taken into consideration, and those are mentioned as ``conditions for settlement``, to elevate the nature values in the urban context, there are some conditions that should happen to make it work.

Animals need initially fresh water and food within a safe distance to settle, also, within this inner circle, those animals need a habitat, where they can breed and hide in case of predators. The flora demands the right combinations to exist, good soil conditions, and the right humidity, water, and parcels of sun. this combination creates a dynamic biotope, the life cycle where fauna and flora benefit from each other, therefore, expanding this into the urban scenario, means that this combination needs to have space to be developed. Vink, J., Vollaard, P., & de Zwarte, N. (2016)

Thus, as described in Writings solutions can be taken to restore and increase biodiversity, not only but also to manage climate extreme conditions, food, fresh water, and air, and at the same time enhance the public health of the city users. (Erik van Eekelen & Matthijs Bouw, 2020)

Nature solutions for cities are placed to achieve and tackle adverse events, simply by blending nature systems into grey environments, those systems should be resilient. In summary, the urban environment must provide space for nature to develop with it, without constraints.



figure 8 source: city digest
(2022)

2.7 HIGHLIGHT POINTS - NATURE APPROACH FOR CITIES.

Before diving into the methodology of Nature Inclusive Design, it is important to highlight the most relevant links into the umbrella of strategies. These points are of major importance to keep the environment balanced and more than that, the strategies are only capable if these points are strengthened.

Firstly the relationship between organisms is vital for the called ``life cycle`` Biotic and Abiotic factors are happening under our eyes and they feed and enrich the environment. Predation is one biotic factor, food is a pre so species can develop themselves.

Urban ecology

Urban ecology studies state that ideal situations need to be in place to make species colonize the area, this overall condition is called the ``climax situation``, and is reached through a series of transformations that give space and conditions to species to evolve, so as Habitat, reproduction, migration, diseases and so. An abiotic factor for instance is the climate, which implies many variables, such as the air and water quality, wind, amount of light, humidity, and quality of the soil, those, for instance, could determine which species could go along with it, for example, the presence of water can be mandatory for the reproduction of some species, hence the abiotic and biotic factors are intrinsically connected because they determine the nature levels of and area. (Vink, J., Vollaard, P., & de Zwarte, N. 2016).

In that sense, is it clear that apart from being an attractive area for some species, the cities are mostly unstable places especially because of the variations in climate, heat island effect, etc. Thus, the literature highlights the importance of green corridors along cities, this because not only changing and managing the climate in those areas but also because different areas can create distinct factors, allowing species to jump around and find the best conditions, making the nesting, sheltering and predatory circles stronger

Restoring connections and creating green corridors are important to restore habitats, fauna and flora depend on different interactions to keep resilient, and facilitating those connections has major importance to support biodiversity. Hence the ideal resolution in cities is providing spaces where nature can develop and interact, and this means that they can evolve without a clash with the grey areas, instead, blending with them. In an ultimate scenario, the forest and mountains surrounding the city are connected and linked through green corridors throughout the city. The nature-based solutions on existing buildings (that we are going to explore further in the case studies review), rich materials and forms, allow plants, animals, and insects to blend within the urban. (Vink, J., Vollaard, P., & de Zwarte, N. 2016).

Interventions in cities must be creative, mainly because of the spatial limitation, thus, utilizing degraded buildings and empty areas as opportunities can increase and create value for those areas, enriching neighborhoods.

For the Rotterdam area, the exploration of wetland areas is highlighted as an important point, the connections between the river and the inland areas are vital to restoring biodiversity because it's the sensible integration of the water and shore, many animals and vegetation are dependent on those areas, hence, the creation and the development of vegetation on the foreshores is a key act.

The riverbanks are relevant for biodiversity and CO2 capture control, these areas have been drastically influenced by urbanization advances, and the banks have been constantly sharpened and waterproofed by concreting. However, these areas are habitats for a myriad of living forms, fauna, and flora connected also to other chains, thus, it is of notable priority to restore, protect and develop these areas. Also claimed in the control of floods and storms, also in water rehabilitation, the creation of tidal parks hold also a social and natural function. Symmank, L., Natho, S., Scholz, M., Schröder, U., Raupach, K., & Schulz-Zunkel, C. (2020)

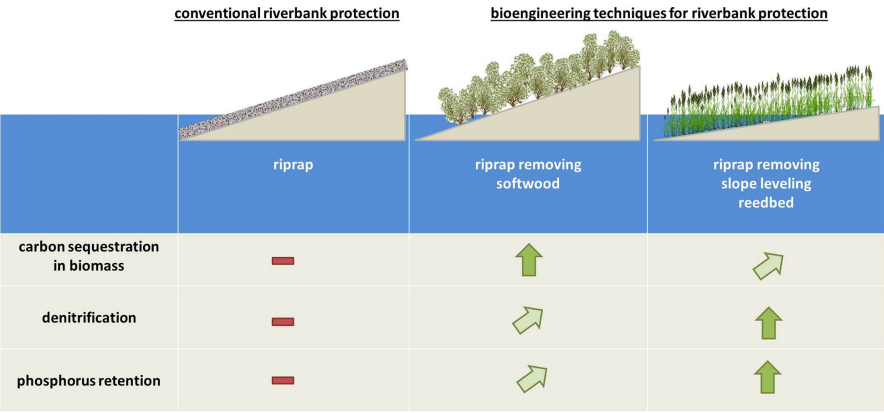


figure 9: Symmank, L., Natho, S., Scholz, M., Schröder, U., Raupach, K., & Schulz-Zunkel, C. (2020).

Wetlands and tidal parks, for instance, play an important role in supporting mitigating intense weather occurrences, they give and create space for new habitats of fauna and flora, increasing the life close to it. The plants can act also as filtering elements, as mentioned before.

floods and the seasonal tides are can be managed by those structures, and attached to it social activities can be placed along the banks or in the tidal zones, putting society in more close contact with nature and promoting experiences . The transformation of sharpened concrete slopes straightening the river branches to a natural, wetland shore is one of the principles of transforming cities into a better healthy environment.

Buffer zones

The development of those areas gathered as a set of interventions, can lead to the creation of Inland buffer zones. The insertion of nature/water into the dense grey environment can be used also to supply storm/extreme weather and also reduce pollutants and heat islands, so as managing water levels. These buffer zones can be developed in many ways, inserted on buildings or through the exploration of park/wetland areas, they provide alternatives to store water and drainage systems at the same time the plants can reduce the overall reflection and temperature, filtering the air and restoring places for animals and insects. Buffer zones can also be integrated and embedded under society's economical aspirations, these places can offer outside activities, such as parks and events, recreation, farming, and energy production.

Materiality is also a very applicable topic that can be analyzed while building with nature and resurrecting ecosystems, the literature describes those rich revetments can produce sensible changes for the environment. Such as form and texture, can create opportunities for habitat and support fauna and flora, a more ``rocky`` environment is more likely for a bird to develop his nest, than a flat shiny sharp façade. Simple cracks and shifted blocks can already encourage insects and animals to find their space in between, as well as the flora. When applied on large scale, those rich revetments can be in direct contact with the natural areas, creating an association between green and grey, at the same time, the materiality offers better circumstances in terms of climate, reflection, and refraction.

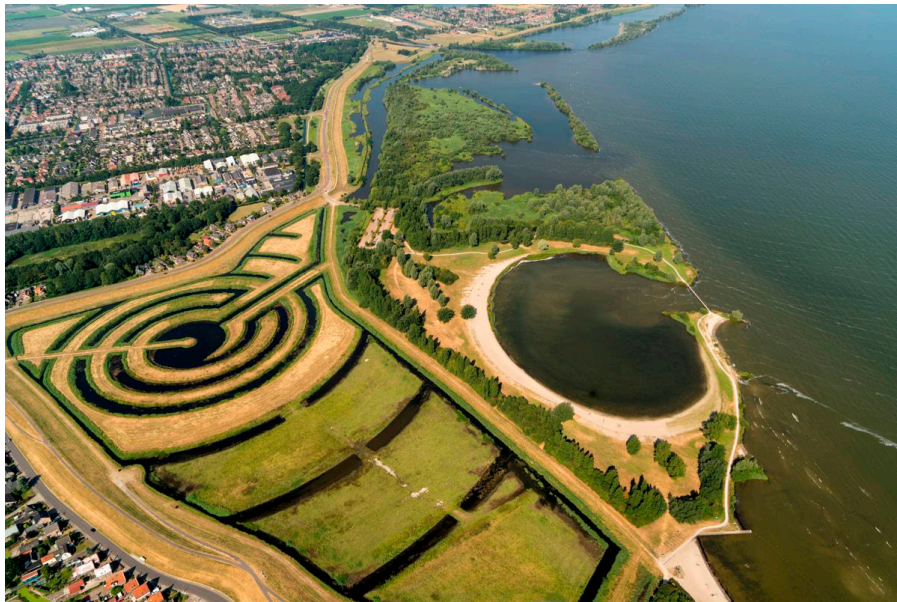


figure 10: ecoshape (2022)

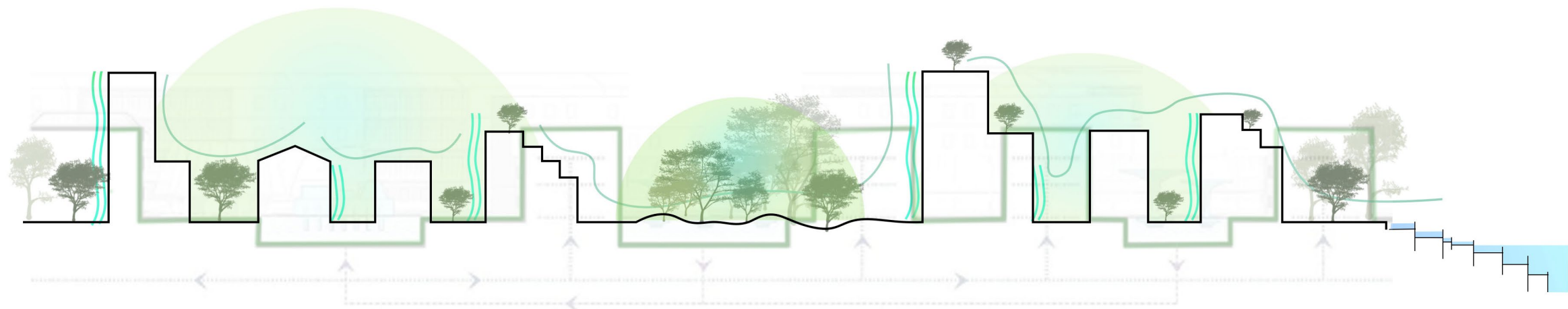
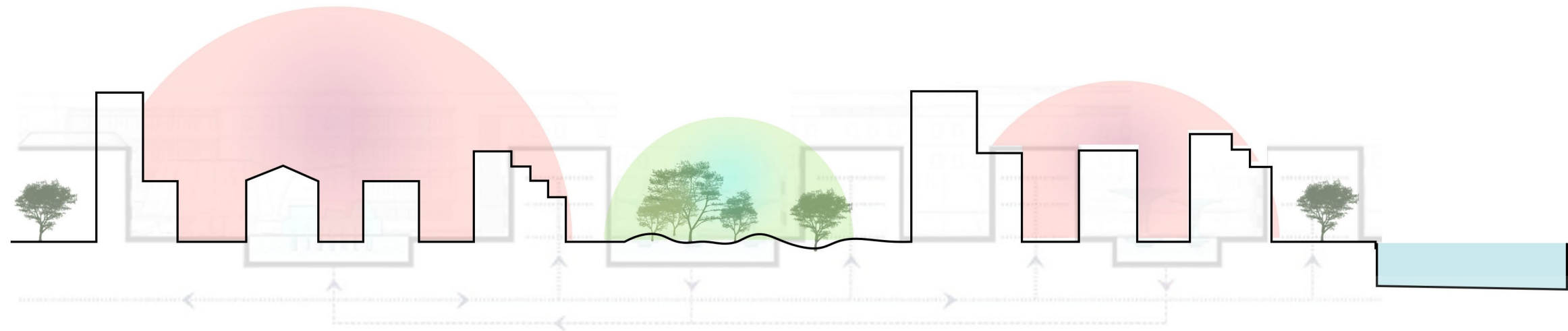
In summary, if conditions are created, nature finds its way to develop through its resiliency. For instance, during the hot days of the summer, is quite typical to see the moveable bridges in the Netherlands being watered, to cool off the mechanical parts that are sensitive to the heat. In this event, is easy to pinpoint the water paths flowing to the ground floor, and is intriguing to see that the green starts rising out from the blocky roads.

This small exercise exemplifies that nature can thrive if the conditions are right. In that situation, probably the requirements are not suitable for the green coming through the blocks, abiotic factors so as the climate and lack of water, for instance, however when some water from the river is constantly pumped throughout hot days, water that is rich in micro-organisms, these small seeds can awake and start rising in between the blocks, combined with the amount of shadow/light. It is even more clear when we see that where the water is not flowing constantly, the green doesn't come out, one more time, clarifying the conditions and pre-requirements.



figure 11: Schiedamse Schie- overschieseweg - author

GREY X GREEN



NATURED BASED CITY

In summary, these strategies combined should be able to balance the green x grey environments. Through a series of actions, green networks blend through the urban areas, connecting and reinforcing fauna and flora.

3 . APPROACHING

- 3.1 theorethical framework (NBS)
- 3.2 case studies design principles

3.1 HOW TO IMPLEMENT - NATURE BASED SOLUTIONS?

What is the methodology around nature-based solutions?

Literature suggests many ways to work with this theme. As stated by Nature-based urbanization (2021), the methodology occurs through a series of analyses, assessments, and identification of a problem and then proposing adaptive strategies. Initially, it initiates with the statement of looking for balancing the urban and natural ecosystems and the myriad of outcomes that will come with this execution. Apart from different strategies suggested and distinct frameworks, they usually go through the same follow-through which consists of the acknowledgment of a problem and then a series of choices to review this problem.

In the figure below (figure 12), as we can observe, the identification of alternatives and opportunities is heeded by a deep evaluation of current scenarios, proposing alternatives.

Adding to that, the methodology is always aiming to collect and balance ecosystems, encompassing socioeconomic and sociocultural systems, so as the well-being and improvement of biodiversity in general. Every topic should be considered and works as a whole at the end. (Roggema, R., Tillie, N., & Keeffe, G.,2021)



figure 12: (Roggema, R., Tillie, N., & Keeffe, G.,2021)

Scanning Opportunities— Identify, System, Recreate (methodology)

The methodology proposes a scanning evaluation process, where firstly, a research problem must be worked out, through parameters initially implemented so a direction can be presented. The key is to identify problems within the parameters established, which can be found and after scanning through the area, evaluate what could be the suitable solutions to tackle it. After the evaluation/scanning, alternatives can be proposed in order to manage the overall situation. Thus, the methodology comes from a process of investigation, and implementation of strategies to tackle the eventual problems, the strategies are based on natural solutions, aiming to restore biodiversity and increase nature value.

The process can be briefly described, as suggested in the literature:

“The main climate change factors impacting the region were taken as the point of departure for the workshop: current maximum temperatures (up to 47 °C) and a maximum potential flood (MPF) [109] level of nine meters above mean water levels, must be seen as the lower limits of change. In this light, it was not enough to restore or manage existing ecosystems and, thus, envisioning a long-term future was undertaken in which the re-creation of the ecological systems was mapped out. In an iterative process, elevation, soil, vegetation, waterways, future flood risk, and ecological remnants were mapped to understand the nuanced sensitivities of life and the reliability of available water, sunlight, shade, coolness, and other factors that determine the opportunities for the historic Cumberland Plain ecology [91] to re-appear in symbiosis with future human occupation...” (Roggema, R., Tillie, N., & Keeffe, G.,2021)

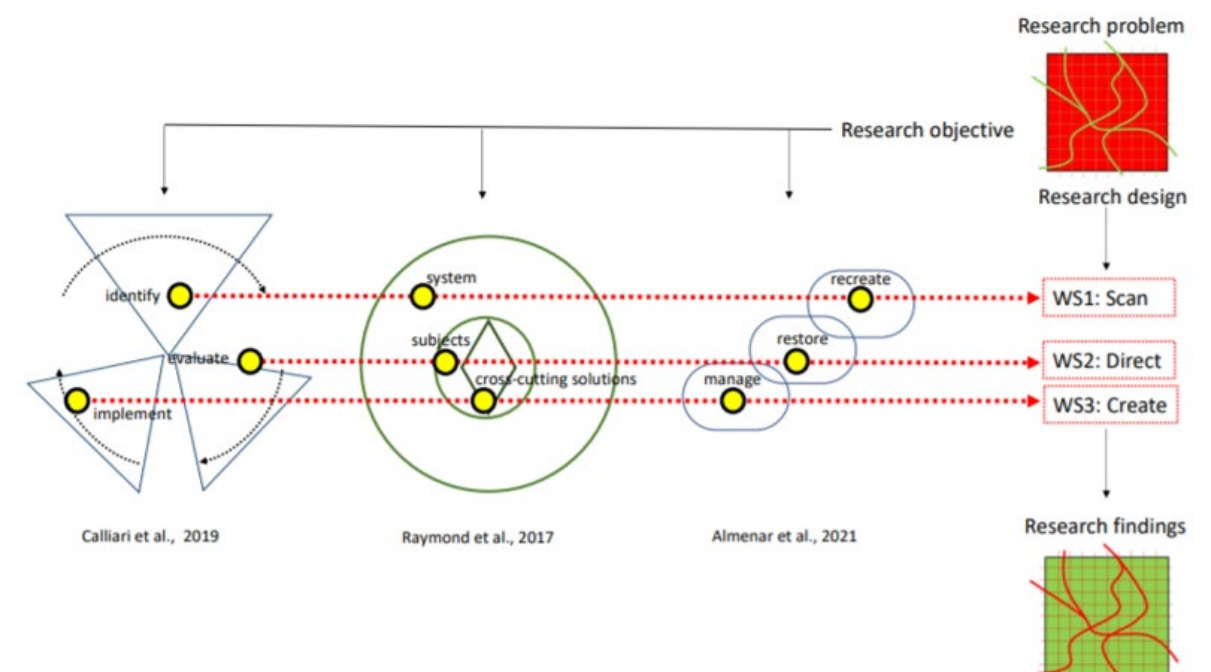


figure 13: (Roggema, R., Tillie, N., & Keeffe, G.,2021)

3.2 OVERALL BENEFITS FROM NATURE BASED SOLUTIONS

In nature-based climate transformation, the goal is to maintain and enhance ecosystem services, which are used to prevent and reduce the escalation of global warming, reducing impacts from predicting negative effects, for example, unbalanced precipitation, frequent overflows as well as heat stress and droughts. Ecosystem-based adaptation is also another denomination for the method, expressed as an integrated approach to restore, conserve and enhance sustainable management of areas, constructing resilient areas against climate change. (Doswald & Estrella 2015).

Initiatives that utilize those processes are focused primarily on ecosystem management, restoration, and conservation to increase the resilience of fauna, and flora, decreasing risks and vulnerabilities in general. It is commented that this methodology can help to address social agents for climate, like the Convention on Biological Diversity (CBD) and the Framework Convention on Climate Change, so as many other agendas for energy that countries have to meet in the near future. (Doswald & Estrella 2015).

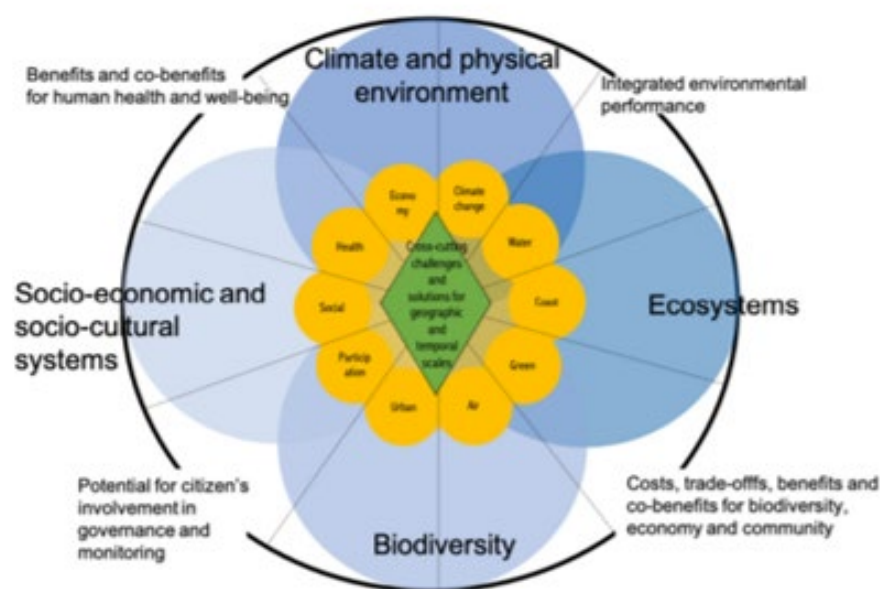


figure 13: (Roggema, R., Tillie, N., & Keffe, G., 2021)

In ecosystem-based adaptation to climate change, it is cited that environmental susceptibility to climate change is mostly a developmental issue rather than an environmental issue. And the series of adaptations can be understood as the number of efforts to deal with those developmental impacts that are inserted in a changing climate.

It is suggested that the series of actions, and the called "impacts management", can protect society and also reinforce economies, simply by predicting and stopping further consequences.

This occurs by Reducing vulnerability to environmental effects and catastrophic weather events that create disequilibrium in our global, those appear as a promising alternative to adaptation. Cities are in the frontline of scope, as many problems are decurrent of dense urbanization, for instance, Heat waves and excessive rains, those extreme weather events can be managed through these actions. (Vignola, R., Locatelli, B., Martinez, C., & Imbach, P. 2009)

Communities, cities, and provinces are already formulating plans and systems for managing climate change consequences. This includes plans to prevent flooding, and heat stress, increase water storage and consumption, and designate extended urban development plans. We can also include the Rotterdam weather document that brings a booklet with a series of analyses and further strategies in order to make a resilient city. (Vignola, R., Locatelli, B., Martinez, C., & Imbach, P. 2009)

Thus, mitigation is the process of tackling the essential causes of climate change through the reduction of emissions and overall consumption. This process includes understanding the different approaches, modifying management, and consumer behavior, including new technology concerning energy control and efficiency.

It is learned that complicated plans like new city development that refers also to new green infrastructures. While planning the city, many situations must be taken into consideration, such as pathways, bridges, and subway lines. Those would demand a high-tech system solution. Adding to that other natural elements should be also considered, such as urban forests, green areas, and natural elements. The idea is also to encompass and combine the more technical solutions with the natural, ones in different scales, and as a pragmatic effect the methodology spreads out. Therefore, it is stated that a multi-sectoral and multi-scale approach is needed in order to adopt and put those ideas into consideration, which would also include investors, stakeholders, municipalities and governments, NGOs, universities and etc. (Vignola, R., Locatelli, B., Martinez, C., & Imbach, P. 2009)

3.2 CASE STUDIES AND DESIGN PRINCIPLES

3.1 theorethical framework (NBS)
3.2 case studies design principles
3.3 mapping and analisys

architects: Chartier Dalix Architects
 localization: Boulogne Billancourt, France
 type of building: School Building (New)

- Passive and Nature-based solutions (energy management)
- Nature value and biodiversity increasement
- Rich materiality (adaptation into urban environment)

Following its form, as an organism that develops not only with sharp edges, but the idea is also to provide shelter for fauna and flora, so as primitive natural environments, where the biodiversity can find its space to grow and develop into the grey forms. It is said also by the designers that the organic form is intended to allow nature to develop naturally and spontaneously, without constant maintenance, which can change the building within 5 or 10 years as nature finds its ways to grow, shape, and reshape.

The overall form develops as an organic shape while the facades intend to be used as habitat and shelter for insects, animals, and plants. The shifted blocky walls are made of pre-fabricated blocks of concrete, produced in two different textures, a smooth and more polished one, that reflects more light, and the other with a rugged texture. Both textures are blended within the façade, channeling water to the side of the blocks, preventing it to age precociously. The shifted blocks also are there to encourage spontaneous vegetation, so small holes, and hollow bricks with porous parts to be sheltered for animals and insects, the overall intention is to provide a safe environment for birds and increase the potential nest habitat in this area, every small detail can be used by different parts of the ecology cycle, and this was also replied into the literature.



Figure 15:
Chartier Dalix (2015)

parameters

The roof is the home for the real garden of the project, encompassing 3 levels of vegetation: mesophilus plants in 50 centimetres of earth, a woodland island followed by a shrub-land fringe planted in 1 meter of earth.

The interchange between species is the aim of this design, creating and providing space for the fauna and flora, ensuring that the biodiversity can be enhanced and develop blending within the urban conditions.

The selection of species and the variation between it, also serves to explore and bring variety to the different organisms that can benefit from it, for instance, the rooftop vegetation, can be space and shelter for small rodents, those would benefit from the high structure and vegetation as a way to shelter. The sifted blocks on the sides can serve as nesting for birds and bats, also insects. With the years advancing, this whole organism can act like a eco cathedral and be reshaped through the spontaneous growth of vegetation. different organisms can also help to reshape this environment, part of the predating, nesting cycles.

In the overall apart from from idea of being a rooftop garden, all the facades are treated in a way to provide space to nature to grow. What is also notable from this project, is the idea of using simple structures and trying to replicate nature in its core, coming from the form, shifted blocks and strategies mixing, is refers to how nature actually happens. Spontaneously and providing conditions so it can strive, addapt and develop.

In the urban scale, it is stated that the neighbors should also benefit from a better micro weather management as the project develops and provide healthier conditions for the surroundings. Also it creates an experience for the users and for the locals, acting like a statement that the urban enviromnet should and can blend with the natural enviroment.

Figure 16:
Chartier Dalix (2015)

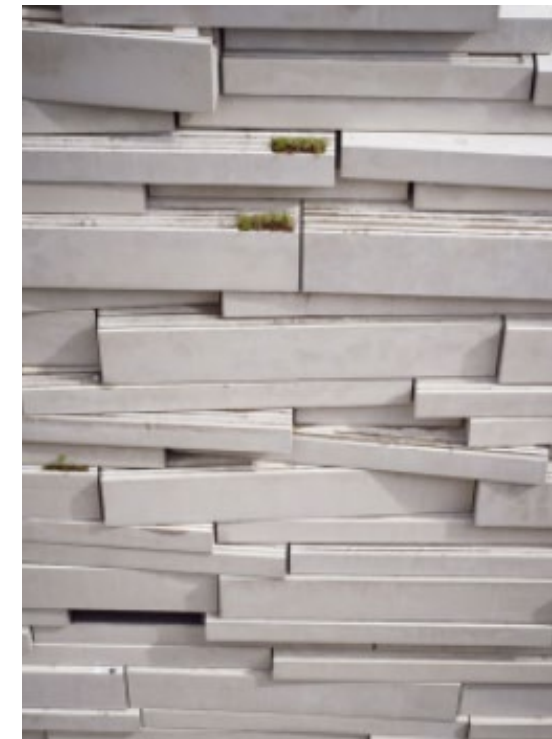


Figure 17:
Chartier Dalix (2015)



Figure 18:
Chartier Dalix (2015)

DE CEUVEL

architects: Delva

localization: Amsterdam

type of building: degraded area restoration

Parameters:

- Passive and Nature-based solutions (energy management)
- Nature value and biodiversity increase
- Rich materiality (adaptation into urban environment)
- area rehabilitation (soil regeneration)

For this project, as we observed during the literature, in the ecology studies, it was observed that nature could have been used to regenerate damaged areas. In the Ceuvel, species of phytoremediation plants, with filtering capabilities, were added to clean up the place and improve the nature value. Also in this project energy is generated through solar panels spread throughout the buildings. Biomass is also produced by plants, and organic waste, and utilized for gas production. It is stated that the retrofits and the strategies save over 200.000 tonnes of CO2 emissions throughout the site's existence.

the polluted and contaminated docks are now part of a project to transform the area into an ``eco-hub paradise``, while businesses are relocated there to give life to the area, like catering and events. Several strategies were applied to balance the ecosystem back to its normal standards. De Ceuvel utilizes phytoremediation techniques to clean up the soil, this is occurring as experimentation in partnership with Ghent and Wageningen universities. The idea is to leave the soil untouched by humans, while it is remediated throughout the years. The regeneration of the soil allows better water management, preventing drought and also further contaminations, it also opens possibilities for the development of fauna which will serve to compose the ecology cycle.

Biofilters collect and clean up water to be used by the buildings on the site, saving up 6 million liters of water from being used to flush waste and diverting 10 million more liters into on-site biological treatment.



Figure 19:
Delva (2022)

The relevance of the research:

the whole intervention is an interesting initiative that combines the physical built environment and nature to coexist. The whole set turns around the biological environment, as the main topic, so even the pathways are lifted as decks, so the soil can be regenerated, and the ground vegetation grows without barriers.

The methodology is one of the main points of this intervention: how to revitalize a degraded and contaminated area with a natural and sustainable approach? Firstly, the notion of analyzing the damage that was made to the plot and the soil, after the deactivation of the dockyard. The scanning process highlighted that a treatment on the soil was needed to bring back the balance and return this to a proper ecosystem. Other strategies took place to explore even more the natural approach and heal the soil.

The called purification park is also an urban biorefinery, that combines small scales strategies to improve and provide a sustainable relationship between the built environment and the ecosystem that was damaged surrounding it. Small strategies such as biofilters, vermi composter, bioreactors, and water reuse, took place in order to form De Ceuvel as a living organism.

Simple and low-budget strategies took place as a prospect project that aims to collect the maximum goals and outcomes in 10 years, where the area can be returned to the Amsterdam municipality for maybe other initiatives or an expansion of the plot.

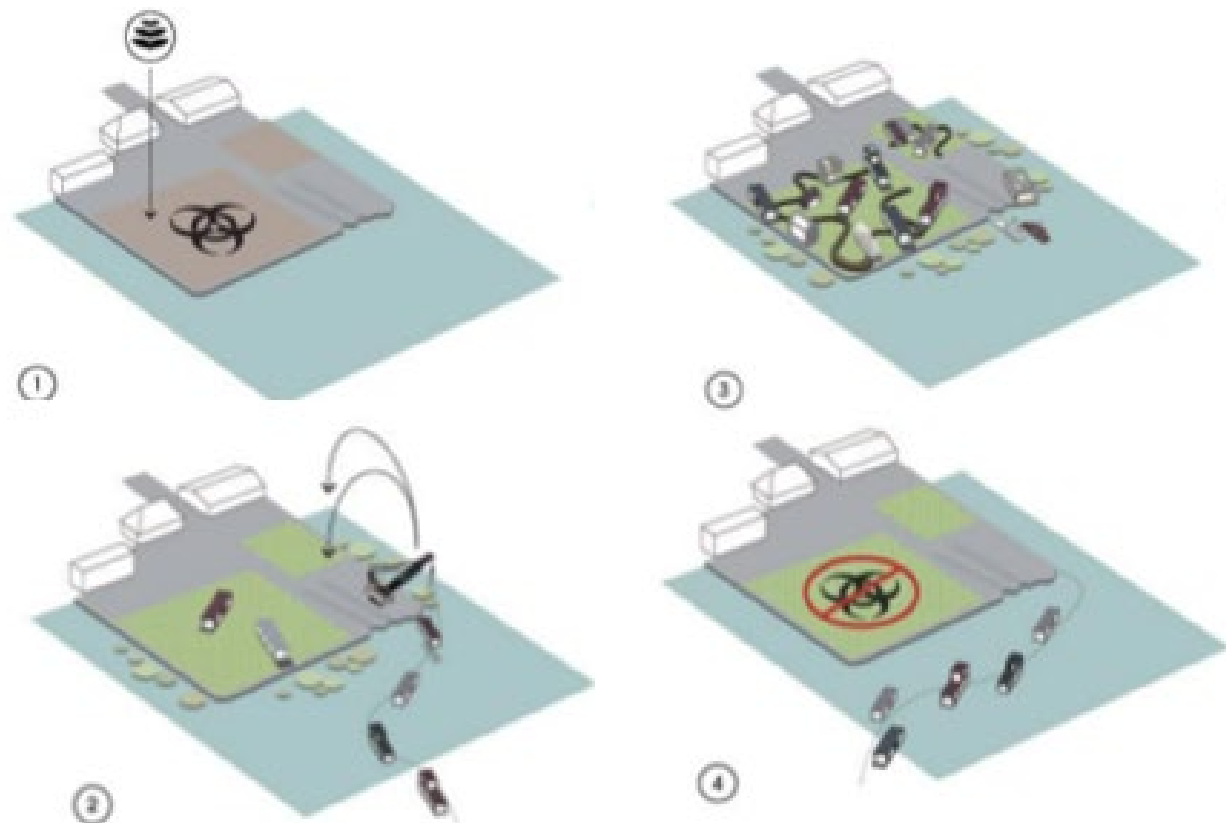


Figure 20:
Delva (2022)



Figure 21:
Delva (2022)

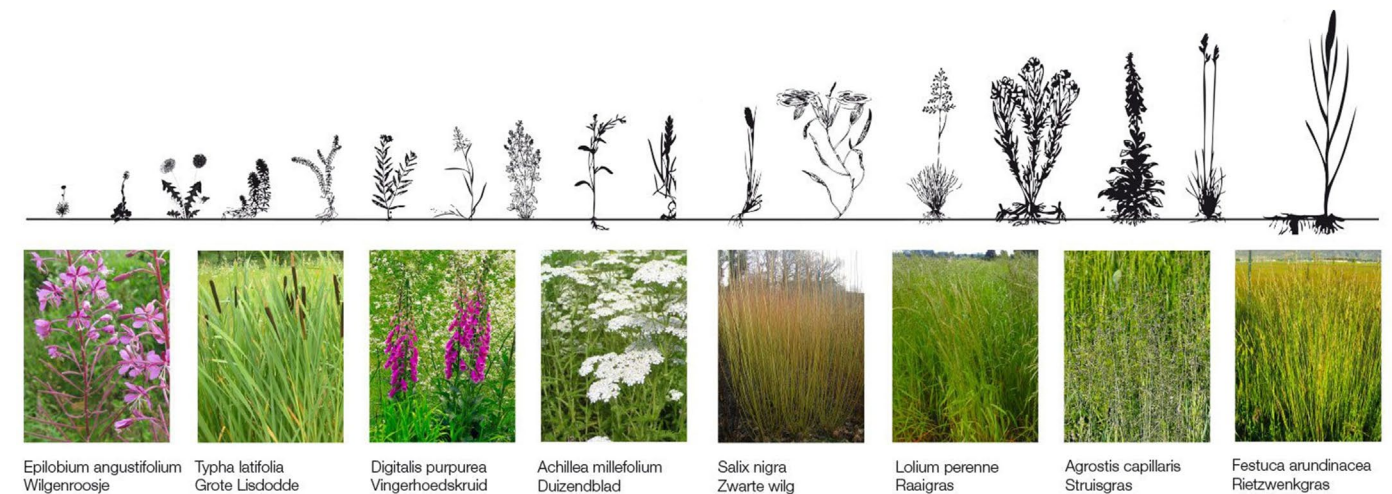


Figure 22: Purifying plants species
Delva (2022)

ONE CENTRAL PARK

architects: JEAN NOUVEL + PATRICK BLANK

localization: SYDNEY

type of building: MIXED USE

Parameters:

- Passive and Nature based solutions (energy management)
- Nature value and biodiversity increase
- Rich materiality (adaptation into urban environment)
- building active interventions

The one central park was placed into this research by many factors that will be debated in this topic, apart from doubts and controversial actions, this project is an act towards ``green infrastructure`` and biophilic projects on high-rising buildings. It counts on a series of alternatives: water management, reuse, and harvest, sewer filtration, living facades with green walls and green roofs, and recycled demolishing materials. The project counts more than native Australian species of plants, composing the green walls, roofs, and pots. At the same time is a statement that ``high rising`` and also expensive buildings can approach and bring nature into their projects, not only as an accessory but also whit the resources management. The variety of species of plants provides seasonal changes, giving also space for insects and animals. The users also collect the benefits from it, with cooler ambiance provided by the green screens and facades, so as the whole resources management. The approach also tries to break the idea of high-density blocks including green on its edges.

Irrigation was a big topic for this project, and of course to make it more energy neutral, some systems have to be incorporated in order to make it doable. The sewage is filtered and the water is returned to the irrigation system, so as water harvesting and overall reuse.

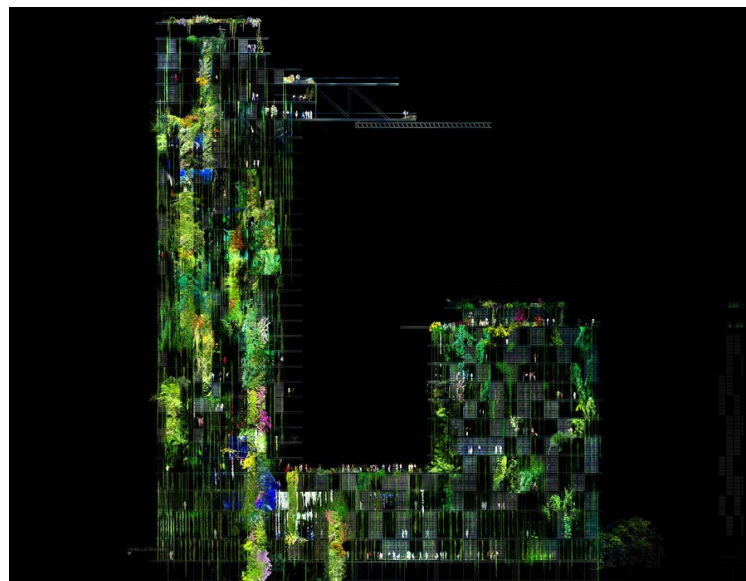


Figure 23:
Atelier Jean Nouvel (2014)

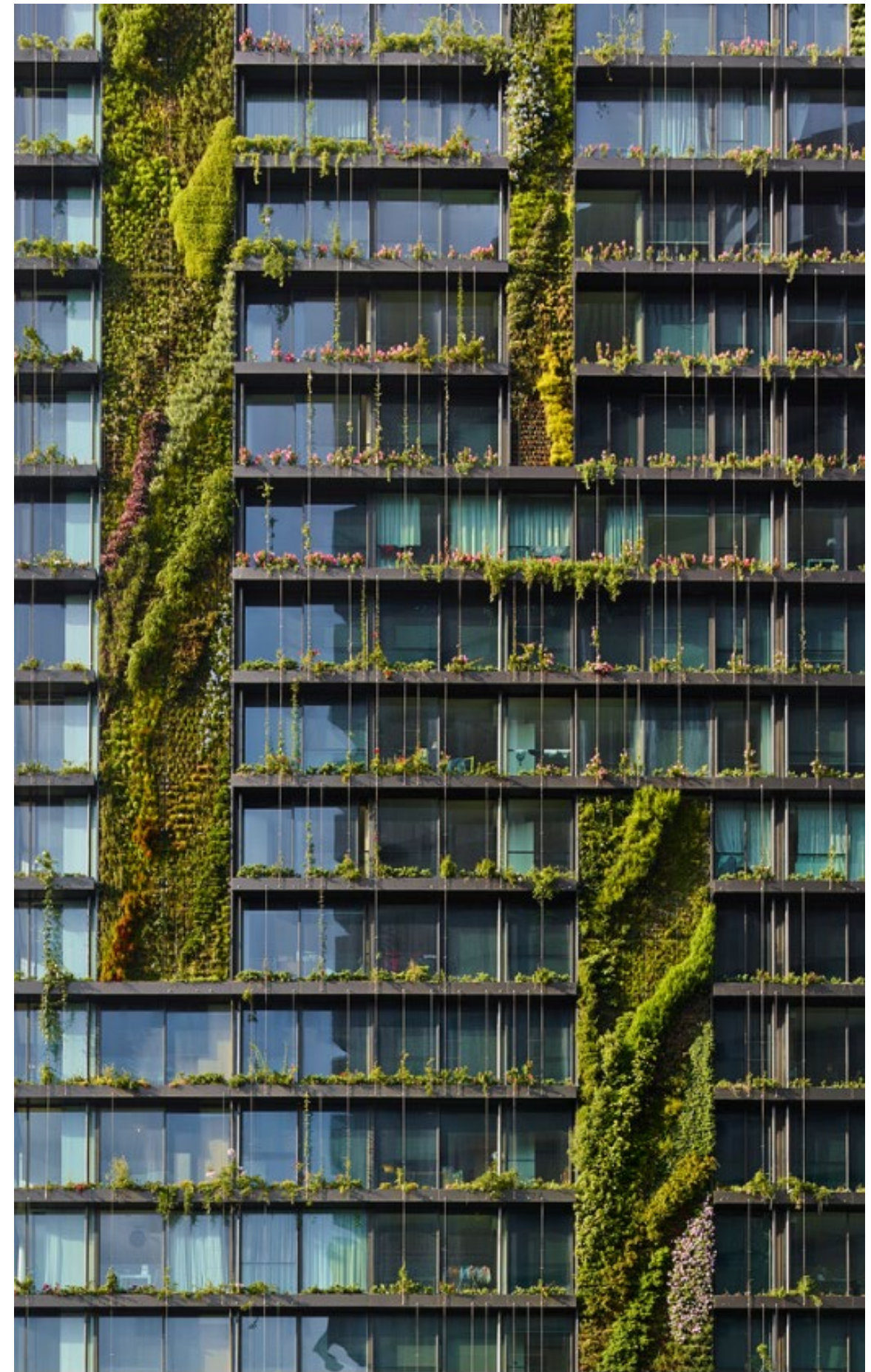


Figure 24:
Atelier Jean Nouvel (2014)

parameters

The project recycled 93% of the demolition material before the construction. The whole resource management of the building, attached to the greenery in the facades helps the building to reduce 80% of greenhouse emissions with a 90% level of carbon neutrality, of the same building without the strategies. The recycled water supplies 100% of the irrigation and also 100% of air conditioning water usage needs. The management of the building on sewer also helps to reduce the connection on the public sewer system, impacting less. Central park is considered to be one of the most self-sufficient mixed-use buildings in Australia.

Relevance of the research:

A topic that could be lifted initially is the size and amount of materiality that was used in order to provide these systems, of course, apart from the building being claimed to be self-sufficient and recycled materials of demolition, and with low impact, a high-tech investment in infrastructure was needed in order to make it possible.

The number of aids that have been used in order to make it work perhaps has had an enormous impact. In that sense, the high-tech and superstructures are not the aims of this research, however, the building is a statement that the resources can be well-managed and plants, combined with other strategies can be incorporated into buildings in order to accomplish sustainable goals, either to reduce emissions, to help on inner comfort and increase nature value in urban areas, because certainly, organisms will benefit from the green infrastructure, such as new habitats, nesting, food, and predatory cycles.

The methodology was also a point to be highlighted, during the development process, many strategies were tested in order to adapt the most adequate ones in order to help reduce emissions and etc. The green facades and screens help to reduce the inner temperatures, utilizing less air conditioning, and purifying the air and life quality.



Figure 25:
Atelier Jean Nouvel (2014)

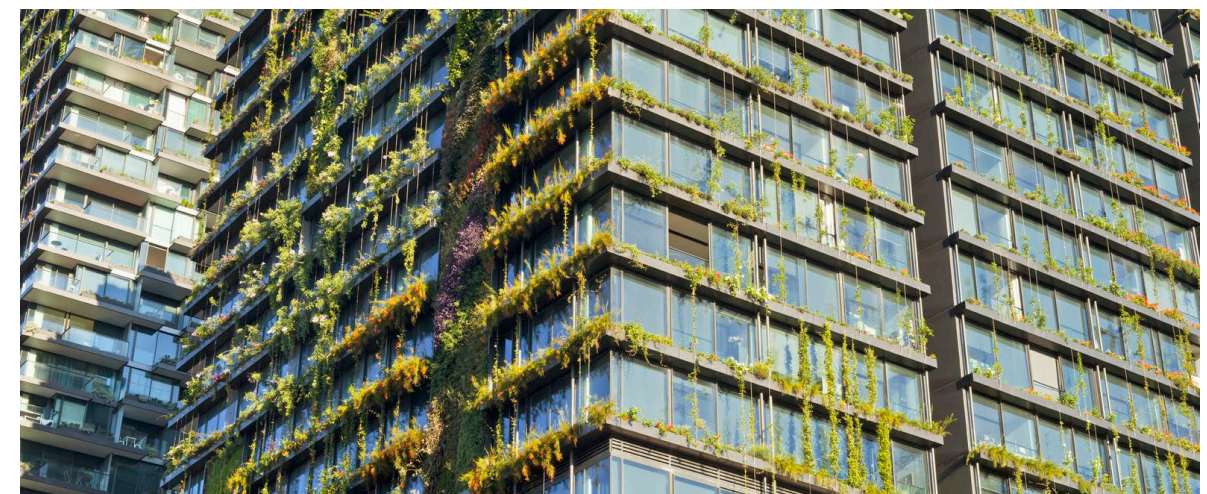


Figure 26:
Atelier Jean Nouvel (2014)

4 . ANALYSIS

4.1 - Mapping and analysis (green Rotterdam

4.2 - area of study

4.3 - climate impacts

SOUTH HOLLAND HOLLAND CONTEXT AND GREEN CORRIDORS

As mentioned during the research, green corridors are one of the main assets to restore biodiversity inside urban environments. The connection between green and blue paths around and within the city can provide various benefits, in terms of habitat, nesting, hunting, and roaming occurrences. the interchanging of fauna and flora and the variety that occurs along those connecitons only enpowers the overall nature value of the city, fortifying biodiversity. The Rotterdam municipality proposes the reinforcement of the green areas of the city, which starts on the hinterland, transiting through the urban area, and then connecting with the river. These green areas should be worked out and reinforced, also by the placement and creation of other adjacent connections, creating a sort of network, where the green blends within the grey.

More than adding to fauna and flora, the green network can be a great asset to be used as buffer zones, managing climate, the benefits are listed below:

- BIORETENTION
- WATER MANAGEMENT
- AIR MANAGEMENT
- SMART STORM MANAGEMENT
- BIOCHAR
- MANURE AND ENERGY
- WILDLIFE CORRIDOR FAUNA AND FLORA
- LESS POLLUTION - AIR, NOISE, VISUAL

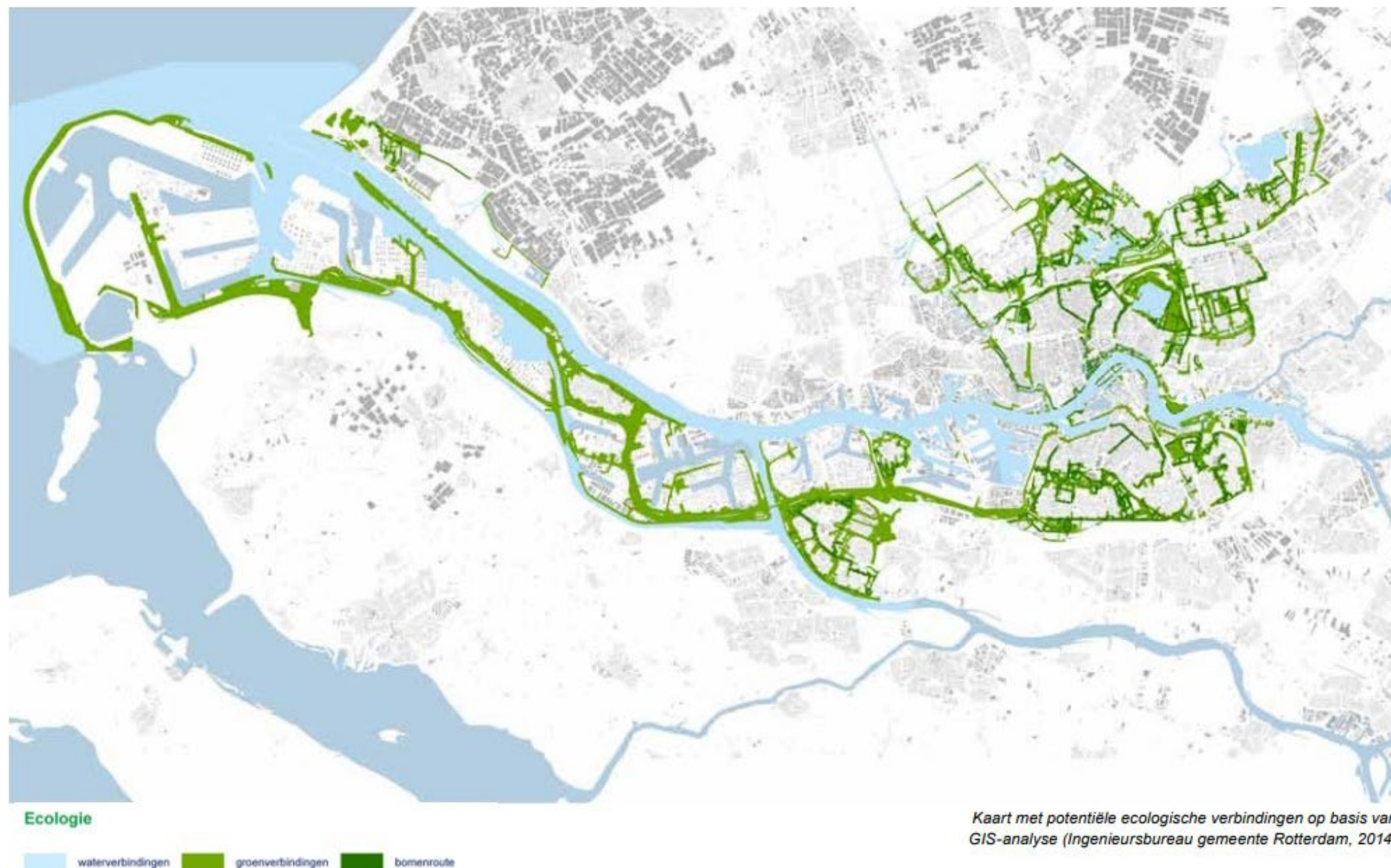


Figure 27:
 Green areas - Gemeente Rotterdam (2014)



Figure 28:
prevailing green areas and networks accordingly to Rot-
terdam municipality - Author (2022)

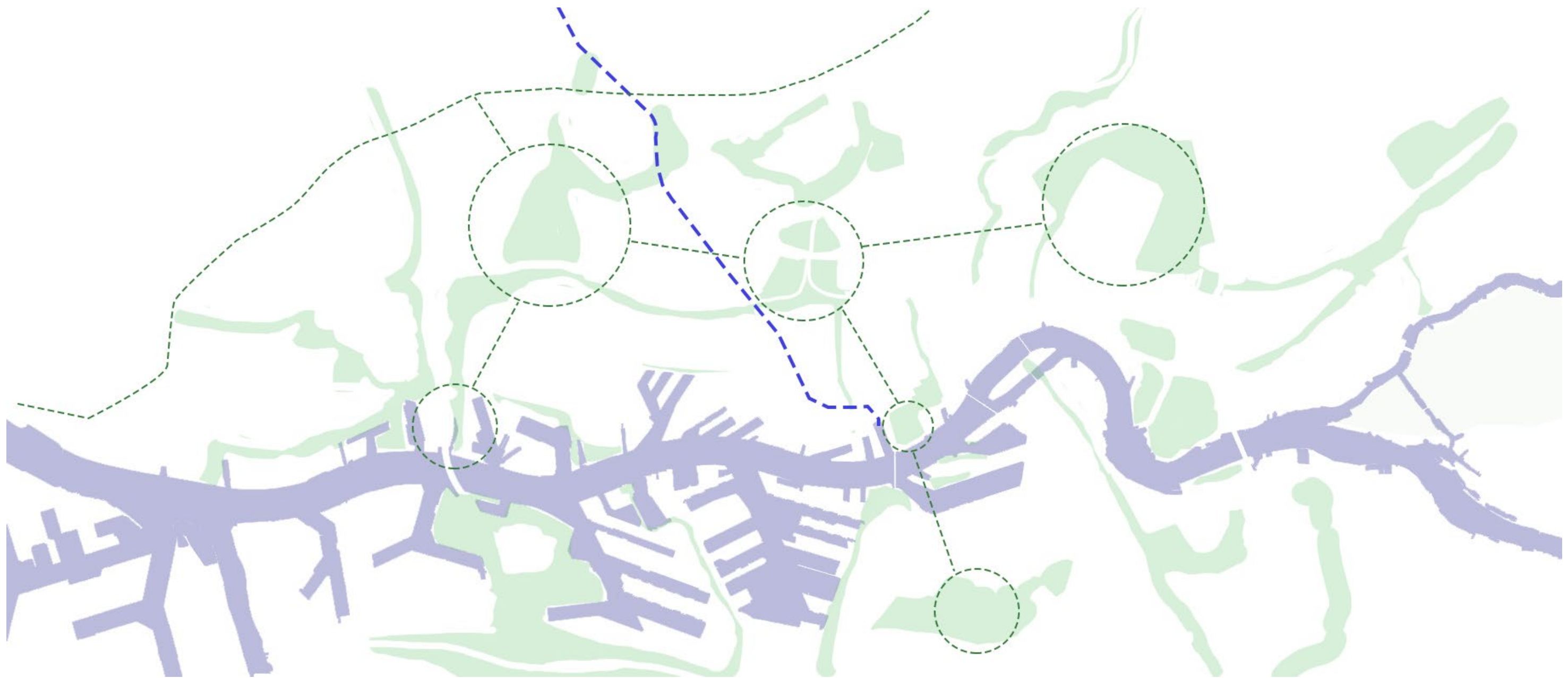


Figure 29:
prevailing green areas and overall connections - mea-
dows, urban parks, and corridor and rivers. - Author
(2022)



Figure 30:
reinforced connections and creation of a network, pro-
posed by Rotterdam municipality under existent condi-
tions. - Author (2022)

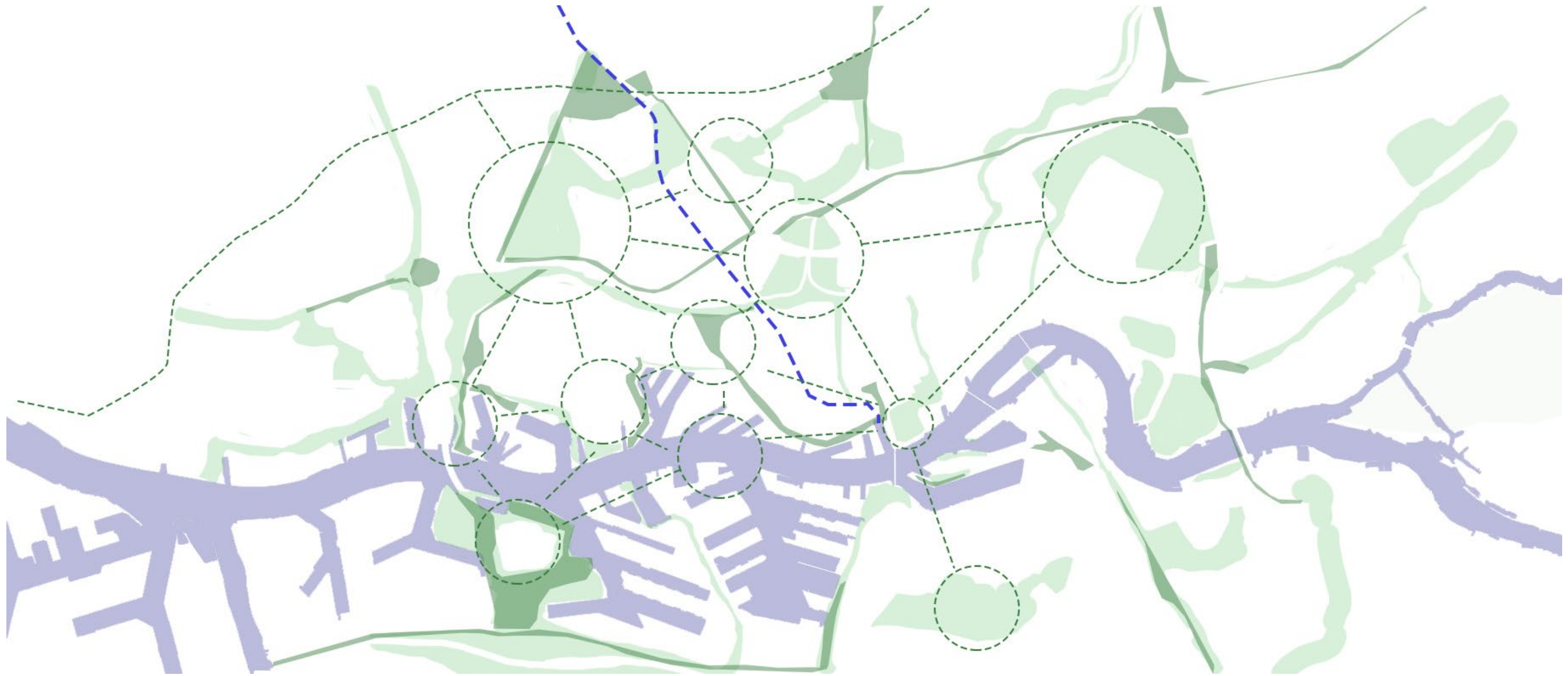


Figure 31:
if the existing corridors are reinforced and explored the
network in the city expands and it starts to become a
web of corridors. - Author (2022)

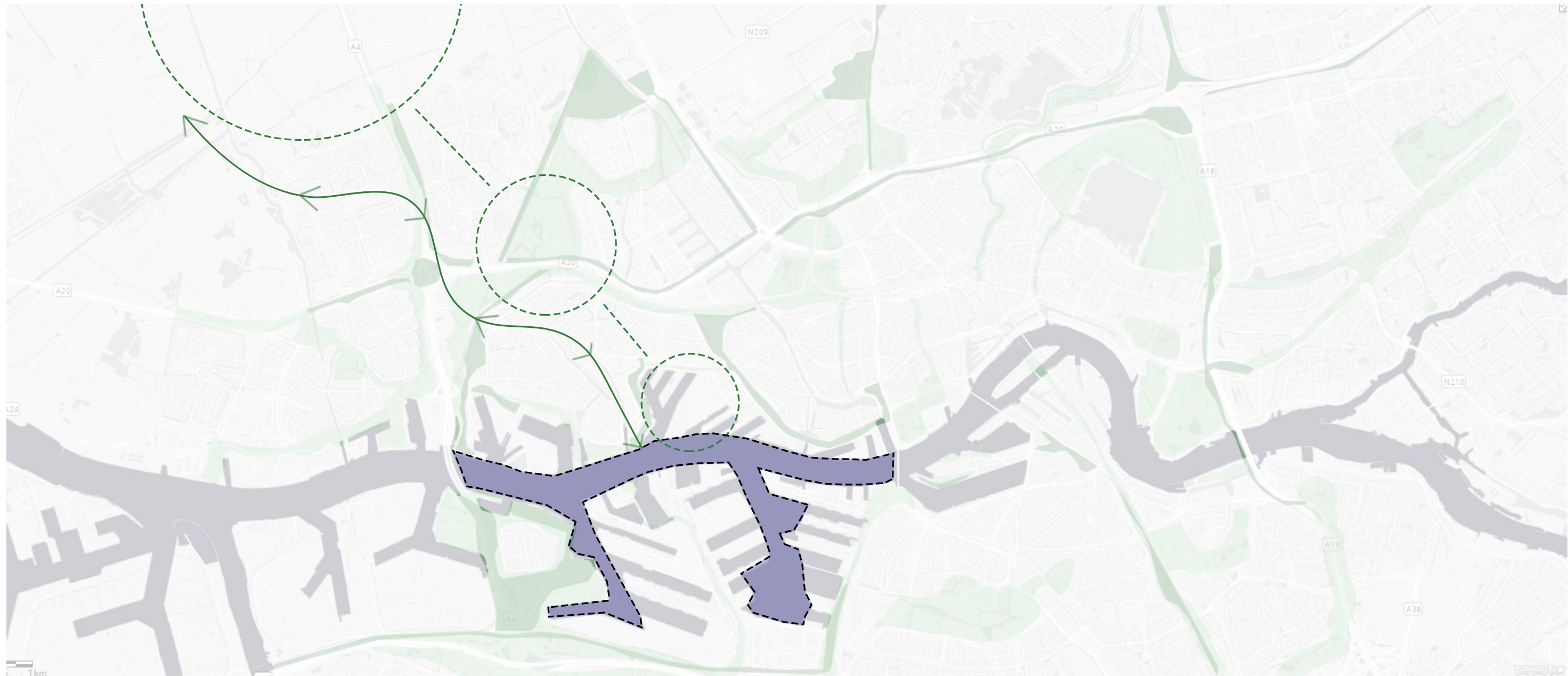
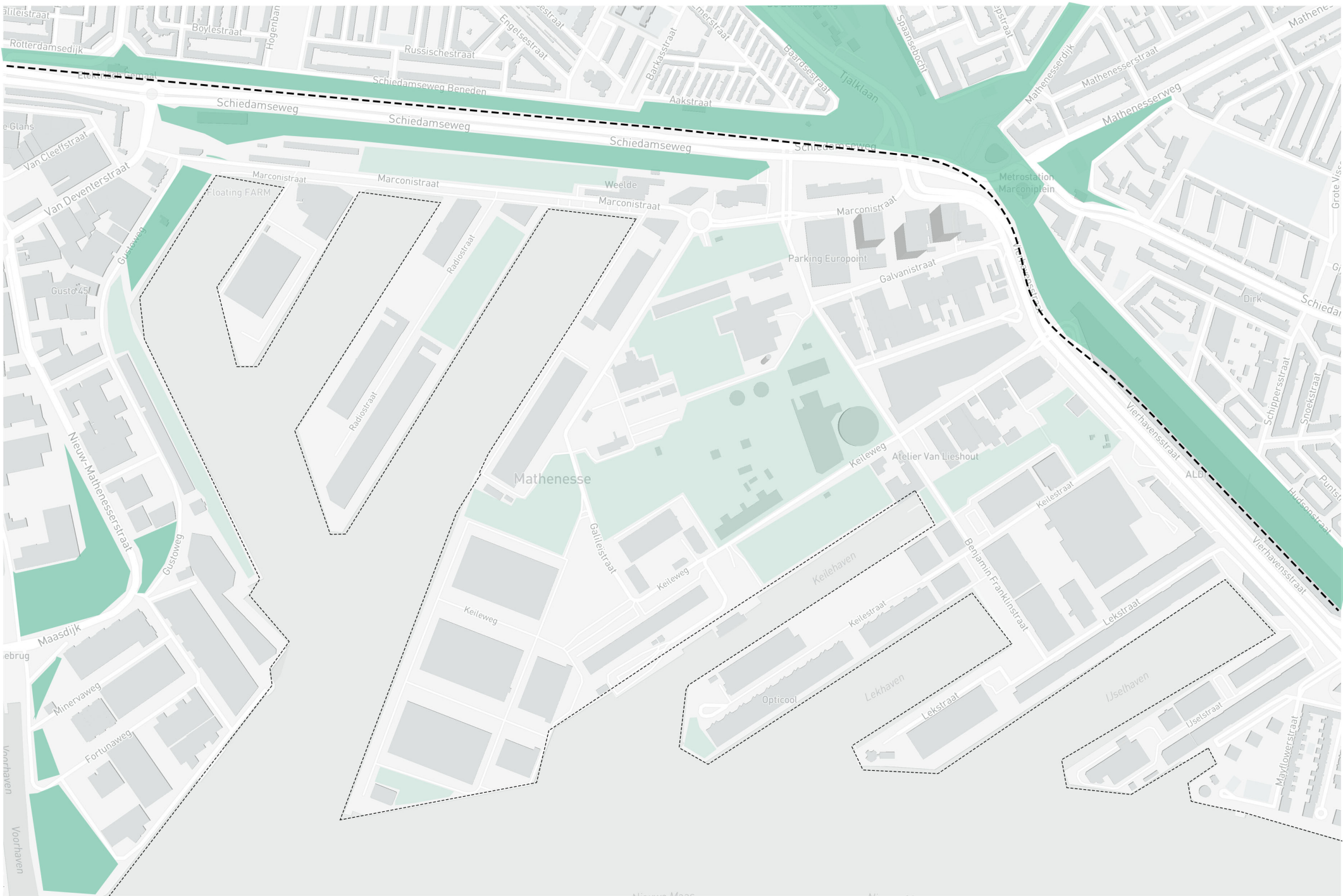


Figure 32:
 the importance is also the transition from the natural instances of the land, the meadows in the hinterland, and the transitions that pass through the city and reaches the river, for that, the heaven areas are highlighted as our object of study, marked also as a fragile area for the municipality - Author (2022)



Figure 34:
 therefore to analyze the opportunity and reinforce those connections the M4H area is selected, of its position in the city an the opportunity of connecting and creating new corridors.- Author (2022)



legend gteen areas

Figure 35:
this area is characterized with an old industrial use, and stands now in between corridors, the direct connection with the water is also noted, therefore it presents itself as a area to be analyzed. Author (2022)

4 . M4H AREA

4.1 - Mapping and analysis

4.2 - area of study

4.3 - climate impacts

4.2 AREA OF STUDY

Merwe Vierhavens is the area chosen to be our plot of exploration and methodology application. The area is located on west Rotterdam, between Schiedam and central areas, on the north bank of the Maas River.

the Merwe Vierhavens (M4H), in its history, was a common estuary from 1923 to 1932 and had modernization after the wars. The peak was after the 70s, when the havens established themselves as one of the most important and busiest fruit ports in the world.

The decline started when the harbor lost its power of logistic point as the distribution got stronger in other ports around the world, the area is mixed with different uses, and because of mischaracterization of the area, the character of the plot got mixed, with new and outdated buildings with different functions and services. Stadshavens Rotterdam (2011)

Rotterdam is established nowadays as a progressive city, and one of the main points of its economy is port functions, however, with the new zoning plans and developments, the main port functions moved further west, and therefore some parts of the harbor that were closer to the city lost their purpose. The city then found some territories outdated with big unused warehouses or logistic points that remained in the middle of the inner ring, conflicting with the inner functions of the city. The city needed to adapt itself to the current trends of the economy, a more sustainable and circular one. Therefore, the Havens in the city are outplaced in the current scenario, apart from some of them still providing vital functions to the port, the overall areas need to be adjusted. That's the case of M4H, in which some areas are disconnected from the rest of the city.

Currently, there are developments and master plans occurring in the area, which brought it to the spotlight, they are now being executed by the Municipality of Rotterdam as the called Makers District ambition, having the Delva Landscape as the head of the master plan. TOEKOMST IN DE MAAK (2019)



figure 29: google earth (2022)

This research will not take completely into consideration the Delva further clarifications, because the idea is to explore the area as a canvas for the experiment, however, points that are approached by the current plans can also be highlighted and incorporated.

Eight principles are listed for sustainable area development accordingly to the Rotterdam Stadshavens development in partnership with Delva and Makers district:

- permanently gives space to different types of makers.
- sharing facilities rather than individual enterprises.
- an area for experimentation and learning, teaching.
- production and use of sustainable energy.
- the area values residual flows
- sustainable mobility
- works as one resilient climate-adaptive plan;
- the area builds on industrial capability and quality.

Delva has an ambitious masterplan for the area, and the main reason is that it tries to balance the vital functions of the port, such as the big logistic centers, but at the same time balancing and dividing the 4 havens into different neighborhoods, with different typologies. TOEKOMST IN DE MAAK (2019)

The concept is to encourage and divide the Havens into new functions, stimulating and exploring the integration that this location could have with the rest of the city and nearest neighborhoods, so housing, entrepreneurship, manufacturing, arts, and culture are spread out throughout the plots.

The main matter is that the interventions are encompassing a sustainable approach where the areas and the new facilities should be neutral in terms of emissions, but not only that, but those structures could also promote and offer something for the area, for instance, energy generation, food production, and cultural promotion. TOEKOMST IN DE MAAK (2019)



figure 29: toekomst in de maak (2019)

Combining the zoning plan for the area, also considering what is been already suggested in the masterplan proposed by Delva, we can identify and highlight the main functions of every neighborhood. The plan of Delva clarifies that every piece should have its particularities, and this is responding also to the zoning plan, initially proposed by the Rotterdam municipality. An gripping point is a relocation or conversion of small parcels, such as abandoned or unused warehouses, that could give land space for housing, for instance.

MEWRVEHAVEN AND GUSTAVOWEG
 Housing and offices

GALILEI PARK

Large manufacturing companies
 Innovation and meeting places
 Catering and events
 Testing and making on a large scale

KEILEKWARTIER

Traditional crafts and creativity
 Innovation and creation
 Housing and mixed used

MARCONIKWARTIER

Housing
 Offices and business development
 Services
 ADJACENT PORT AREAS
 - vital functions for port economy



figure 30: author

Two regions are presented are hotspots for creativity, innovation and mixed use, also, they are placed by the Delva plan as central and important areas for meetings and social exploration, through events and etc. Also, because of the concentration of important buildings that are located between of these two areas. Hence, the analysis of buildings, that will follow will take place mostly on those 2 areas, where the main buildings are located. These two areas also present a big possibility of integrating with the rest of the city, mainly because of the equipments that are already there, such as offices, museums.

GALILEI PARK

Large manufacturing companies
 Innovation and meeting places
 Catering and events
 Testing and making on a large scale

KEILEKWARTIER

Traditional crafts and creativity
 Innovation and creation
 Housing and mixed used



figure 31: author

Following the Delva and Zoning plans, and scanning for opportunities, there are already some areas that are listed with major importance, such as monuments or green areas, following this, the strategy starts with trying to understand the relation and which kind of suggestion the plot already promotes on its pre existences.

The buildings

- 01 . FERRO
- 02 . KEILEHAVEN
- 03 . KEILEPAND
- 04 . ALV MUNDO
- 05 . VERTREKHAL ORANJE
- 06 . HAKA
- 07 . MUILTUSE BUILDINGS
- 08 . MULTIUSE BUILDINGS
- 09 . GREEN FIELD
- 10 . ROTTERDAM URBAN FARMING
- 11 . DAKPARK
- 12 . HET STEURGEBOUW



figure 33: author

The view after briefly analyzing those buildings is to select and understand, what possibilities are suitable, to potentialize the area through natural solutions.

Further investigation will follow to understand also the climate conditions and then, understanding what are the issues in the area, steps can be taken in order to develop scenarios:

In the end, the idea after comprehending what is there, and the problems related to the buildings, climate, and surroundings, strategies can be proposed and a series of interventions can take place.



figure 32: toekomst in de maak (2019)



figure 34: author

01 . FERRO DOME



status: unused
prospect: refurbishment
theme: entertainment

The old gas and oil structure are marked at the DELVA development as a hotspot for the new planning, this building is intended to be refurbished to be used for the catering and entertainment industry. However, apart from energy neutrality in most of the buildings, there's no other approach, thus this central area can be used to have a nature-based approach, highlighting the theme.

02 . KEILEHAVEN



status: used
prospect: refurbishing og
theme: Kunst en complex

The kunst en complex is a place for experimentation, related to art and other events, the place is already been refurbished and it's going to keep its activities also related to small business and catering industries. the proximity to water also opens a possibility for integrating with it.

03 . KEILEPAND



status: used
prospect: refurbishing
theme: creative manufacturing

this building was used as a logistic point warehouse and so as today. It needs refurbishment and the whole area can be used for the creative manufacturing industry and offices. the whole plot can be also combined with housing, where new buildings would take place.

04 . ALV MUNDO



status: used
prospect: refurbishing
theme: Kunst

the museum intends to be open 24 hours per day, and the facade is to be refurbished to its original state. It's a place for experimentation and for creative minds.

05 . VERTREKHAL ORANJE



status: used
prospect: further develop
theme: offices

refursbished building used to be a terminal for cruisers during the great times of the docs. now it holds some offices with different themes.



06 . HAKA



status: occupied
prospect: ?
theme: offices

The Hapakand is an iconic and monumental building for the area and the Rotterdam culture, it faces and marks the entry from the city (Delfshaven) to the M4H docks. Apart from its iconic relevance, it would be a great opportunity to express and apply the Nature inclusive design strategies.

07 08 . MULTIUSE BUILDINGS



status: used an unused
prospect: refurbishing
theme: multiuse

a series of buildings add to compose the M4H area, they are divided into many different functions, sizes, and typologies. services, enterprises, and catering companies.

09 10. URBAN FARMING AND GREEN FIELD



status: used
prospect: expansion
theme: urban farming, recycling and greening.

there are already a couple of initiatives in the area focusing on urban farming (Rotterdam urban garden) and collaborative greening, also food production, This is already a movement that encompasses NBS aspects, the idea would be to expand and consolidate it as a standard design approach.



11. DAKPARK



status: used
prospect: consolidated
theme: urban farming, natural areas

a former rail yard gave place to the biggest roof park in Europe, exploring nature solutions, it ts a place for a lot of initiatives that unite the neighborhood, but also enhances the biodiversity of the area, giving spaces for insects, animals, and plants.

12. HET STEURGEBOUW



status: used
prospect: refurbished
theme: creative industry and catering

monumental building from the 30s, the place once for the energy generation offices, now is a creative beacon for events.

4.3 CLIMATE IMPACTS

4.1 - Mapping and analysis

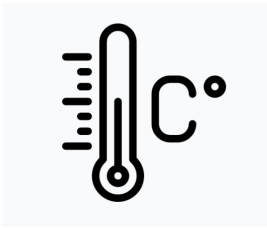
4.2 - area of study

4.3 - climate impacts

CLIMATE CHANGE ANALYSIS - TEMPERATURE

The climate has changed to maybe even irreversible scenarios, if no action is taken into place, the current situation will get worsened. The Royal Netherlands Meteorological Institute (KNMI), has produced a report predicting the scenarios which Rotterdam could face in the next 30 years and more. The following analysis intends to analyze the M4H current situation, and explore the possibilities to reverse the situation.

Temperature predictions:
avarage from 22.1 to 23.5
>30c from 1 to 5.12 days
from 48 to 20 days of froost
from 20 to 35 summery days
Rotterdam Municipality (2020)



implications:

air temperature affects mainly weather patterns, hence more stormy weather, and overall changes in specific climate conditions. That impacts directly on fauna and flora, that are depending on those, hence the overall ecology is degraded by it and in the chain reaction. Such the coral reefs that survive on specific water temperatures, they are food, habitat, and source of o2 generation for many species, including us. The heat islands are worsened with the average overall temperature, impacting also into specific areas. (NOAA, 2022)

Analysis and solutions:

For the Rotterdam solution, there are many strategies to mitigate and reduce the overall temperature. Firstly, for a dense city and area such as M4F, reducing the reflective surfaces and application of light-colored coverings, and implementing more absorbent surfaces, such as green roofs or water surfaces. The lack of vegetation is one of the main reasons for the temperature rising, hence green areas so as more shading surfaces. Energy optimization on buildings is also a factor that could be utilized to reduce emissions and hence decrease the temperature, so as green facades, and water management systems.

As observed in the mapping for heat islands, the M4H area is in a very high score for heat island incidence: lack of vegetation, long reflecting surfaces with a lack of shadowing elements, dense and concrete buildings, and pavement surfaces. Also, the area is marked as a vulnerability to insufficient cooling for buildings, with not enough gardens in the immediate surrounding. This also opens the possibility of exploring nature-based solutions on buildings, so as green second-skin facades, materiality and etc.

vegetation is also marked as a vulnerable area, this can be described as the lack of dense or diverse vegetation, characterizing the area with low and poor vegetation such as green fields that are not explored as they should.

For this specific situation:

- Densification of the vegetation and shadowing areas
- water points for air refreshment
- less reflective surfaces, application of green on facades, also for energy optimization for cooling and heating.



figure 35 heat stress - Rotterdam Municipality (2020)

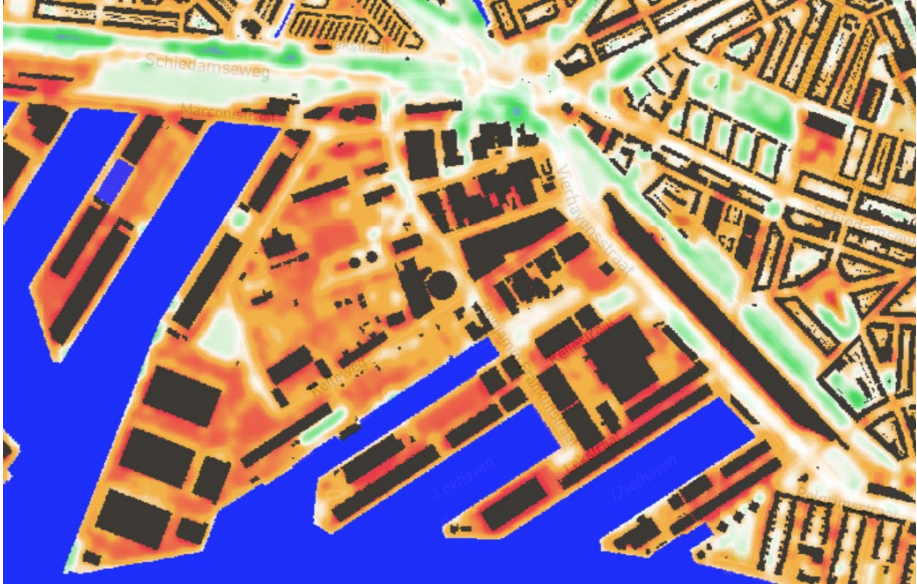
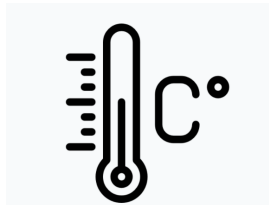
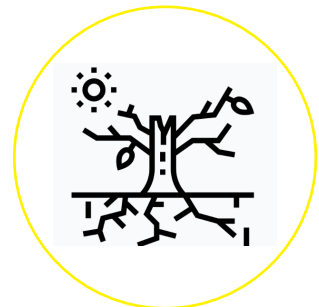


figure 36: ROTTERDAM Qgis, 2021 heat island effect

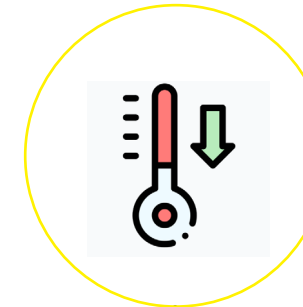


Temperature predictions:
average from 22.1 to 23.5
>30c from 1 to 5.12 days
from 48 to 20 days of frost
from 20 to 35 summery days
Rotterdam Municipality (2020)



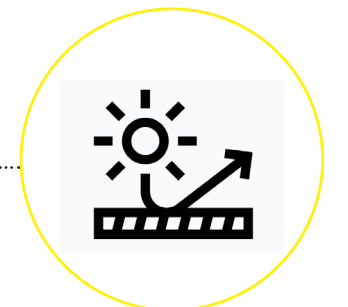
lack of vegetation and shadowing areas - increases the soil temperature, also accelerates the drought process. So a lack of watery areas to balance and humidify the area

possible solutions: shadowing surfaces, denser and vegetation variation, so as water into the built environment



insufficient cooling for buildings

possible solutions: vegetation and watery rooftops, blending vegetation into buildings to decrease surface temperature and energy consumption



reflecting surfaces, and density, so as fully pavement areas, created impermeabilized areas, so as more reflecting surfaces, increasing the heat island effect in the area.

possible solutions: vegetation and watery rooftops, blending vegetation into buildings to decrease surface temperature and reflection.

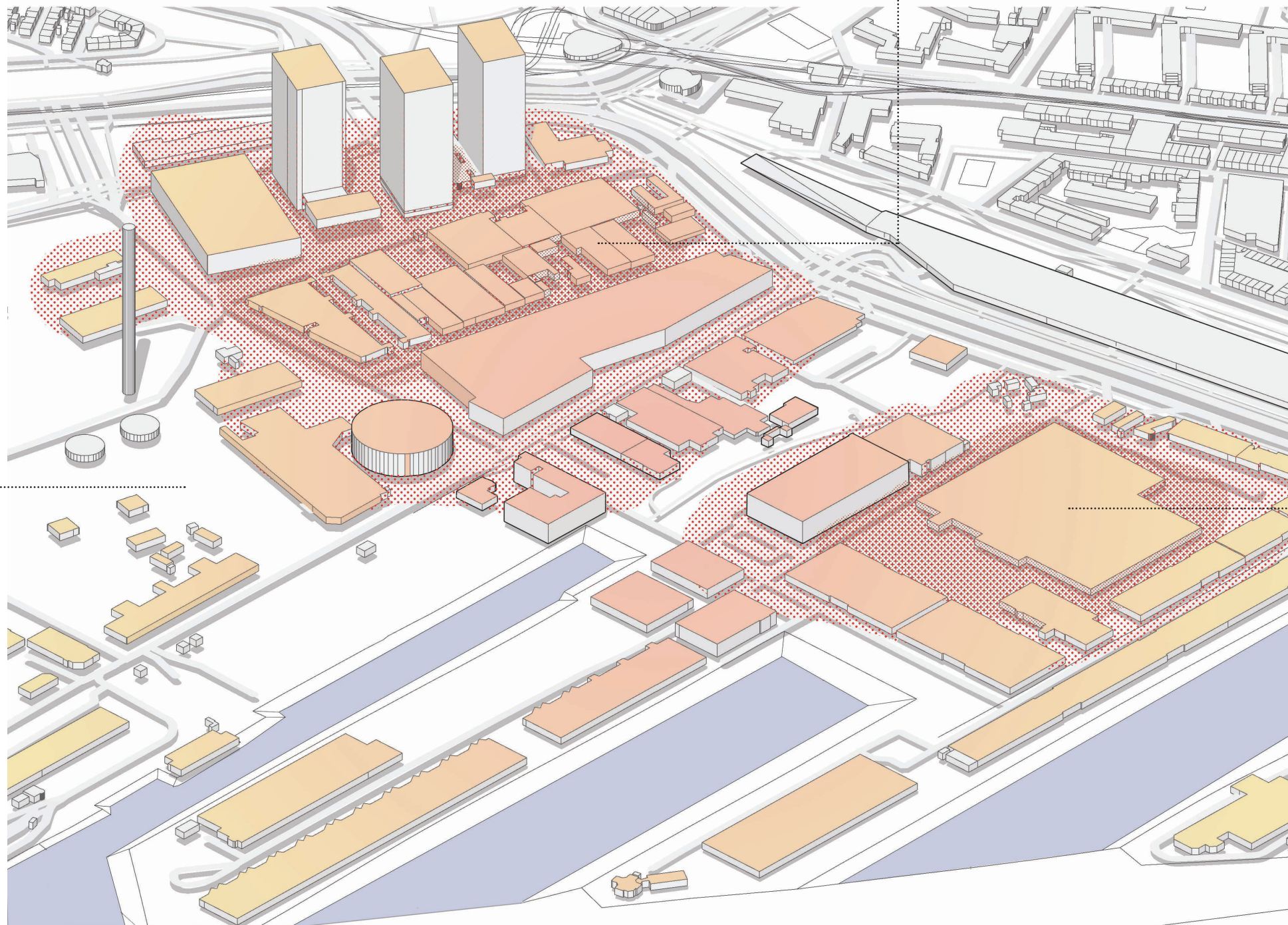
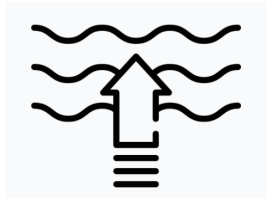


figure 36 heat stress consequences - author

sea and rain predictions:

average level increasing 40cm by 2050 and 100cm by 2100
river flows increasing in winter and lower water levels in summer
rainfall to increase up to 925mm
50mm increase on daily rainfall

Rotterdam Municipality (2020)



Implications:

The potential impacts of heavy precipitation are related mainly to flood risk, leading to a lot of problems in the city. Excess rain also implies soil erosion and vegetation damage. The impacts of sea level rise are even more worrying, in Rotterdam the inundation of the delta could lead to permanent inundation of urban areas, causing chaos for the society, but for the environment, those floodings can cause the loss of many marshes and wetlands, increasing the salinity into vital areas for the wetlands which are habitat for many organisms. (NOAA, 2022)

Analysis and solutions:

For the Rotterdam solution, there are many strategies to reduce the excess rainfall and prevent the sea level from rising, preventing flooding. In Rotterdam, apart from the dike situation, the city should be able to drain water in a natural way, applying the idea of sponge city, where there are more permeable and filtrating areas, where the speed of the water can be slowed before going into the drainage systems. The creation of flooding areas that can support extra water during the rides. For the buildings as well, green gardens and facades can help to drain the water and also slow the drainage.

Vink, J., Vollaard, P., & de Zwarte, N. (2016)

The sea level rise also implies the salinization of the soil, which has major importance for vegetation health, with more salt evaporation, and also penetrating the groundwater, the trees and plants can't grow and survive properly, hence it can cause serious damage to the biodiversity, impacting on several species, aquatic plants, and animals that are in the vicinity of the risings of the delta. The extra salt can affect also the farm soils, and hence impact directly on the food production for humans and also animals, hence Rotterdam cannot only face problems related to flooding, but also a major decrease in the biodiversity due to impacts on the quality of the soil.

vegetation is also marked as a vulnerable area, this can be described as the lack of dense or diverse vegetation, characterizing the area with low and poor vegetation such as green fields that are not explored as they should.

For this specific situation:

- Densification of the vegetation and shadowing areas
- water points for air refreshment
- less reflective surfaces, application of green on facades, also for energy optimization for cooling and heating.

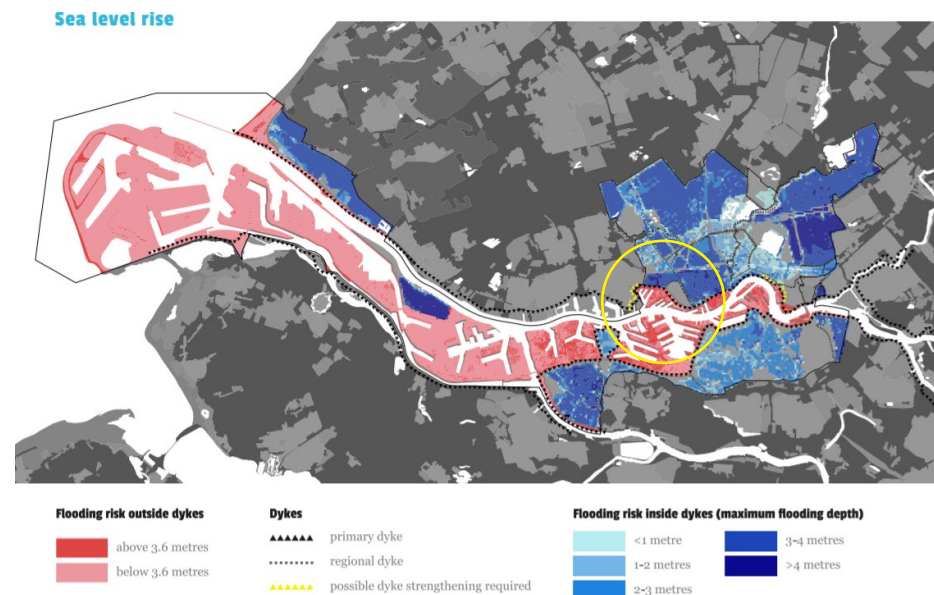


figure 37 sea level rise - Rotterdam Municipality (2020)

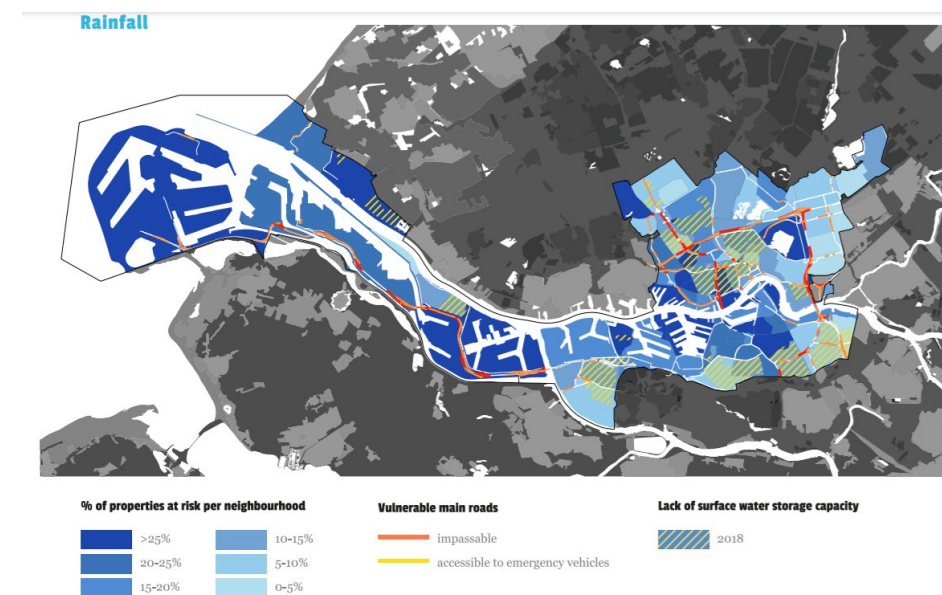
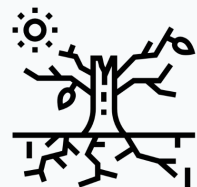


figure 38 rainfall - Rotterdam Municipality (2020)



low capacity for groundwater storage and rainfall sensibility, due to the high urbanization and concreted areas, such as large surface areas and low drainage systems.

possible solutions
drainage systems, introducing rainfall gardens, sponge vegetation and rooftop gardens.

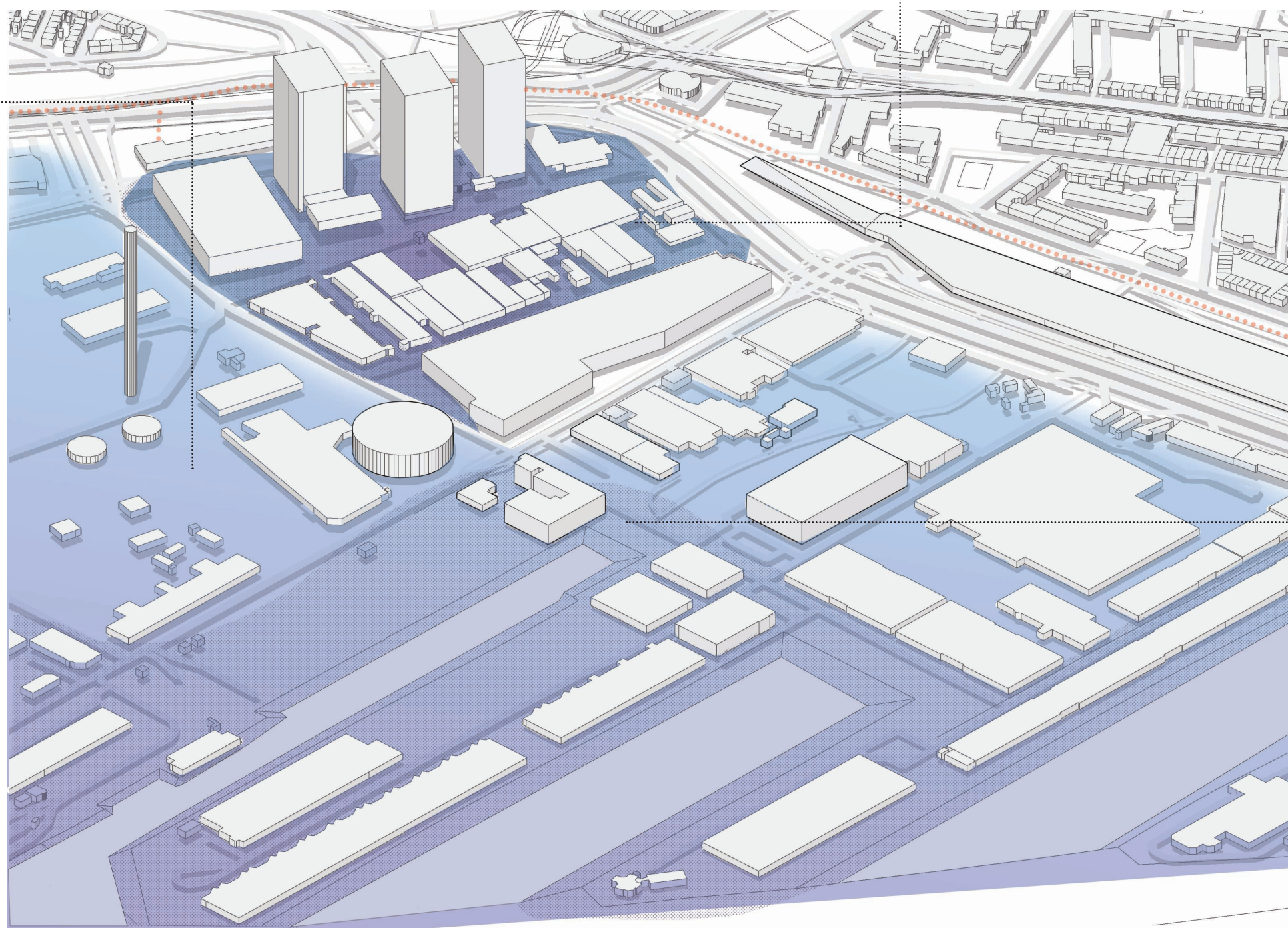


Salinization of soil

One of the biggest problems of the increasing sea level is the intrusion of salt in the soil, this has severe consequences for the environment, mainly related to the decreasing of nutrients caused by that, making the soil poor in quality, and more prone to drought. And the drought is a serious problem that is being traced by the authorities once is expected that ``Drought is expected to Result in a 30-40% increase in freshwater consumption by 2050`` weather urgent document, Rotterdam municipality, 2021)

Possible solutions:

Increase the capability of the soil to resist drought sessions, this is due to resilient vegetation and water storage idea, like wadis, that can keep water for long periods exposed.



Overall sea level rising and flooding risks

This area is marked as a sensitive area for flooding, mainly because it is excluded from the primary dikes and dunes, hence, rainfall and sea level rising can disturb the overall liability of the city.

Possible solutions:

Riverbanks can be restored to their natural resolution, creating natural barriers and more absorbing surfaces, controlling better the tides and waves, and consequently managing the sea level in a better way.



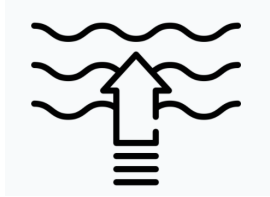
figure 38 sea level rise consequences - author

BIODIVERSITY IN ROTTERDAM

Accordingly, to the latest “Uitvoeringsagenda Biodiversiteit”, there’s a hurry in Rotterdam, the biodiversity is decreasing in the city as urbanization advances, and it’s stated that the city is constructing a lot. Impermeabilization of the soil, artificial light in excess, noise, and visual and air pollution are affecting animal habitats, orientation, and reproduction. It is also stated that the greenery of the city is only encompassing, the same trees, grass, and plants. Rotterdam Municipality (2020)

sea and rain predictions:
average level increasing 40cm by 2050 and 100cm by 2100
river flows increasing in winter and lower water levels in summer
rainfall to increase up to 925mm
50mm increase on daily rainfall

Rotterdam Municipality (2020)



Rotterdam faces the challenge of building 50.000 new homes by 2040, at the same time that those buildings are needed, the levels of urbanization are decreasing considerably biodiversity of the city, however, this situation is also an opportunity to explore and reduce the “petrification” of the city, the municipality intends to introduce 20 hectares of greenery in various initiatives encompassing nature inclusive design, such as green roofs, and green facades. (Rotterdam Municipality, 2020)

Analysis and solutions:

For the Rotterdam solution, there are many strategies to reduce the excess rainfall and prevent the sea level from rising, preventing flooding. In Rotterdam, apart from the dike situation, the city should be able to drain water naturally, applying the idea of a sponge city, where there are more permeable and filtering areas, where the speed of the water can be slowed before going into the drainage systems. The creation of flooding areas that can sustain extra water during storms. For the buildings as well, green gardens and facades can help to drain the water and also slow the drainage. Vink, J., Vollaard, P., & de Zwarte, N. (2016)



figure 39 drought - Rotterdam Municipality (2020)

Also related to water and green surfaces, it can be observed in the graph above, that drought is sensitive in the area, which means that the area is susceptible to dry soil, and the reasons are lack of groundwater surfaces, lack of absorption, and varied vegetation. Those areas can suffer from the lack of or poor vegetation, impacting directly ecology terms and the organisms that are related to it.

As described in the Biodiversity report, the recent efforts and investment in applying strategies to improve biodiversity in the city can be already observed as shown in the graph below, where the population of meadow birds is slightly restored after several years of decay in the population. This clarifies the necessity of investing in and utilizing nature as an asset, blending it into the built environment. Rotterdam Municipality (2020)

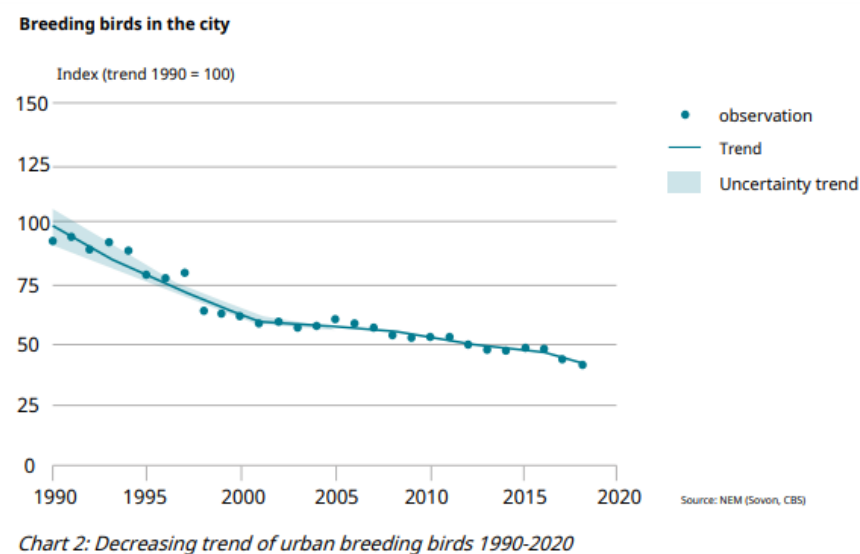
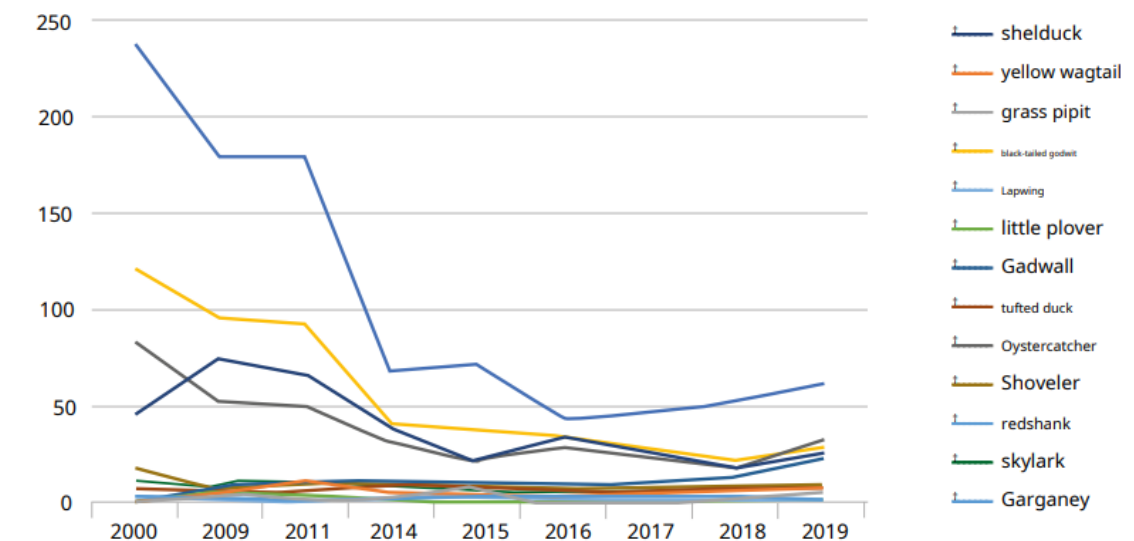


figure 39 drought - Rotterdam Municipality (2020)



Graph 3: Number of meadow birds in Polder Schieveen between 2000 and 2019.
figure 40 drought - Rotterdam Municipality (2020)

ROTTERDAM BIODIVER-SITY

sea and rain predictions:
avarage level increasing 40cm
by 2050 and 100cm by 2100
river flows increasing in win-
ter and lower water levels in
summer
rainfall to increase up to
925mm
50mm inscrease on daily rain-
fall

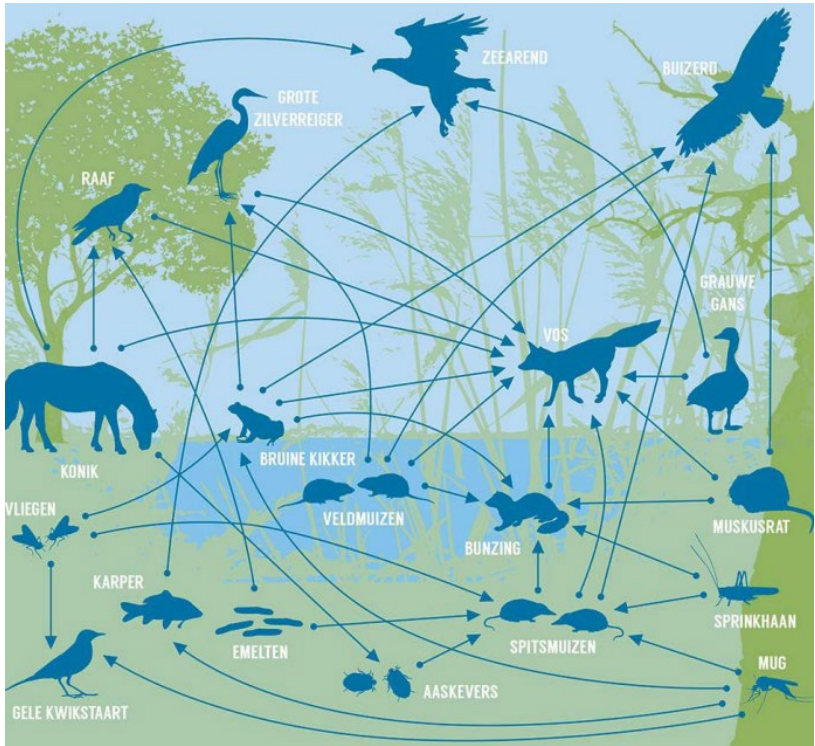
following the graph below, provid-
ed by the Urgent water document,
the Nature and Landscape are in
a very low score in the Rotterdam
municipality, even compared to
other dutch municipalities the
score is relevantly low. This means
that there's a relevant decline in fau-
na and flora management, as other
topics were considered more rele-
vant or had a more direct approach.
This can be explained also by the
dense urbanization that has been
occurring in Rotterdam, where
there are way too few areas for suit-
able biotopes where fauna can find
eco-habitats and flora develop free-
ly. it is clear that Rotterdam needs
to give space and create conditions
for nature to develop.

Rotterdam Municipality (2020)

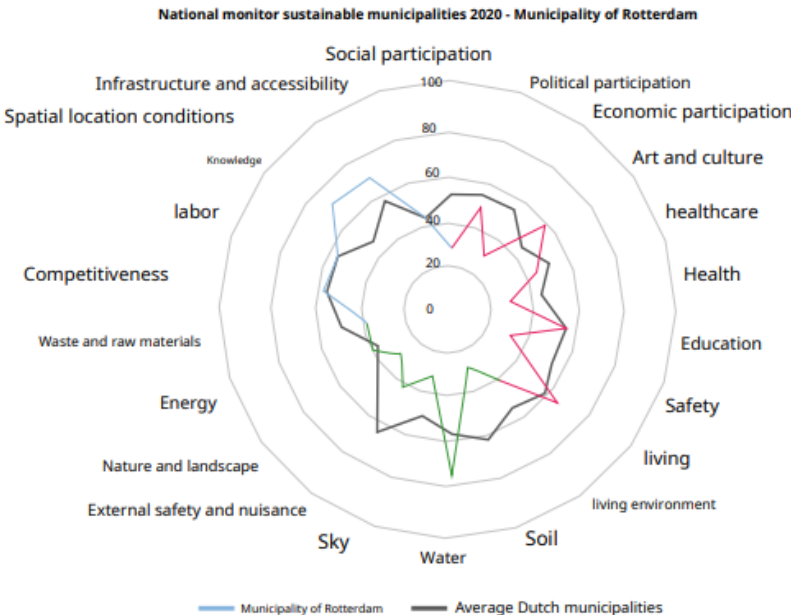
as described, two topics are very
relevant to improving the bio-
diversity in Rotterdam. Firstly
conditions must be created for
fauna and flora, into the ecolo-
gical scheme, if some instances
are restored, most of the outco-
mes come into a chain reaction
system. For instance, if more ha-
bitats are created, more species
can develop, and participate
under the ecological circle. as
observed in the scheme on the
right side, the Netherlands fau-
na Cercle is entirely connected
and also related to the habitats,
if those conditions are restored,
the overall balance can be rees-
tablished

Conditions can be created if the
environment can be restored.
For instance, in the riverbanks,
instead of the sharp concrete ed-
ges, vegetation can be reintro-
duced, layering from the deep
water to the dry soil, where dif-
ferent species of fauna and flora
can establish their relations with
the environment.

Rotterdam Municipality (2020)

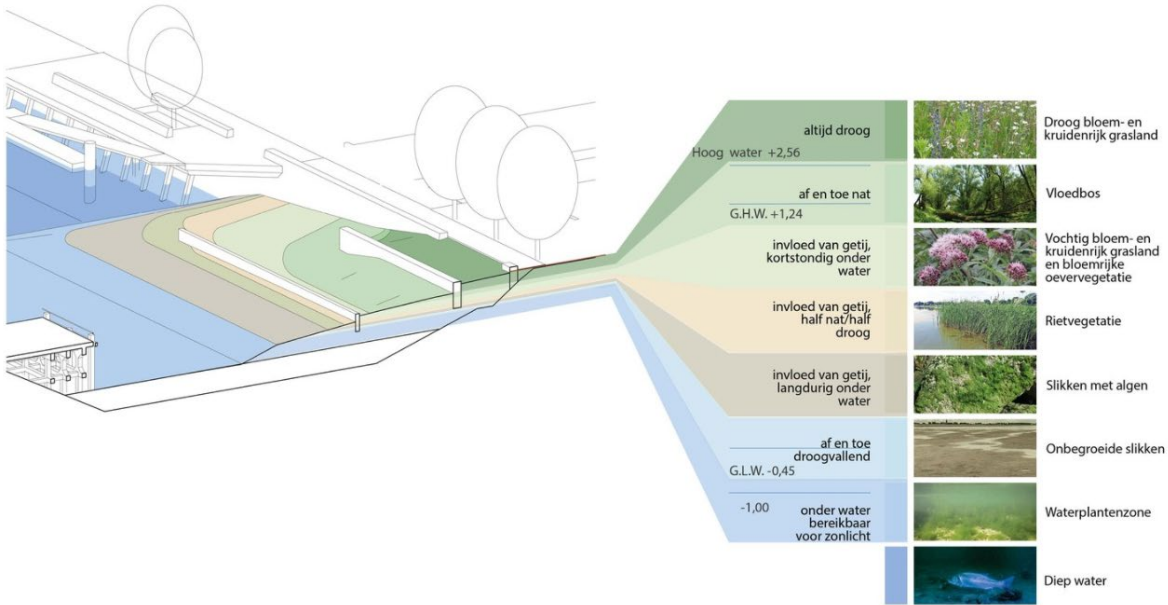


source: weather urgency document, Gemeente Rotterdam 2020



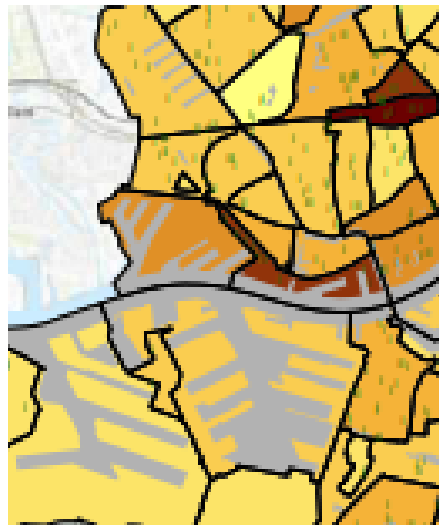
Graph 1: Situation of economic, socio-cultural and ecological capital Rotterdam.

figure 40 drought - Rotterdam Municipality (2020)



figures 41: de urbanisten 2020

IMPACTS ON BIODIVERSITY CURRENT - USE OF LAND



**poor
prone** **vegetation
to** **and
drought**

the area is mapped as a sensible area for drought which means that the current vegetation is either not able to overcome drought seasons, but also they don't have the capability of decreasing the drought effect.

possible solutions: shadowing surfaces, denser and variated vegetation, wadis for water management, so as temperature control, and sponge gardens.

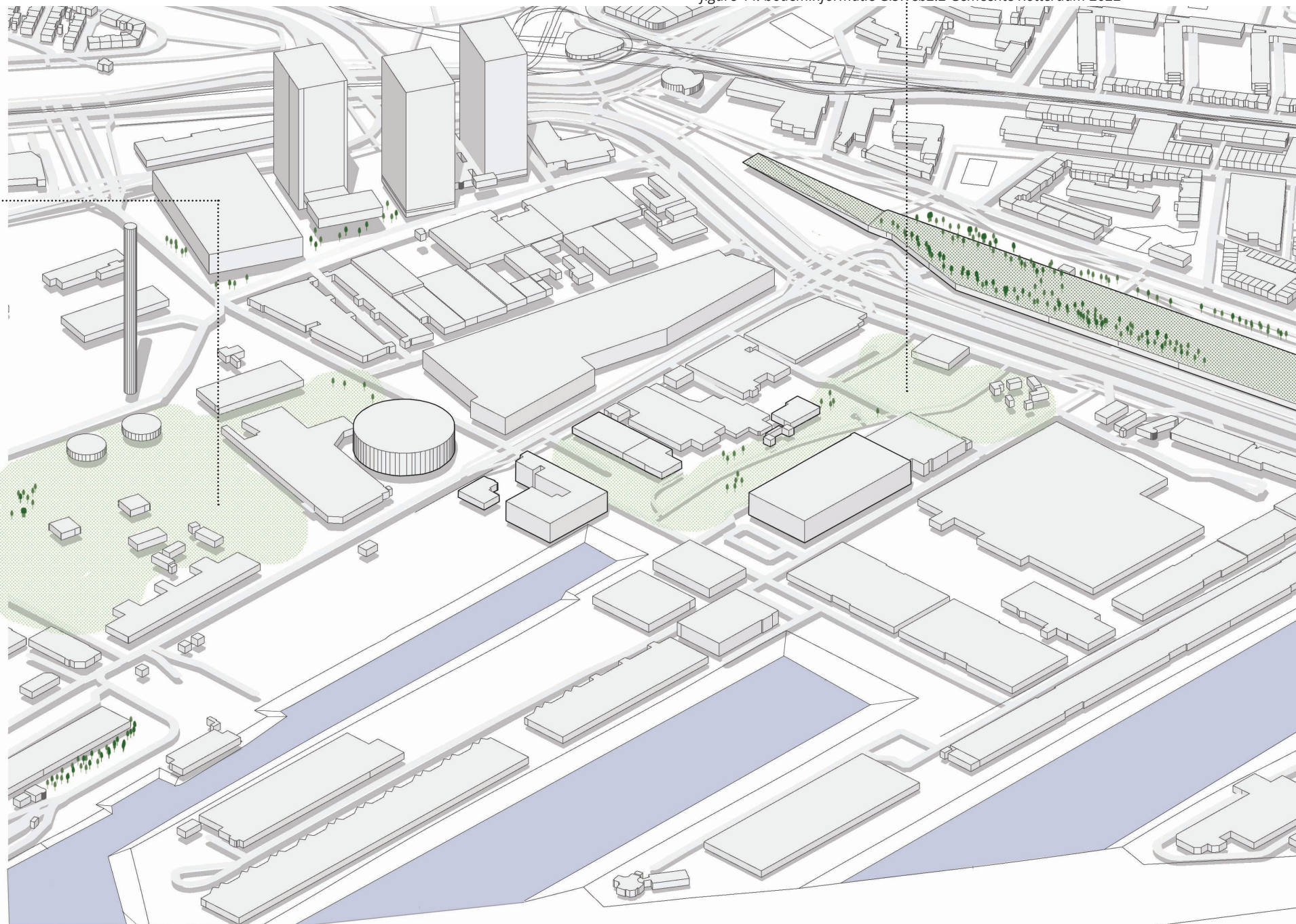


figure 43: author

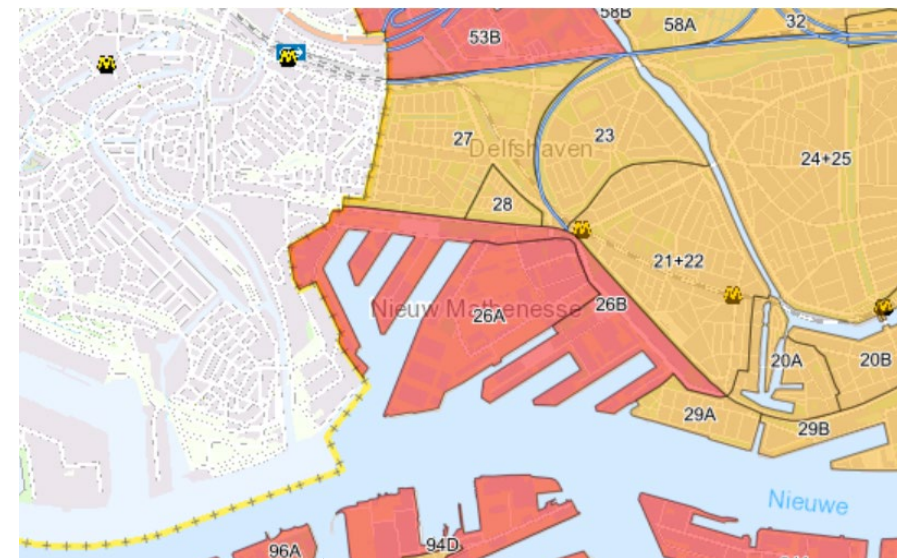


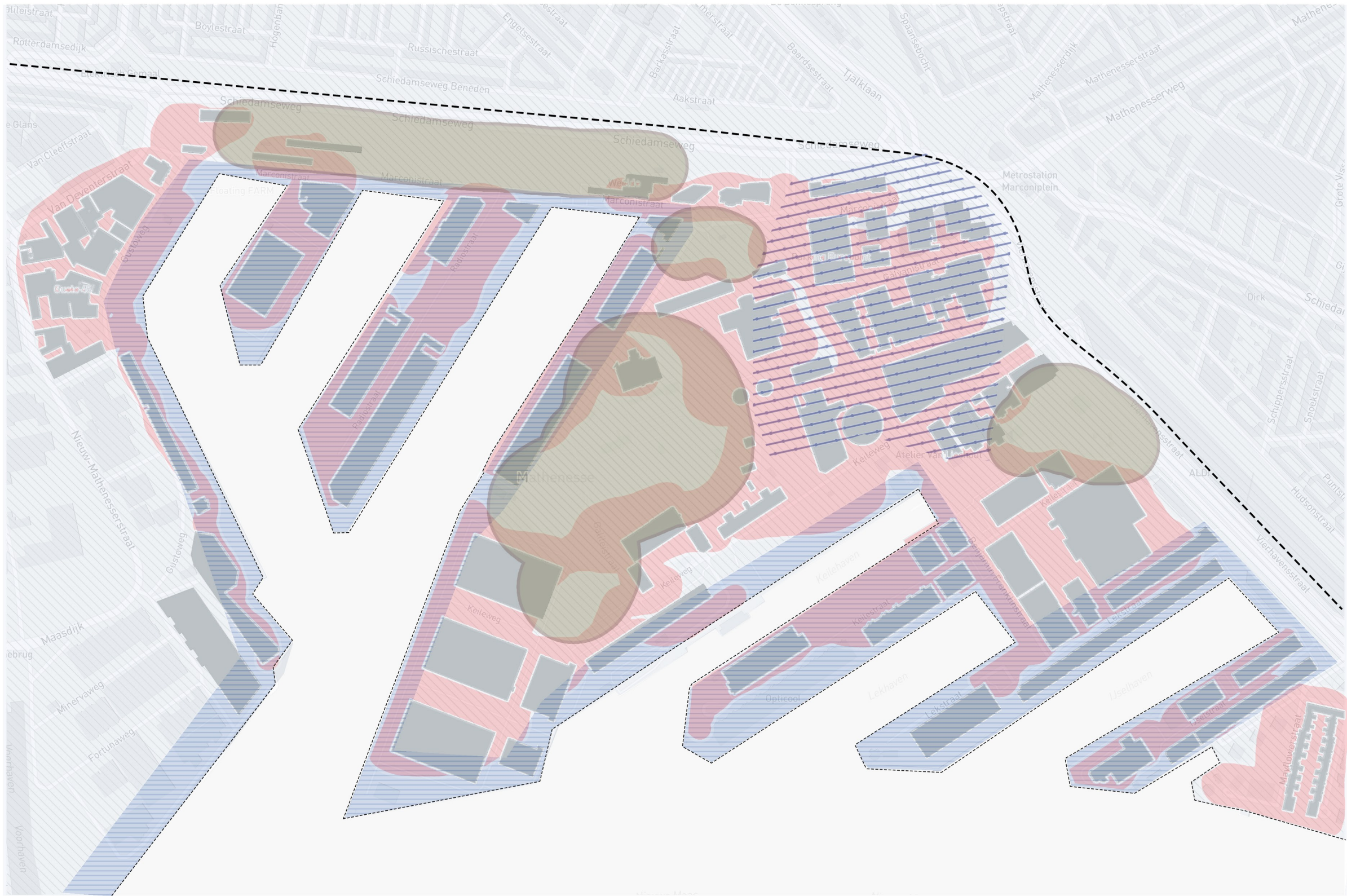
figure 44: bodeminformatie GisWeb2.2 Gemeente Rotterdam 2022

Contaminated soil

the whole M4H area is classified as an old industrial area with moderate soil contamination, which is very worrying for fauna and flora in the area, it could be that some species cannot develop because of the soil contamination. The underground water can also be affected by that.

possible solutions: a mix of Phytohydraulics and Phytoremediation plants, that can both prevent the transposition of pollutants from the air to the ground floor, and also extract the contaminants from the soil, this combination could restore and preserve the soil, increasing the overall liveability.

CLIMATE IMPACTS SUMMARY



legend

- flooding zone
- heat island effect > warmer + signiff. warm
- green areas prone to drought
- flooding zone secondary area
- large reflecting surfaces

5.0 INTERVENTIONS

5.1 - Interventions

01st

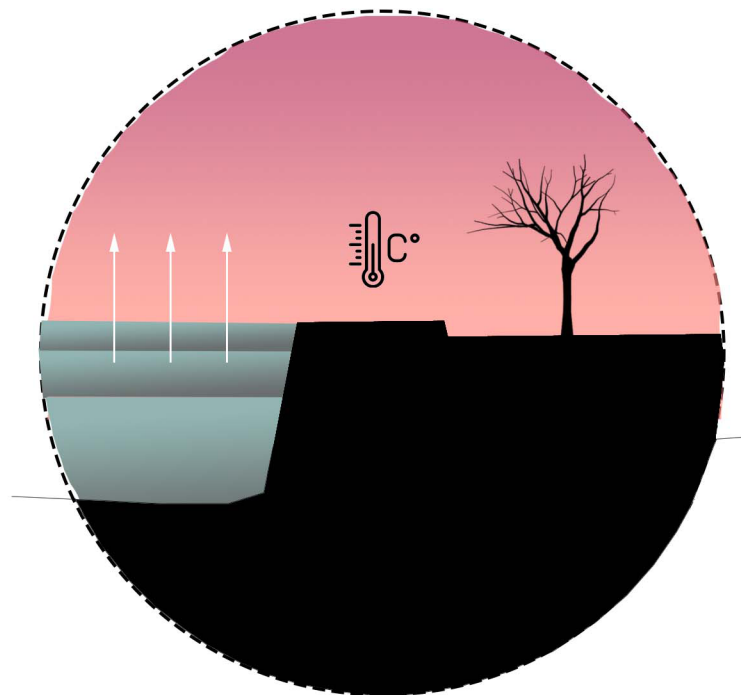
increasing **nature value** of the area,
 restoring **biodiversity**



an **intervention that adds, increase and restore the biodiversity, encompassing the biotope** of the area. the methodology can be applied to the area to explore the possibilities of greening more the concretish environments

02nd

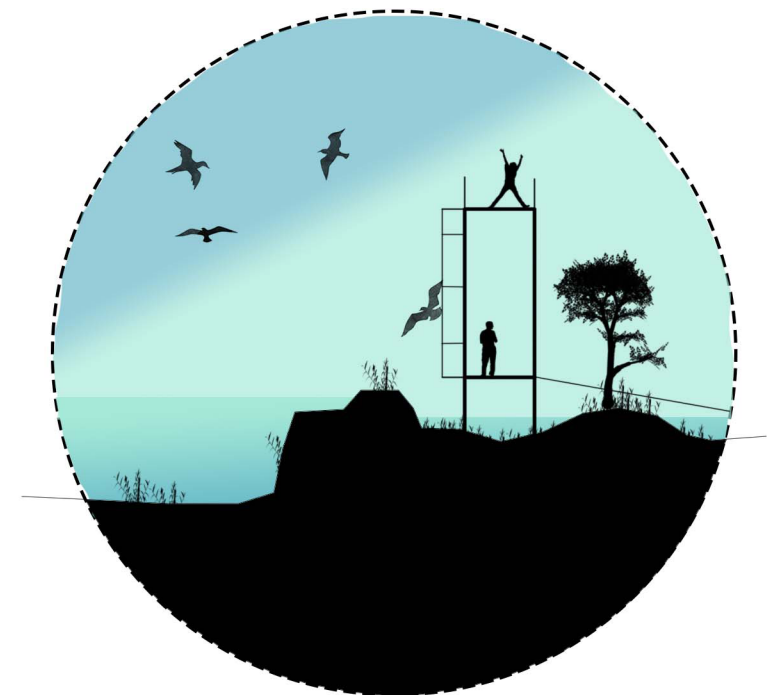
resilient nature, and area as an agent of **climate buffer**



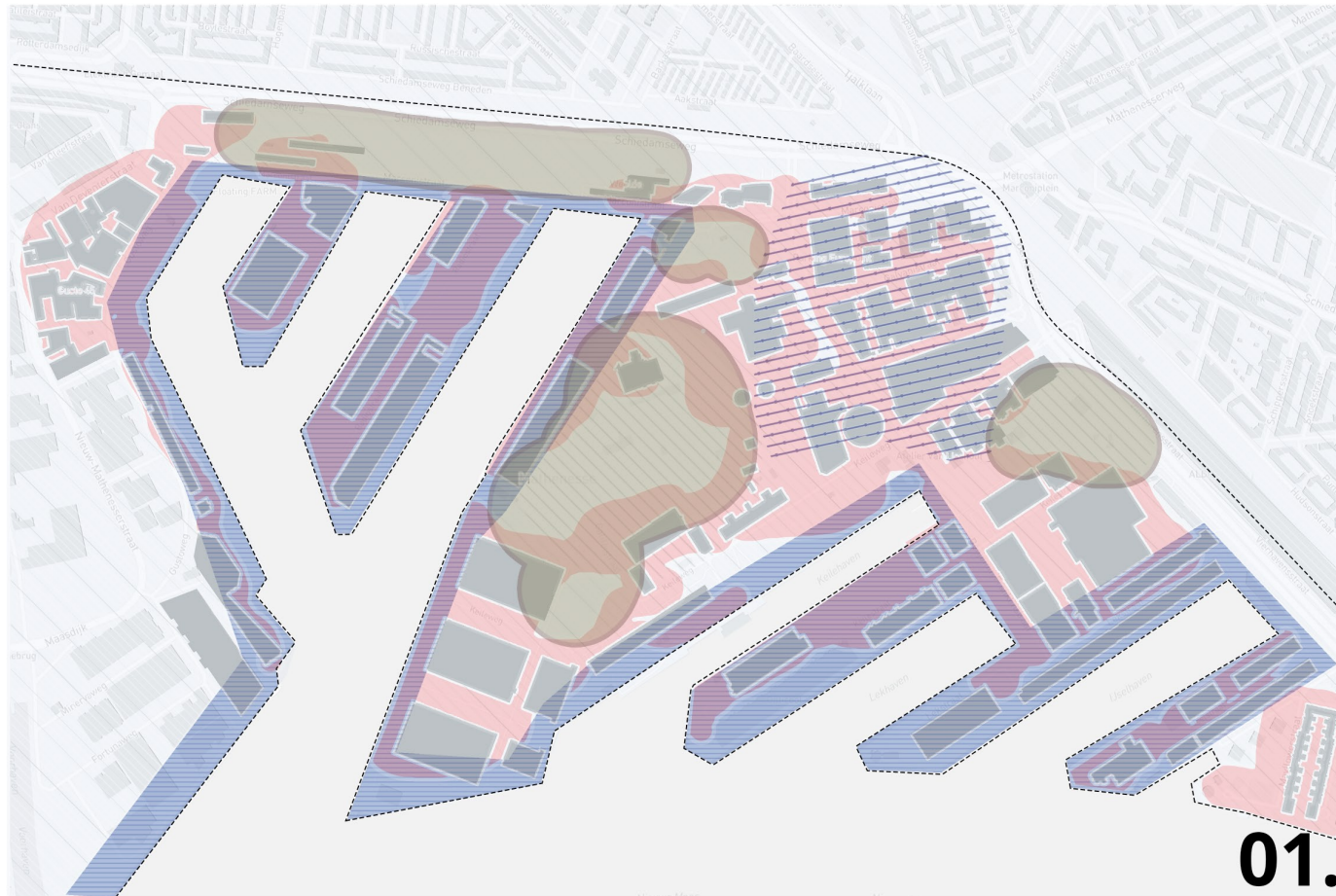
an **intervention that acts like a buffer zone** to mitigate climate change effects on urbanized areas. For instance, an area that can be resilient in terms of floodings, dry soil, heat island effect, lack of fauna and flora. Contributing to a less polluted water, air and adding for a healthy environment.

03rd

creating and promoting the area for **social benefits**



an **intervention that is able to achieve societal challenges, but also promotes a valuable interaction with the natural environment**, creating spaces for the users and activating the area as a whole.



01.

INTERVENTION ANALYSIS

Strategies to tackle scenario issues

① step

analysis of buildings and climate. The layers are overlapped, mapping the area with the main occurrences.

② step

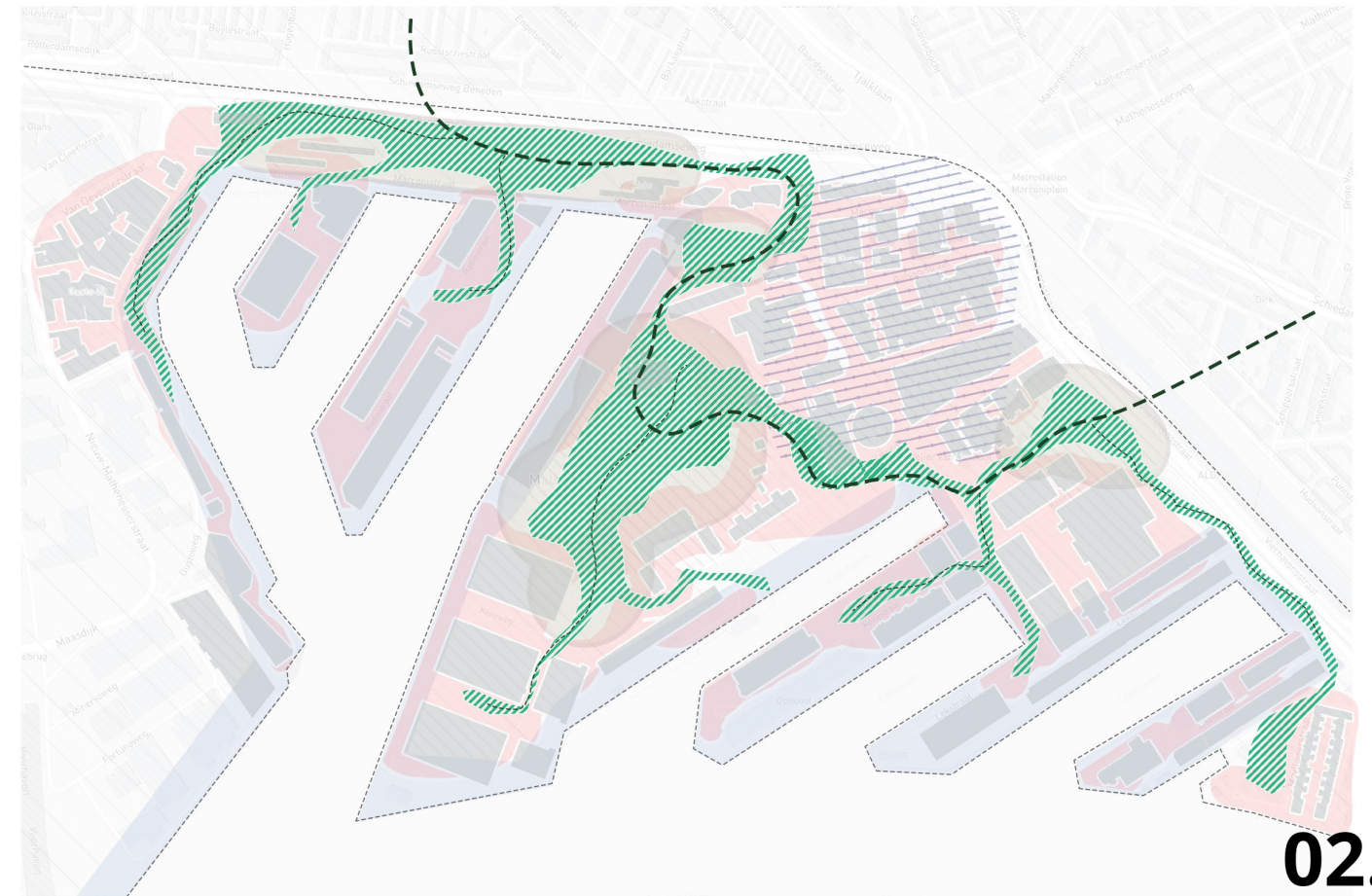
first act, on top of the occurrences map, is to trace a corridor throughout the area, This intends to hold a ``green infrastructure`` that would be path for secondary and localized strategies that could tackle the issues of the area

③ step

The green corridor should provide ecosystem services, such as: regulating air quality, water, wheater, pollination supporting nutrient cycling, and soil formation. It supports the natural cycles and provides biomass, food, and fiber, extending even to cultural and ethical values, such as recreation existence values. Greening paths, should be able to provide and spread those actions, to regenerate the ecosystem of the region.

In this step, also the existence of the area is encompassed, such as the buildings. Those should also support the ecosystem services of the area and be used as assets to tackle the weather problems, such as placing green facades and roofs to mitigate heat-stress.

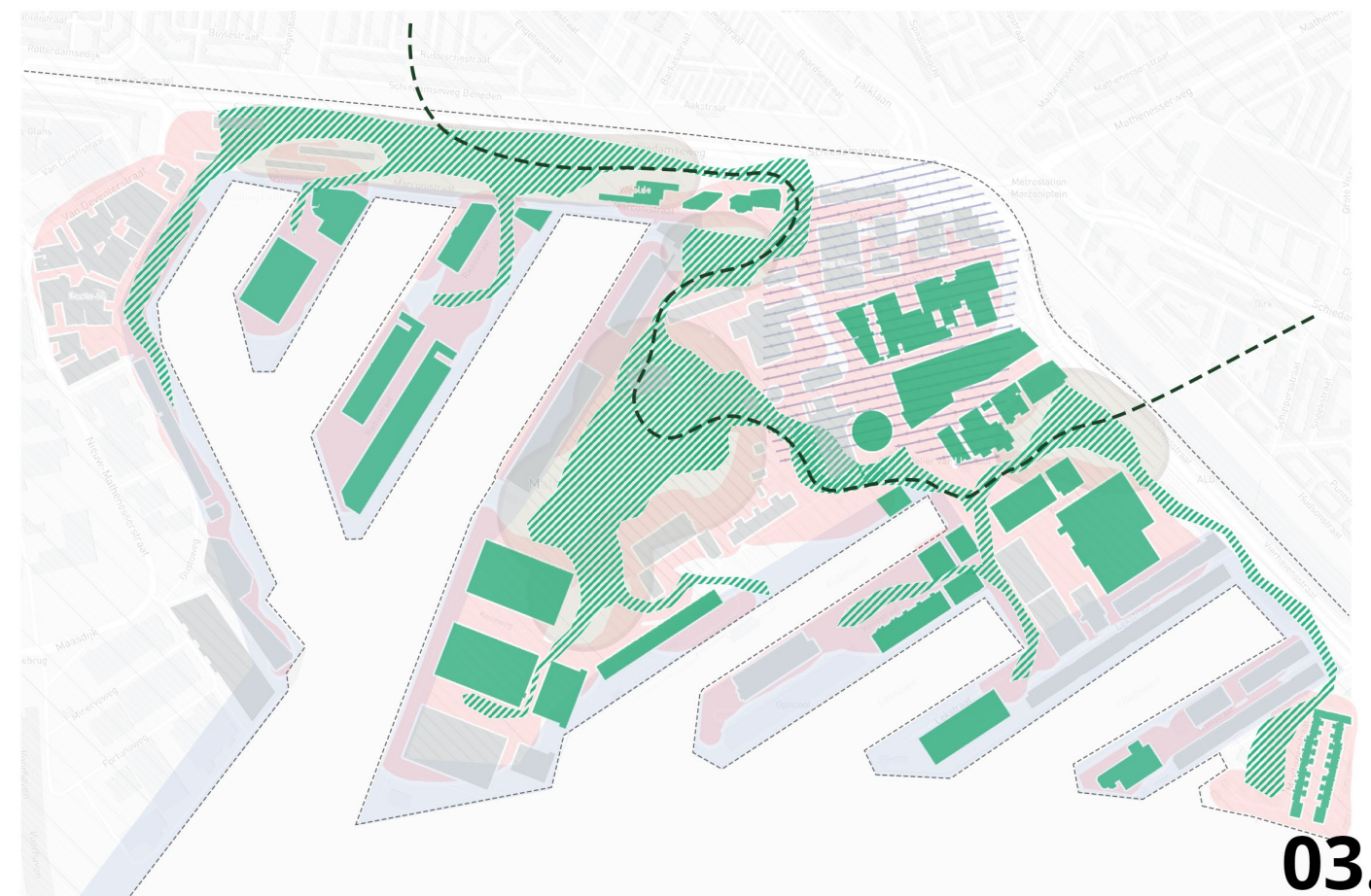
- legend**
- flooding zone
 - heat island effect > warmer + signiffi. warm
 - green areas prone to drought
 - flooding zone secondary area
 - large reflecting surfaces
 - insufficient cooling 25%



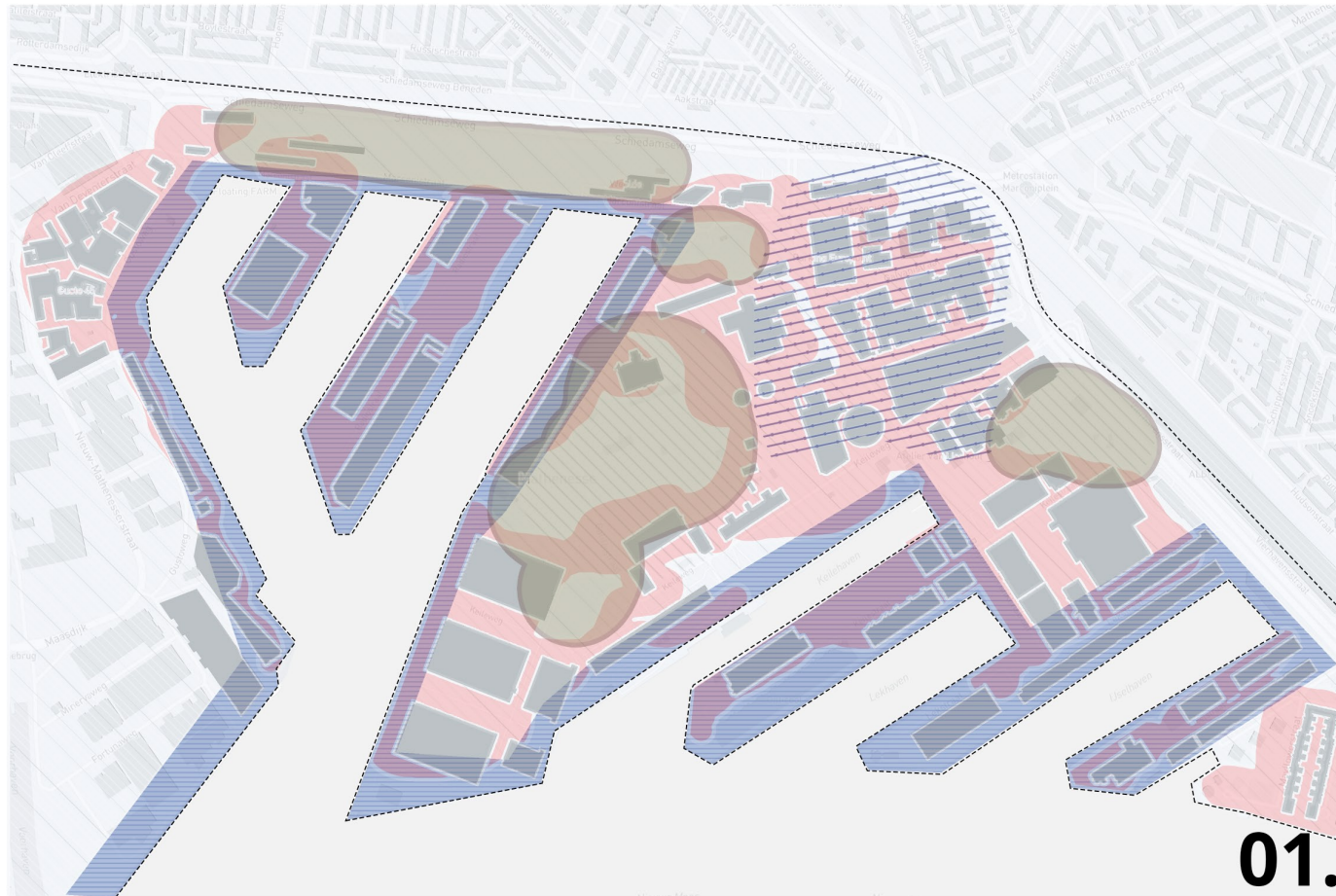
02.

② map 2 - first interventions - green corridors + strenghtening connections

③ map 3 - building interventions along the corridor



03.



01.

Strategies to tackle scenario issues

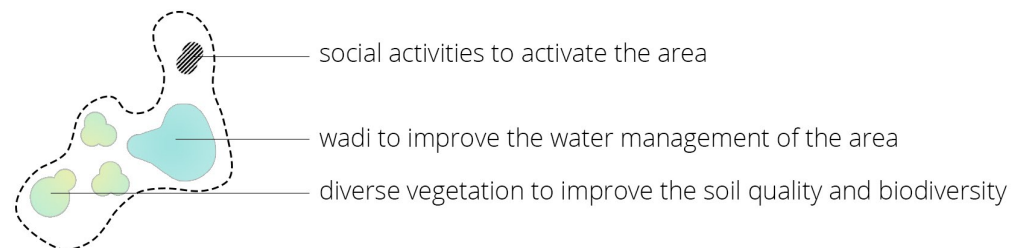
④ step

strengthening green connections of the corridor with the surrounding building, integrating and forming an unity, so the strategies are blending and getting stronger united

⑤ step

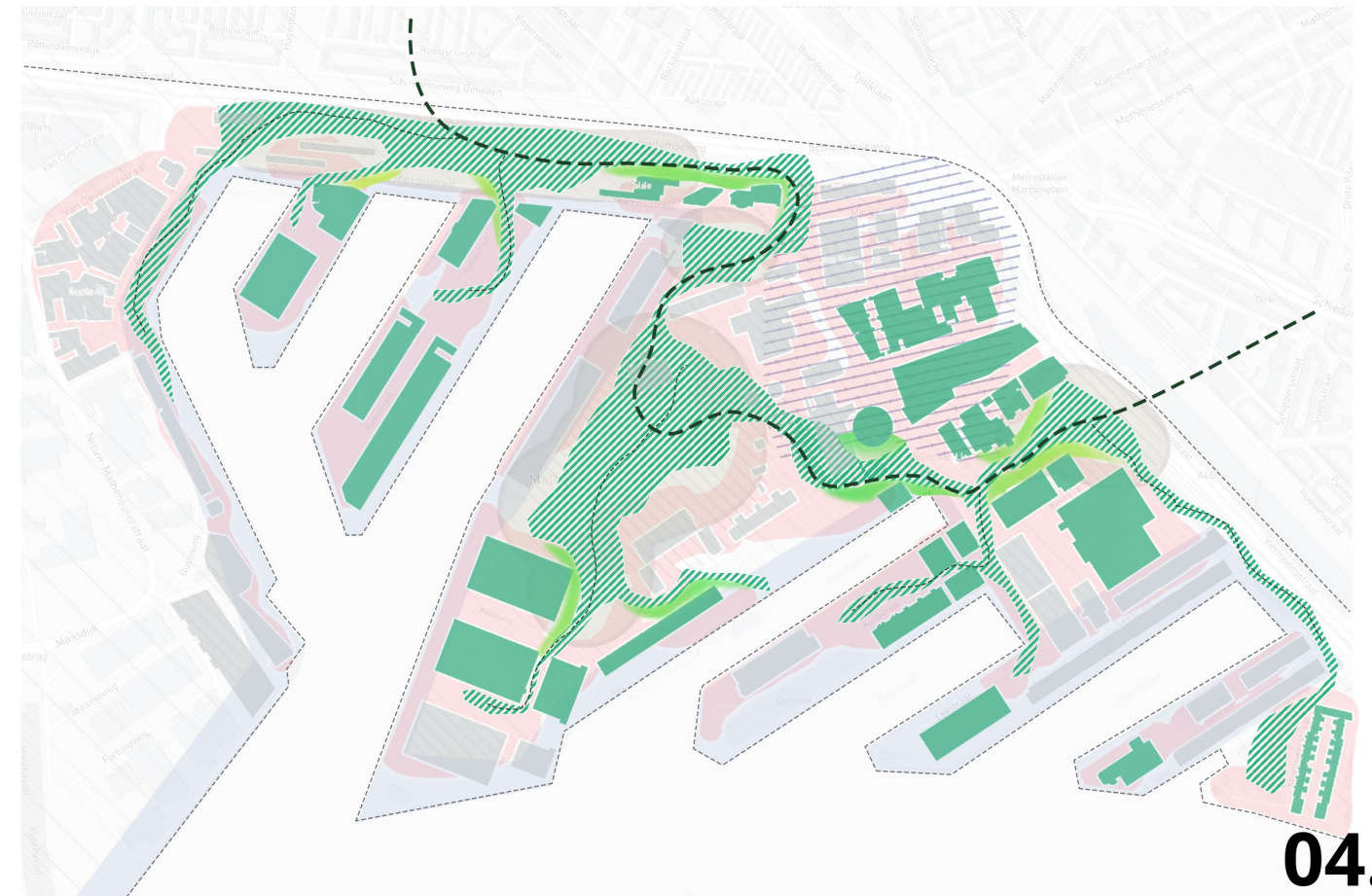
the quay is also modified to promote the interaction with the green corridor, at the end every instance is being at least approached, and further pin-point strategies will be placed in other to respond to specific demands.

For the specific demands, a bundle of techniques is placed. Strategies combined are used to attack wheater demands or achieve societal needs, this idea is spreaded out throughout the green corridor. (See example below)



legend

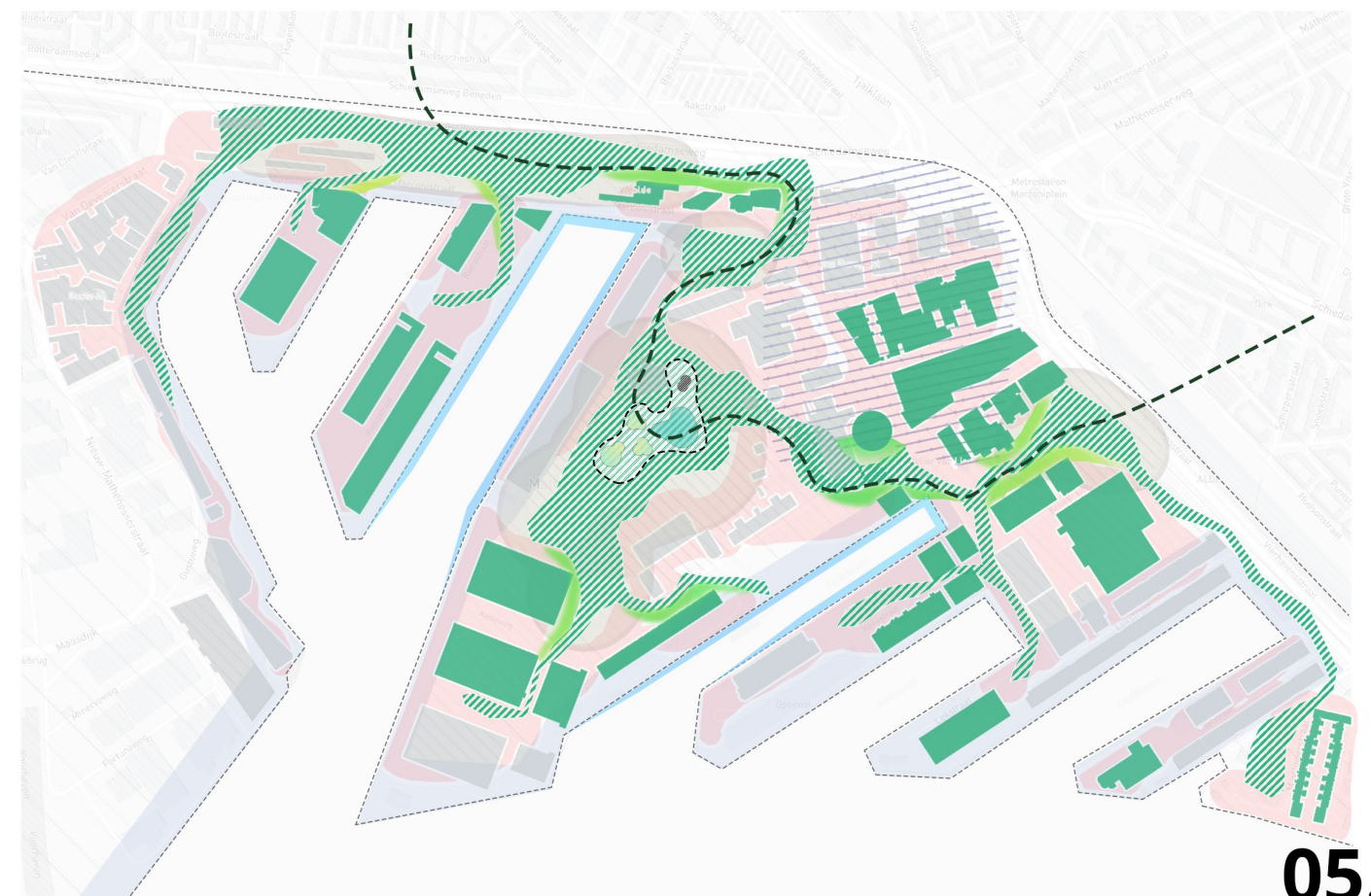
- flooding zone
- heat island effect > warmer + signiffi. warm
- green areas prone to drought
- flooding zone secondary area
- large reflecting surfaces
- insufficient cooling 25%



04.

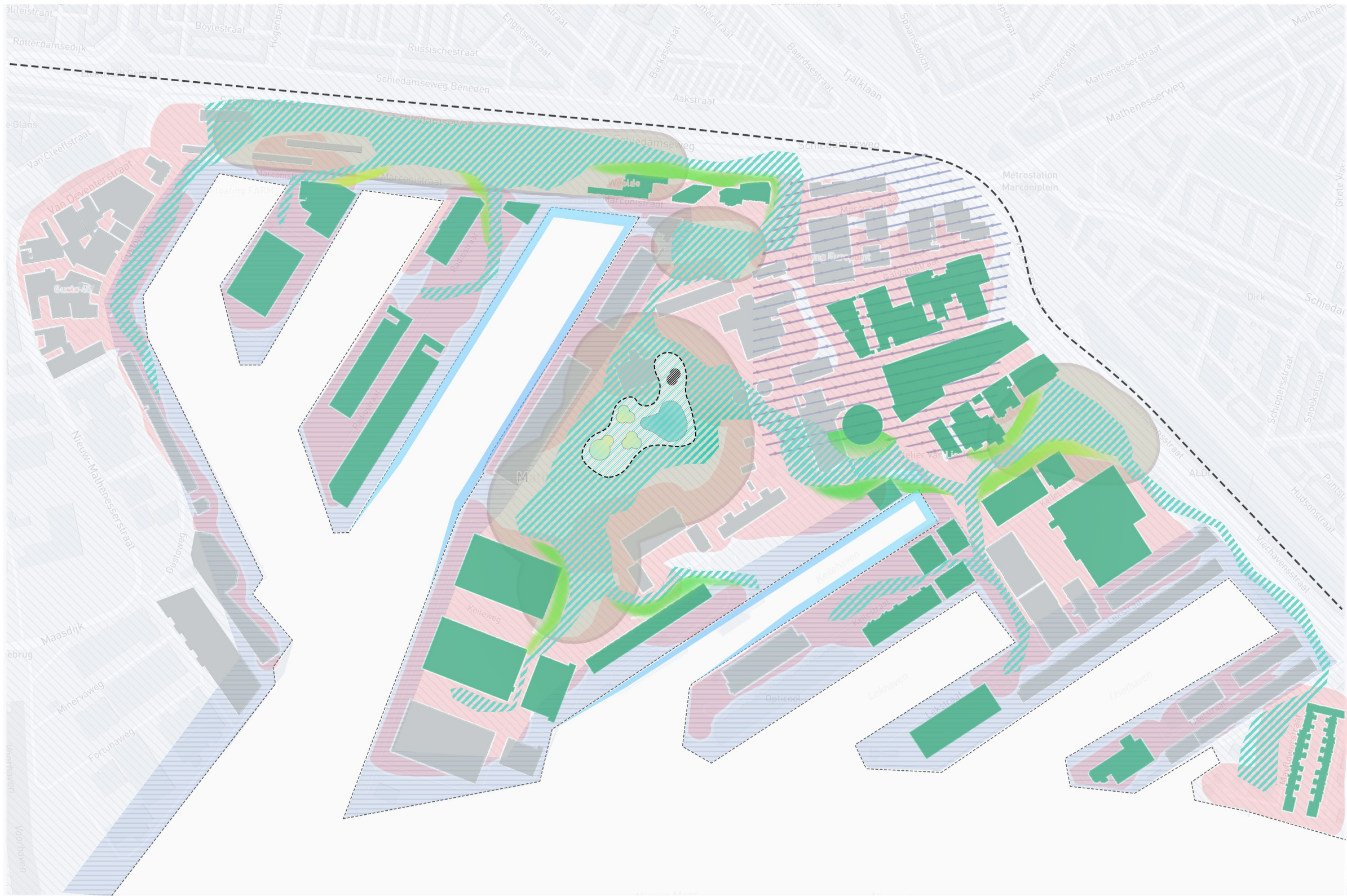
④ map 4 - promoting interaction between green corridor and existing buildings

⑤ map 5 - quay interventions, modification on the banks and pocket bundles







05.

CLIMATE X CORRIDOR

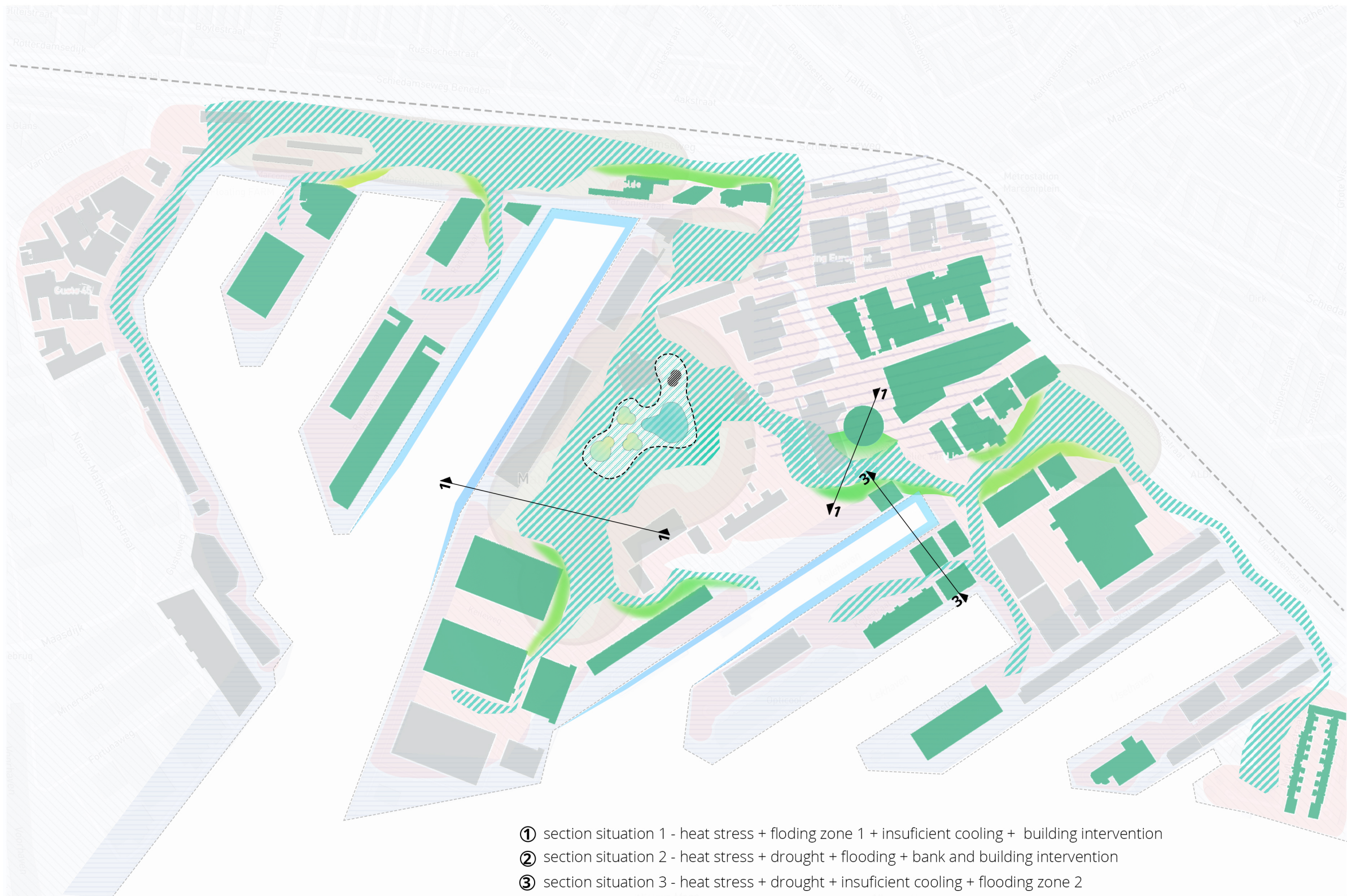


legend

-  green corridor
-  buildings interventions
-  building interaction with corridor
-  bank intervention

the result of the analysis and the first placement of strategies is a green corridor that tries to approach the area as a whole and provide a different set of strategies, as we will investigate further. The drawing of the corridor tries to answer the demands with a potential of expansion.

GREEN CORRIDOR PROJECT



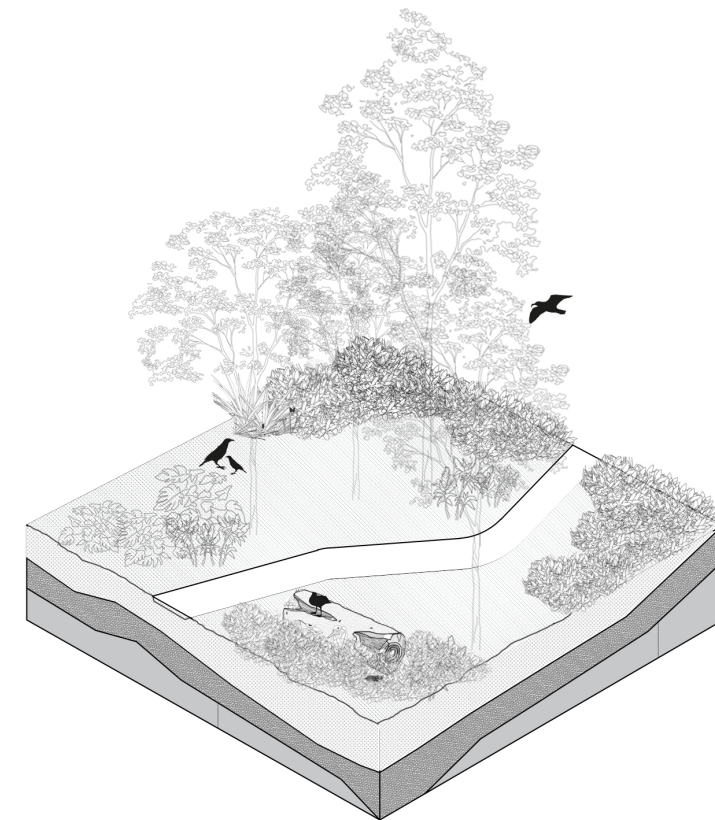
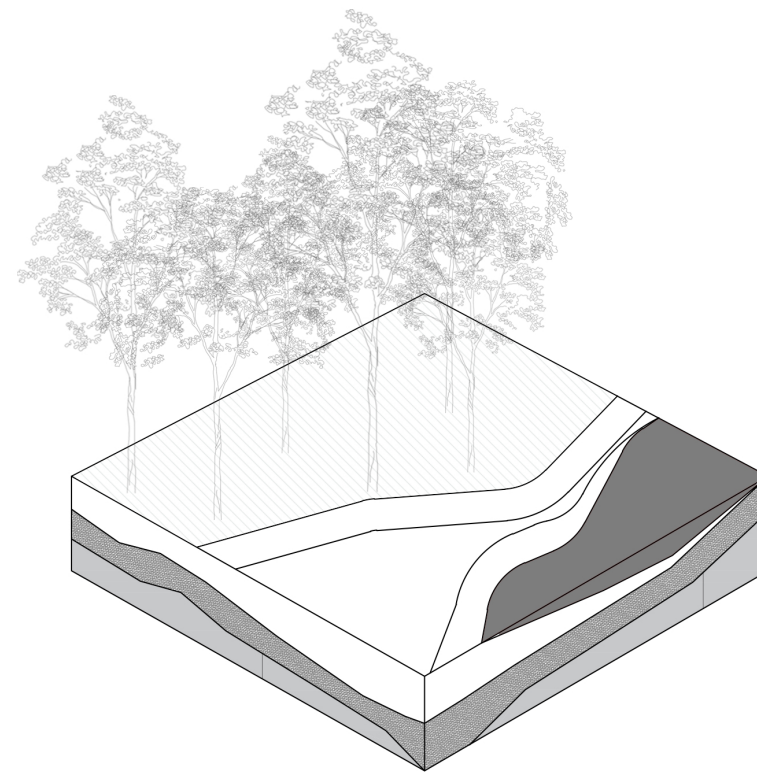
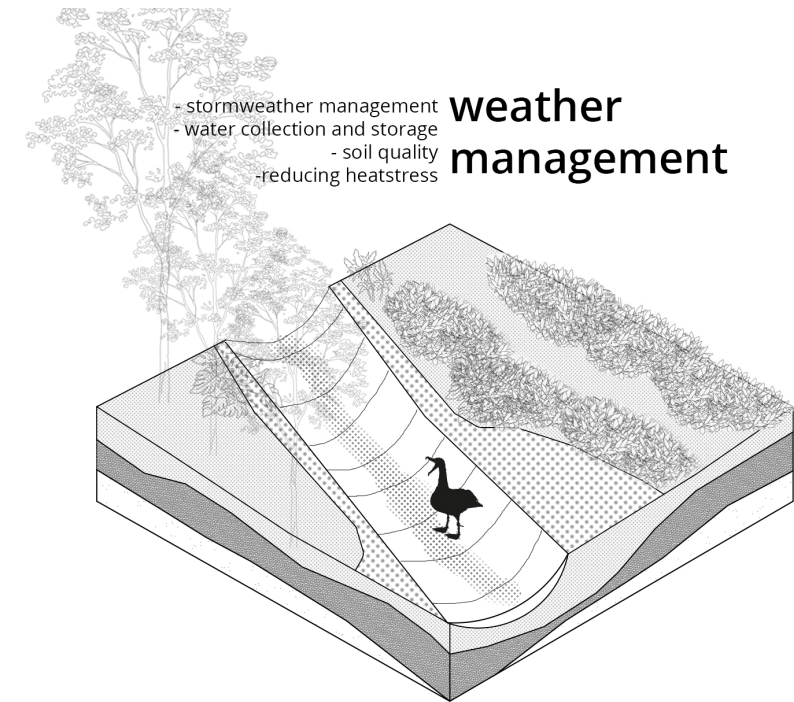
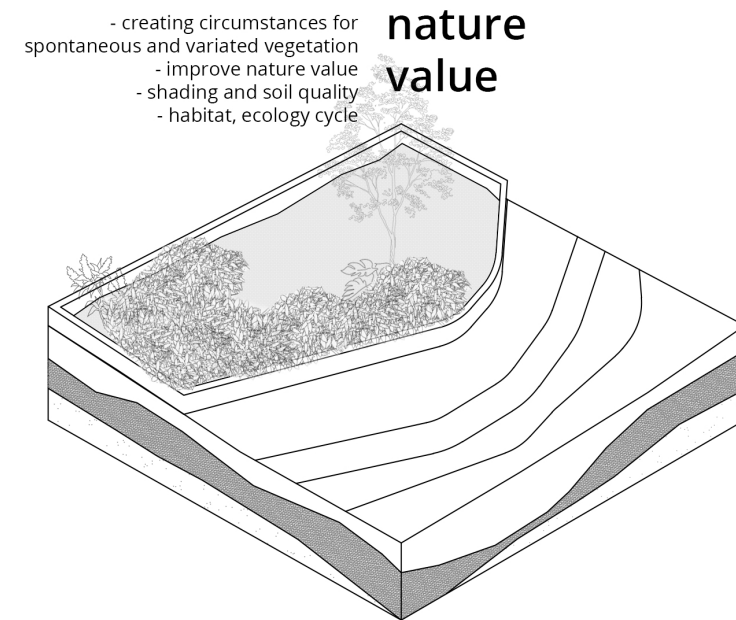
legend

- green corridor
- buildings interventions
- gbuilding interactions with the corridor
- bank interventions

the corridor project then is expressed as a set of generic and global motions, that intend to spread out throughout the area as a bundle of actions that could help to respond to the demands. This corridor should be able to unite and provide different solutions along the path, aiming to increase the nature value and control stormwheather.

In terms of the called generic and global gestures, those are the central actions that will be described in the next pages. The vegetation, 3 types of nature are explored, the wilderness, where it provides spaces for spontaneous organisms to develop, followed and integrated by man-made nature, where some strategies are integrated with nature, and both ends are beneficial (for instance a bioswale, that helps water management, but also create conditions and improve soil quality). The last would be the urban nature, with geometries and paths or greenery areas pre-established by the design. 3 sections are placed in order to analyse different developments in the corridor.

GREEN CORRIDOR PARAMETERS



GREEN CORRIDOR STRUCTURE . 00

- the green corridor intends to be a set of global actions, that combined, they are able to modify the current scenario, answering the problems of the area, that were found through the analysis

protective layer

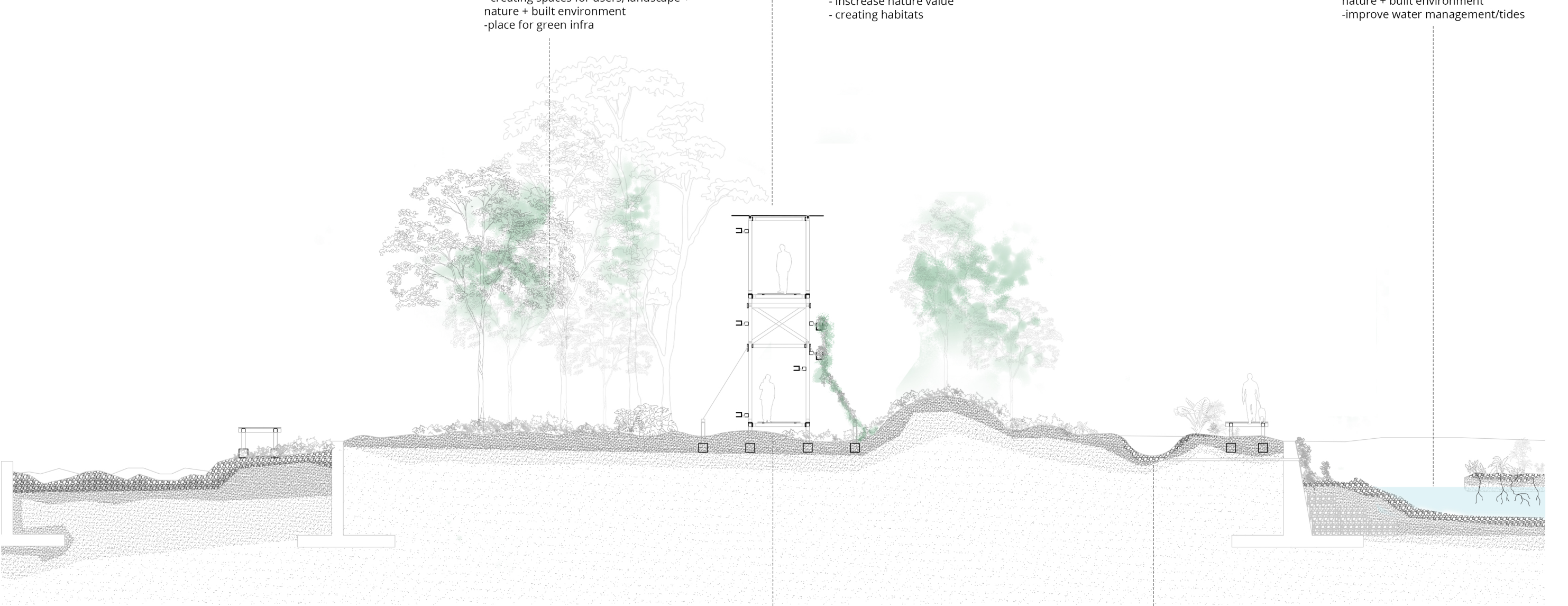
- creating circumstances for spontaneous and variated vegetation
- improve nature value
- shading and soil quality
- creating spaces for users, landscape + nature + built environment
- place for green infra

green facade

- improve cooling and optimize consumption
- water storage
- reducing heat island and reflection
- inscrease nature value
- creating habitats

tidal zones

- creating conditions for spontaneous and variated vegetation
- improve biodiversity
- creating spaces for users, landscape + nature + built environment
- improve water management/tides

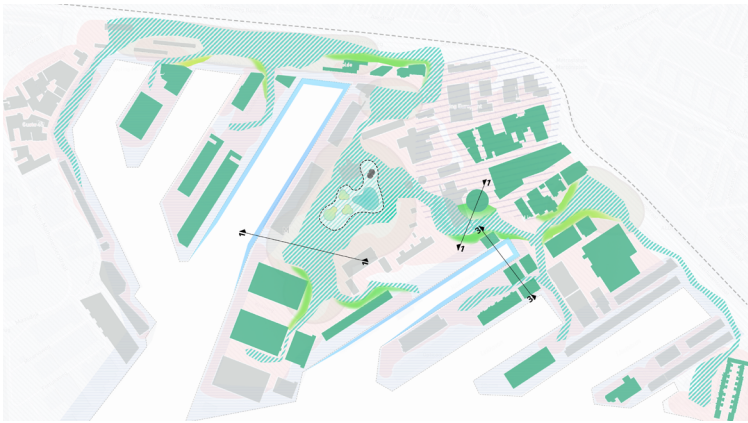
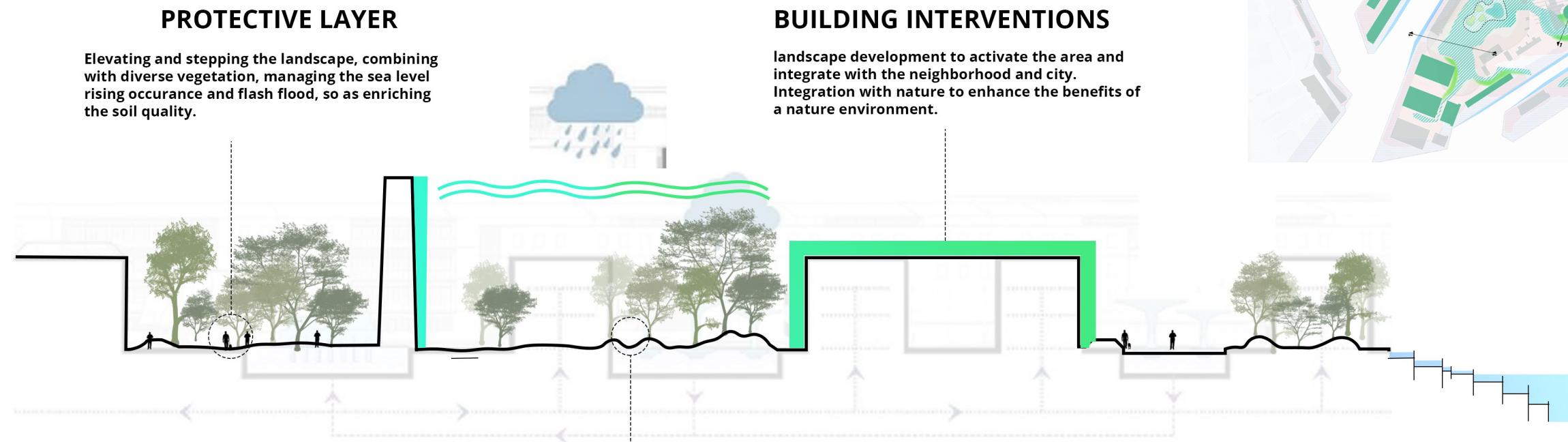


social functions

- creation of functions for users
- offering activities to the city
- improving value of the area

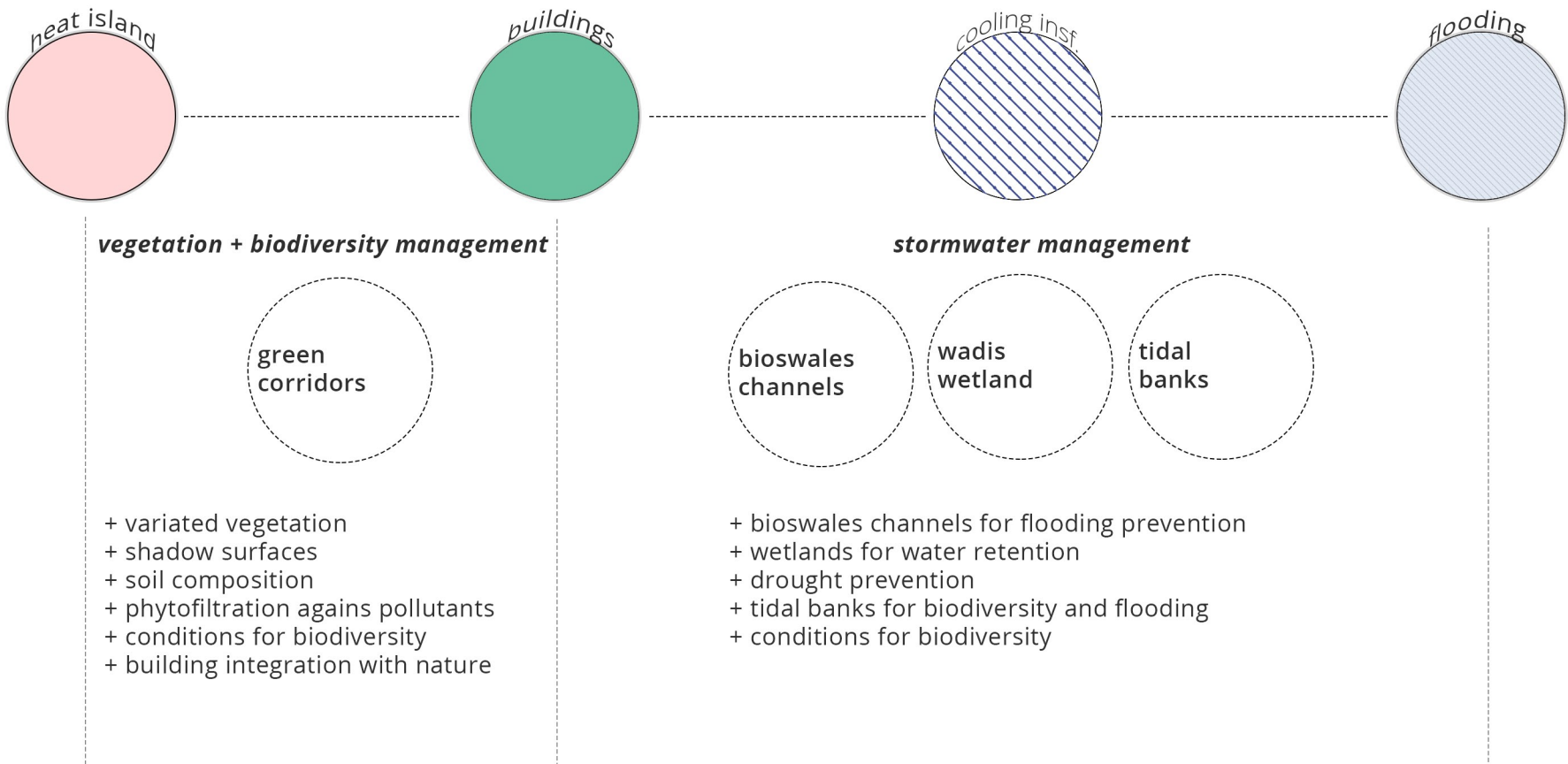
water management

- landscape variation
- water storage/drought proof
- source of water for animals/insects
- inscrease of nature value
- enrichment of soil
- stormweather management



GREEN CORRIDORS

Providing ecosystem services in terms of water retention, storm water management, biodiversity and social interactions. Combining buildings + landscape increasing nature value and creating conditions



Temperature predictions:

avarage from 22.1 to 23.5
>30c from 1 to 5.12 days
from 48 to 20 days of froost
from 20 to 35 summery days



01. ferrodome

facade intervention \

the ferrodome has marked a building with sporadic use, that is only contributing to the heat island effect in the area, hence, this point could be utilized for overall improvement of the facade by exploring a second skin solution attaching green infrastructure to improve overall energy and inner comfort aspects, so as creating habitats and promoting a connection/experience with the green corridor.

01. current status/scanning

facade intervention \

As observed in the mapping studies, the area is prone to heat island effect and drought, this can be explained by the impermeabilization of the surfaces, the quality of the soil is poor, as there's no variation. As marked in the Delva Planning, this point could be a potential central point for the whole area.

- Current use:

Sporadic events such as music concerts, festivals, and catering events. However, the appearance is of an empty building that is lighted once in a while. The opportunity is also to explore and transform an old use and function into a new hotspot in the area, activating the overall.

02. problematization/biodiversity & climate

facade intervention \

overall improvement of the facade exploring a second skin solution encompassing nature to improve overall energy and inner comfort aspects, so as the creation of habitats and conditions.

PROBLEMS:

- HEAT ISLAND EFFECT
- LOW BIODIVERSITY LEVELS,
- IMMEDIATE PRONE TO DROUGHT
- FLOODING ZONE

SOLUTIONS:

- an exploration of materiality, reducing reflection, increasing texture, creating eco-habitats
- second skin facade
- the creation of new social activities
- the exploration of the landscape, wadis, and variation of strategic vegetation

parameters/references



source: <https://www.landschaftspark.de/>

In order to tackle the concerns observed after the area scanning, accordingly to some references, this intervention should be approached in two instances, the building and the immediate surrounding. In the Duisburg gasholder intervention, firstly, a layering of vegetation was placed around the building, in order to create a natural barrier and protect the first envelope of the building, this strategy is very simple, and it has been proved by the Building Physics calculations that, this arrangement can provoke a considerable reduction into the surface temperature, as we will see in further in the research.



source: : fedawardak

In the building envelope, a second skin can be placed in order to improve the inner comfort, it also creates and give space to nature to grow within, and at the same time form spaces for possible habitats, for small animals and insect nests, for instance.

Those changes would be able to modify the majority of the characteristic of the current building and increase its overall nature value of it.



source: : gemeente rotterdam

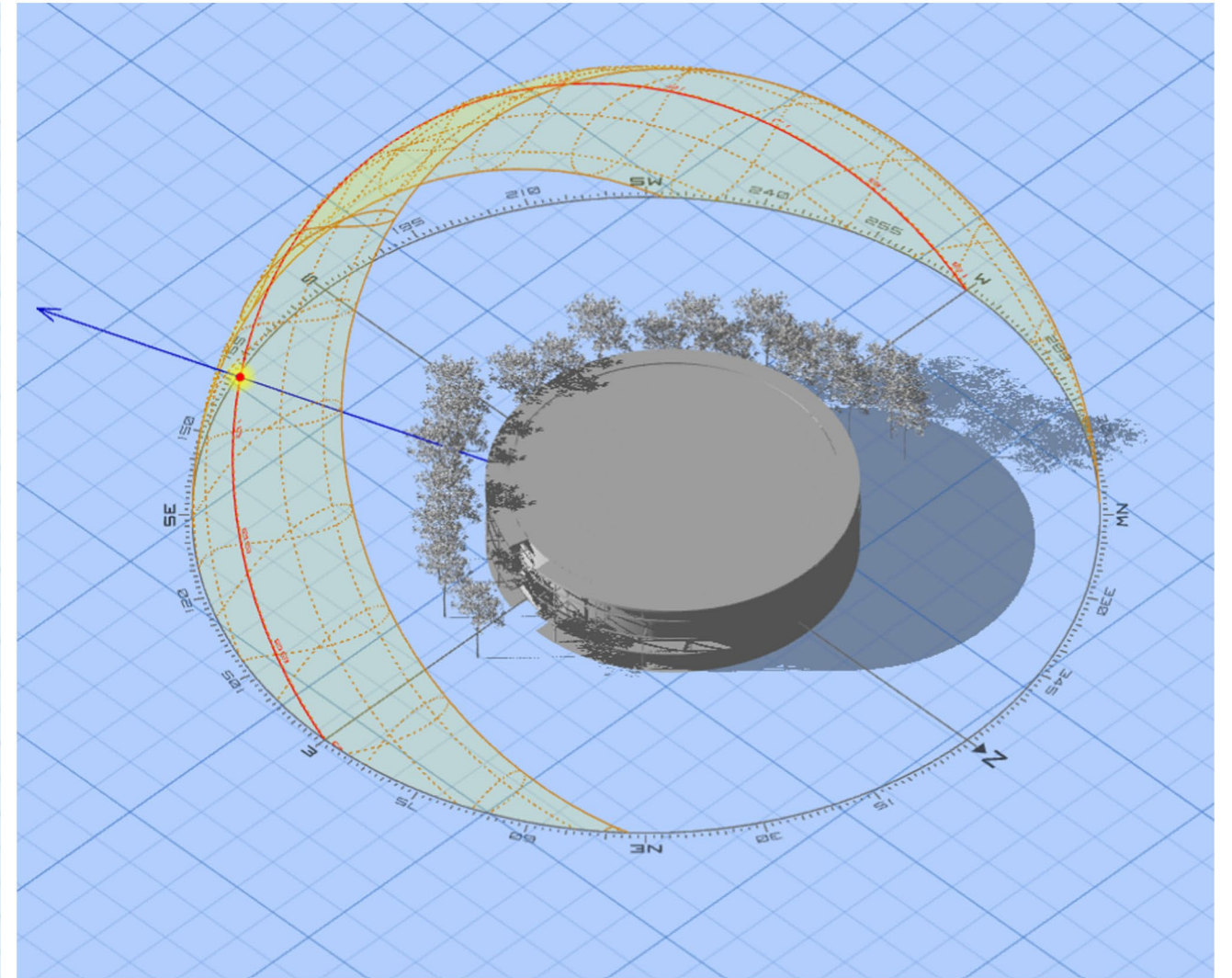
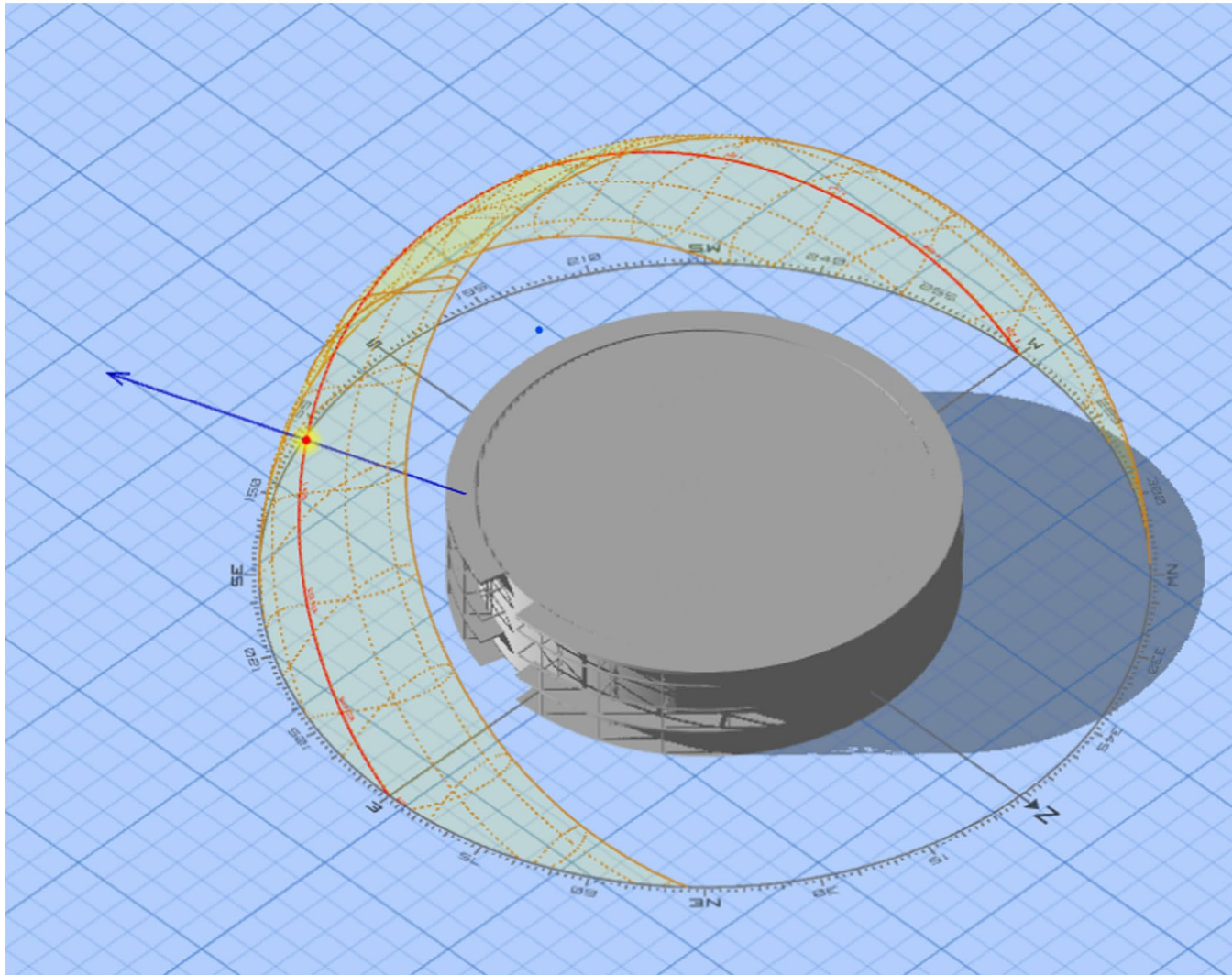


Figure 35:
the first strategy is setting a tree line for shading to wrap and protect the building from solar incidence, for that, a solar study is set in order to see how the trees should be placed. Author (2022)

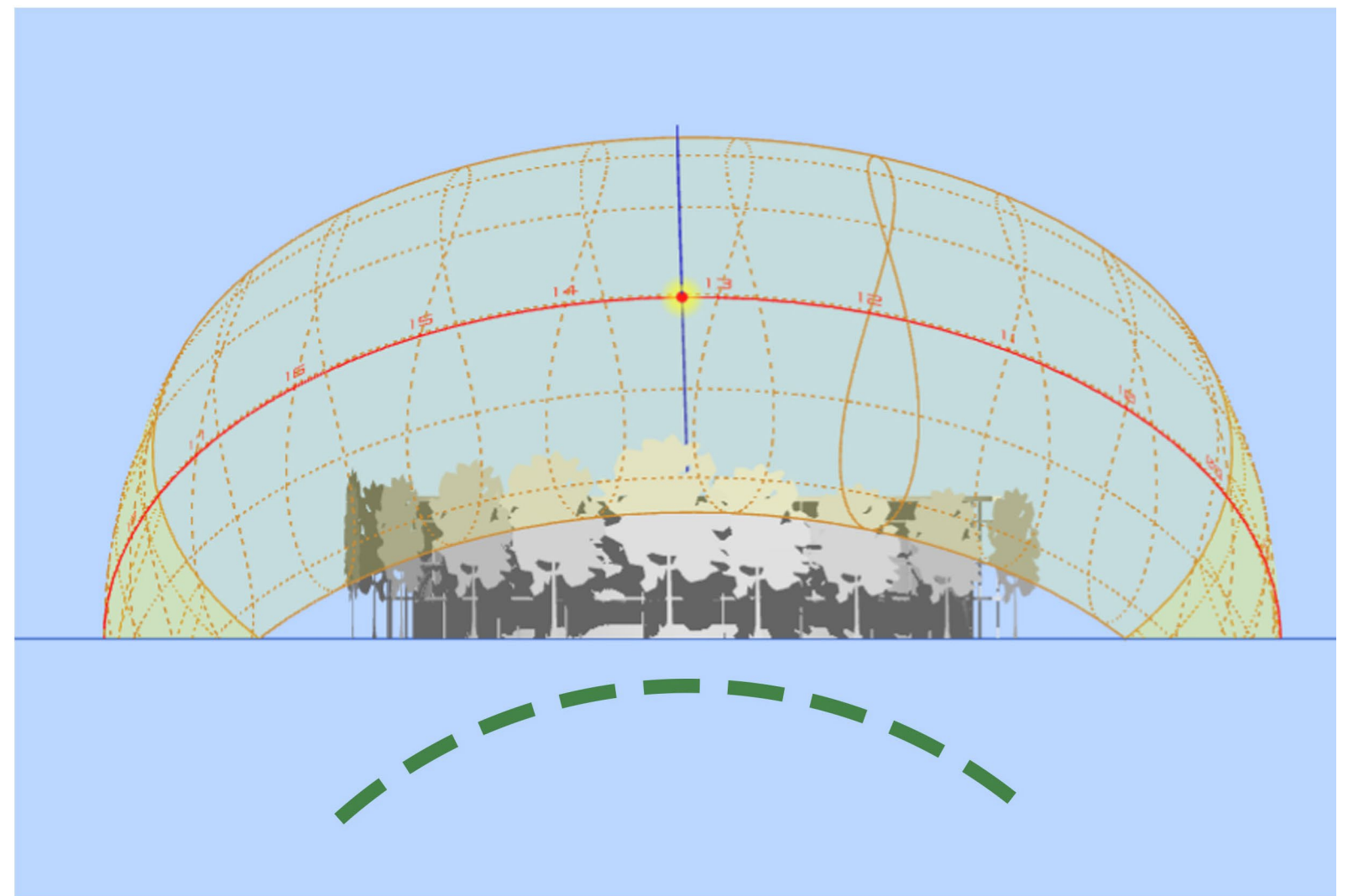
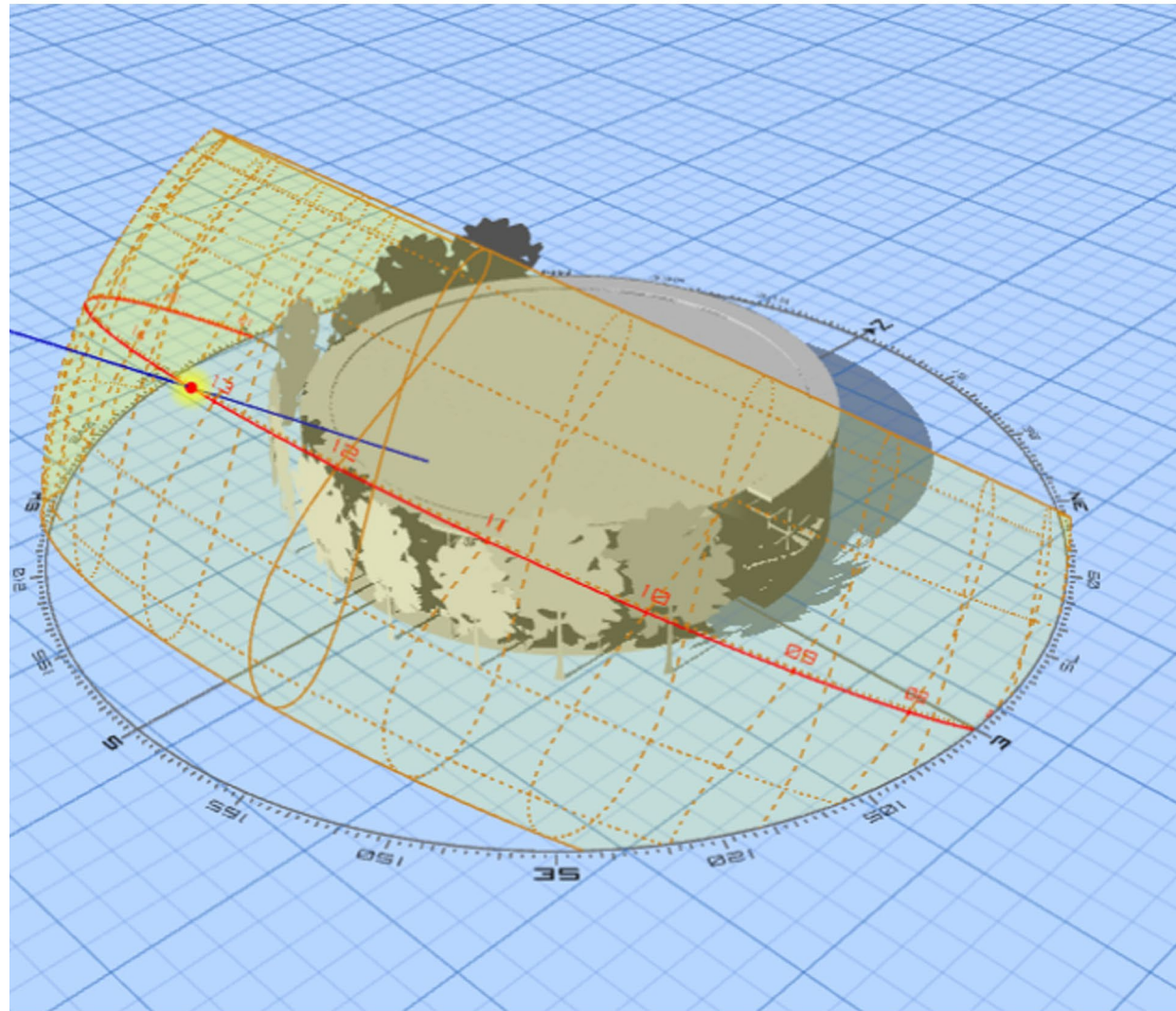
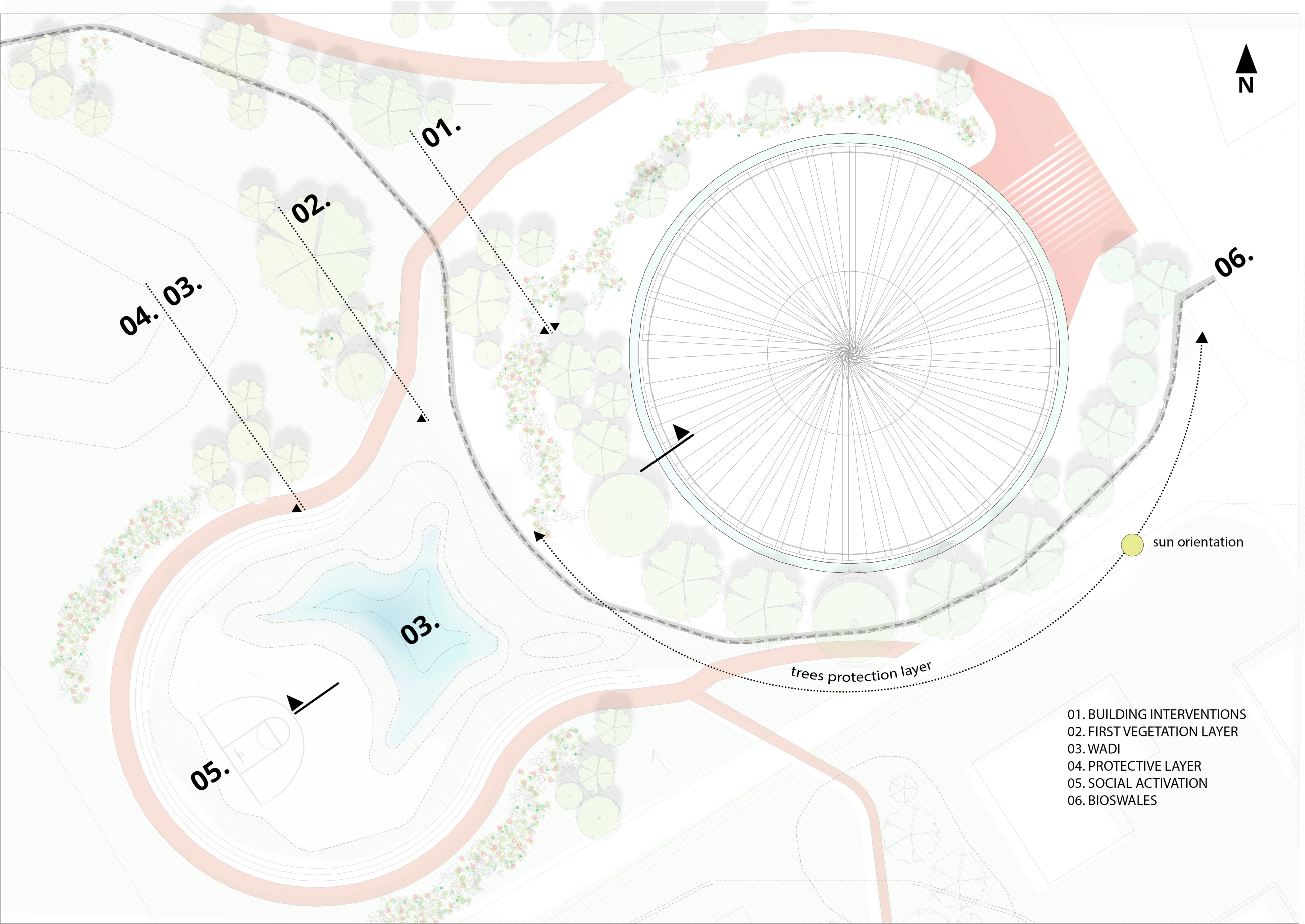


Figure 35:
the solar study highlights the weak points in the facade in terms of shading, and with the yearly chart is possible to project and place the right tree species accordingly to dimensions and solar incidence, maximizing the shading, hence protecting the facade. Author (2022)

INTERVENTIONS



SECTION . 01

heat stress +
floding zone 1 +
insufficient cooling

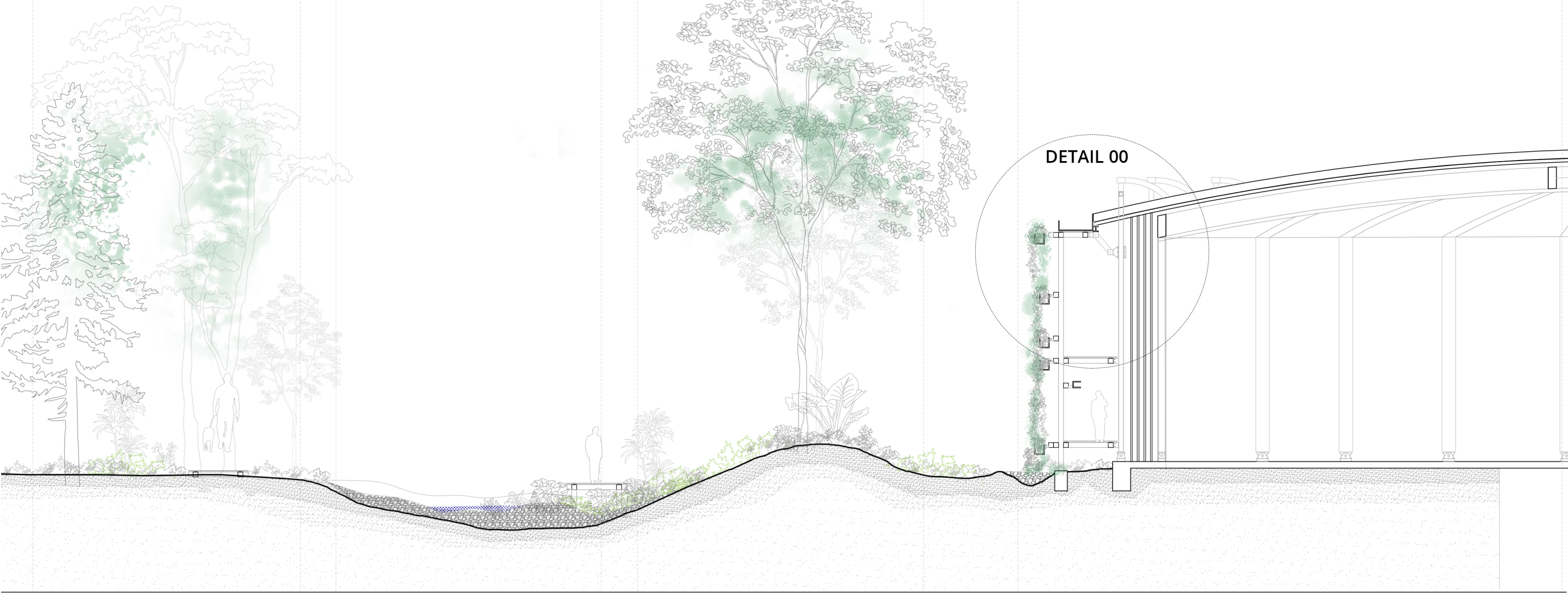
- improving cooling and optimizing consumption
- water storage and management
- reducing heat island and reflection
- creating habitats + nature + built enviroment

Protective
layer ④

wadi ③

first
vegetation
layer ②

green
facade ③



- creating circumstances for spontaneous and variated vegetation
- improve nature value
- shading and soil quality
- creating spaces for users, landscape + nature + built environment

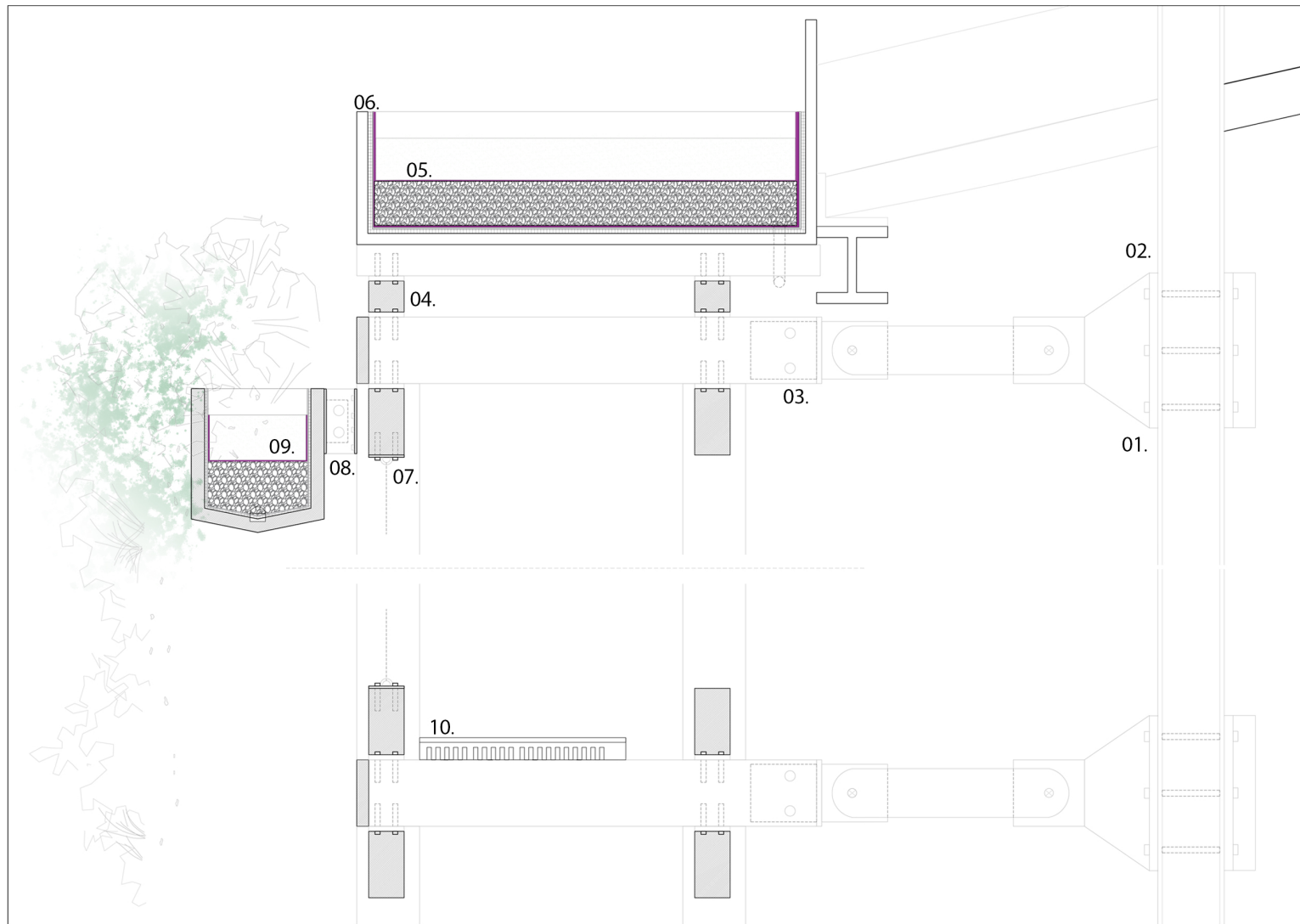
- landscape variation
- water storage/drought-proof
- a source of water for animals/insects
- habitat/ecology cycle



- create conditions for spontaneous vegetation, ferns, and bushes
- first layer to protect the building/ shading/ wind.
- soil enrichment through variated vegetation

species:
-horse chestnut - 20-39m
-paardenkastanje 20-35m
-platanus 30-50 m

- improving cooling and optimize consumption
- water storage
- reducing heat island and reflection
- creating habitats + nature + built enviroment

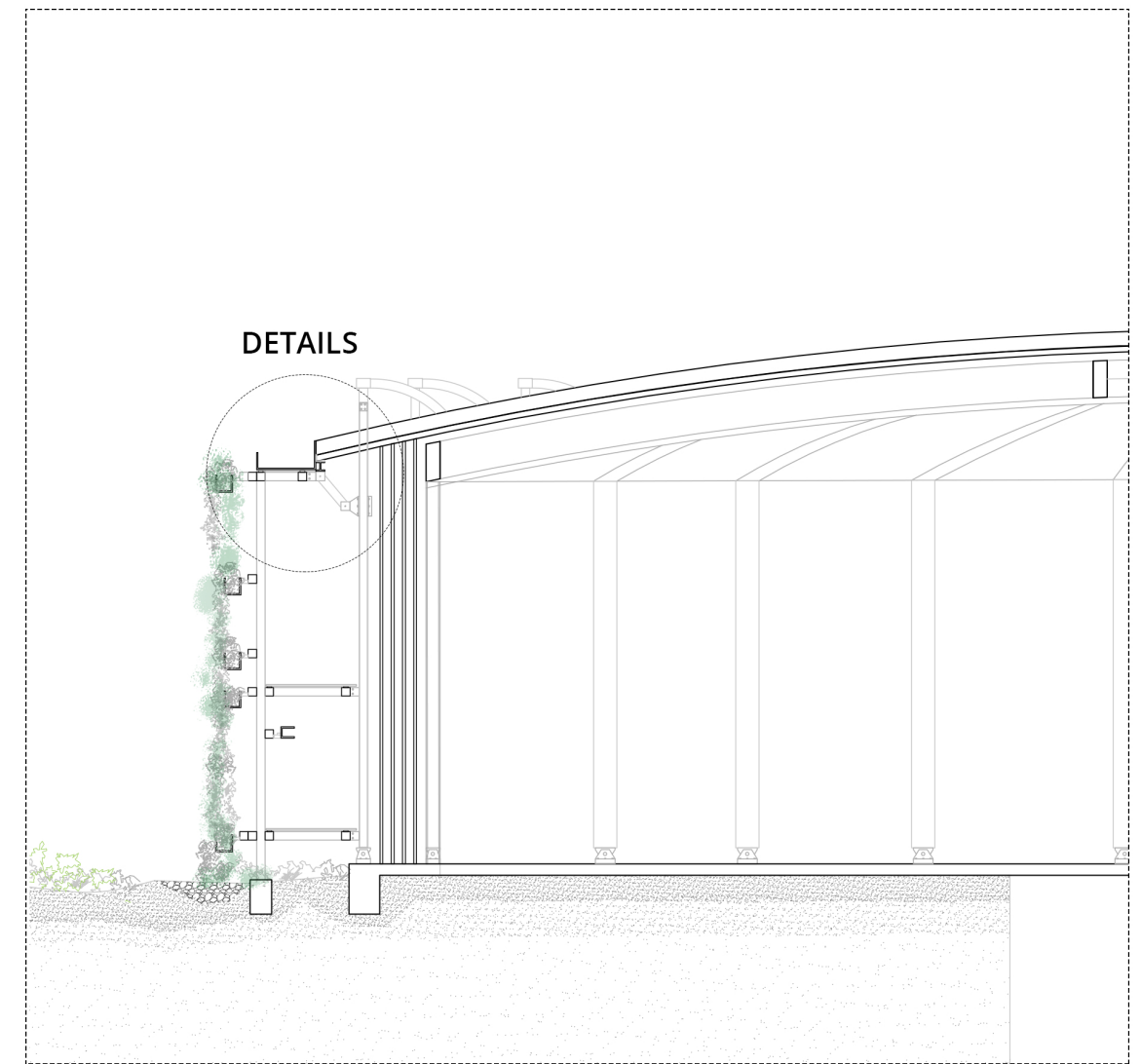


An important part of the green corridor project is the facade interventions, some existing buildings on the site can be improved in many aspects by just adding some extra modifications. In the ferrodome, the idea is to create a second skin facade, that gives place to vegetation to be incorporated on its surface. This application intends to explore the connection of the corridor with the building, a way to perform it is to also bring some green infrastructure to the buildings, especially the old ones. This second skin facade, combined with other placement strategies can help to reduce the heat island effect caused by big surfaces and overall energy management, as less cooling will be demanded.

This structure is based on wooden parts, that can be also found in the whole site during assembly; disassembly processes, or for instance from the Buurman initiative, which works with circular wood. The aim of this structure is also to use less quantity of welding as possible, keeping the mounting process easier and demanding less energy, generating less waste.

green facade

③

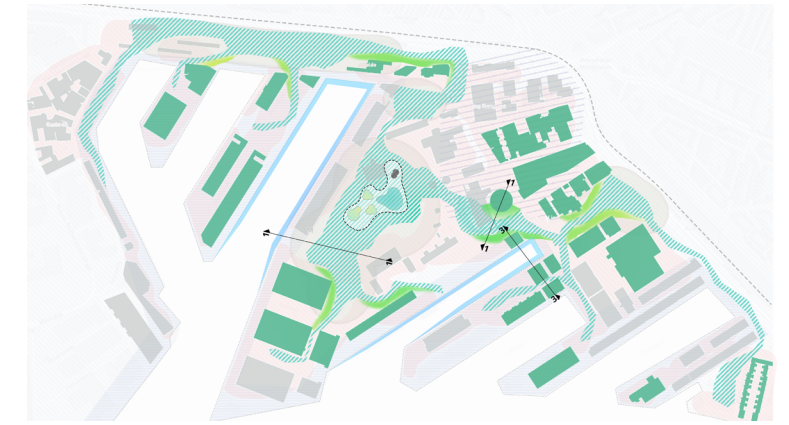


- 01. CONNECTION EXISTING + NEW
- 02. EXISTING PILLAR
- 03. CONNECTION WOOD + STEEL
- 04. WOOD BEAM - GREEN ROOF
- 05. GREEN ROOF
- 06. GREEN ROOF LAYERING
- 07. PIECE FOR GREEN SCREEN
- 08. CONNECTION WOOD + PLANT PLOTS
- 09. GREEN POTS
- 10. STEEL GRID - WALKING PLATFORM



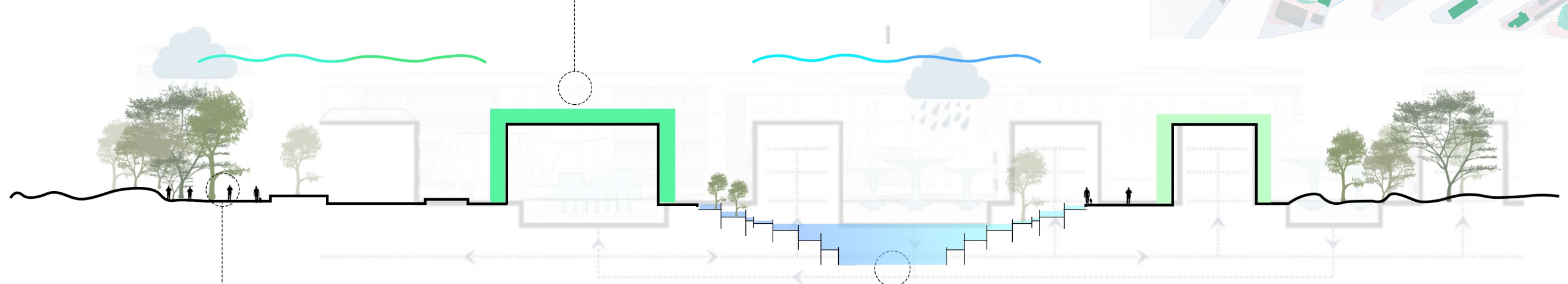


SITUATION 02 - FLOODING AND RESILIENT BUILDINGS



BUILDING INTERVENTIONS

landscape development to activate the area and integrate with the neighborhood and city. Integration with nature to enhance the benefits of a nature environment.

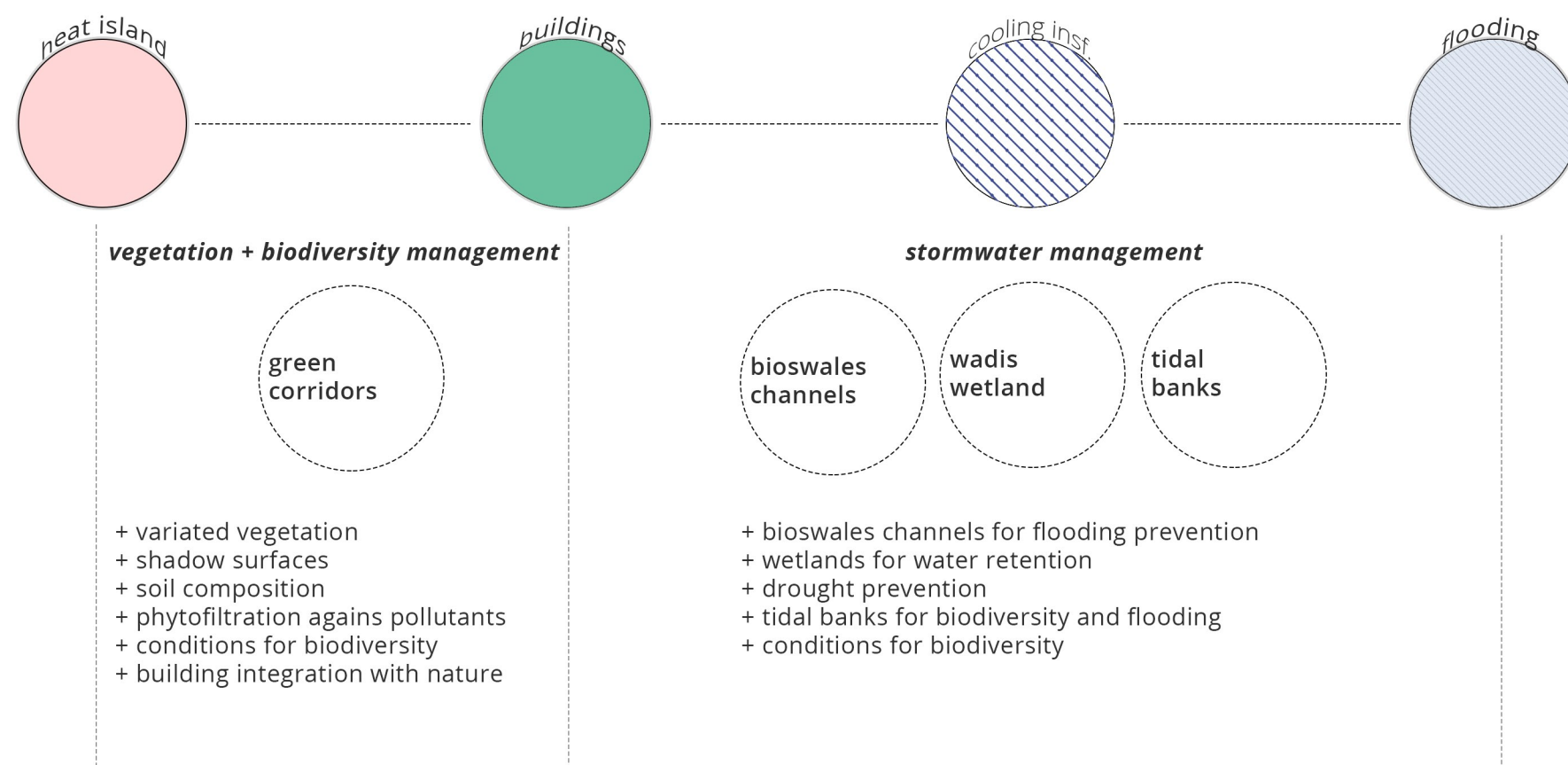


PROTECTIVE LAYER

Elevating and stepping the landscape, combining with diverse vegetation, managing the sea level rising occurrence and flash flood, so as enriching the soil quality.

TIDAL PARK

Natural estuary system in the city, enriching the quay areas and increasing biodiversity, attracting different types of nature and animals, and controlling tide modifications



Temperature predictions:

avarage from 22.1 to 23.5
>30c from 1 to 5.12 days
from 48 to 20 days of froost
from 20 to 35 summery days



01. KEILEHAVEN

facade intervention \

The Keilehaven building is a building that holds arts events and ateliers, it's a remarkable building that will remain with the new urban plans. It is positioned in one strategy because of its proximity to weather. For this intervention, some improvements in the facade so as solutions to control flooding and improve biodiversity.

01. current status/scanning

facade intervention \

in this exercise, also to help decrease the overall heat-stress of the area, the facade will receive modifications, as observed in the case studies, small modifications in the materiality and forms can provide improvements for the inner comfort so as to generate conditions for fauna and flora. for this exercise calculations will be performed in order to validate the interventions.

For the landscape intervention, for the proximity with the water and the imminent fragility regarding flooding or stormwater control, an internal tide pool is proposed, it can manage water coming from the land and from the river, so as to create new dispositions for fauna and flora.

- current use: arts

02. problematization/biodiversity & climate

facade intervention \

PROBLEMS:

- HEAT ISLAND EFFECT
- LOW BIODIVERSITY LEVELS
- FLOODING ZONE

SOLUTIONS:

- the exploration of materiality, reducing reflection, increasing texture, creating eco-habitats
- greenroof
- creation of new social activites
- Tidal pools

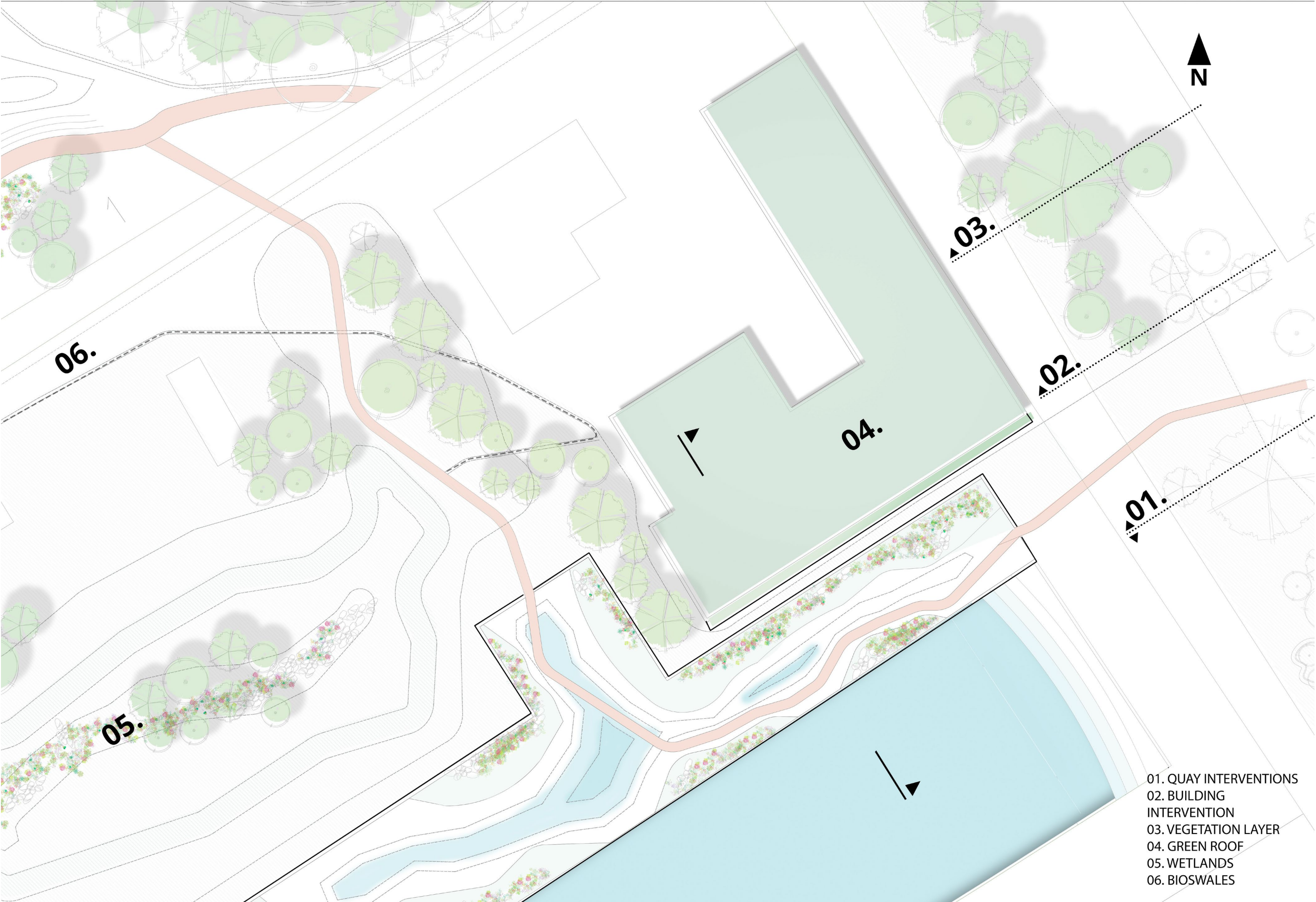
parameters/references

Figure 17:
Chartier Dalix (2015)



source: MLNA, Elizabeth
Felicella

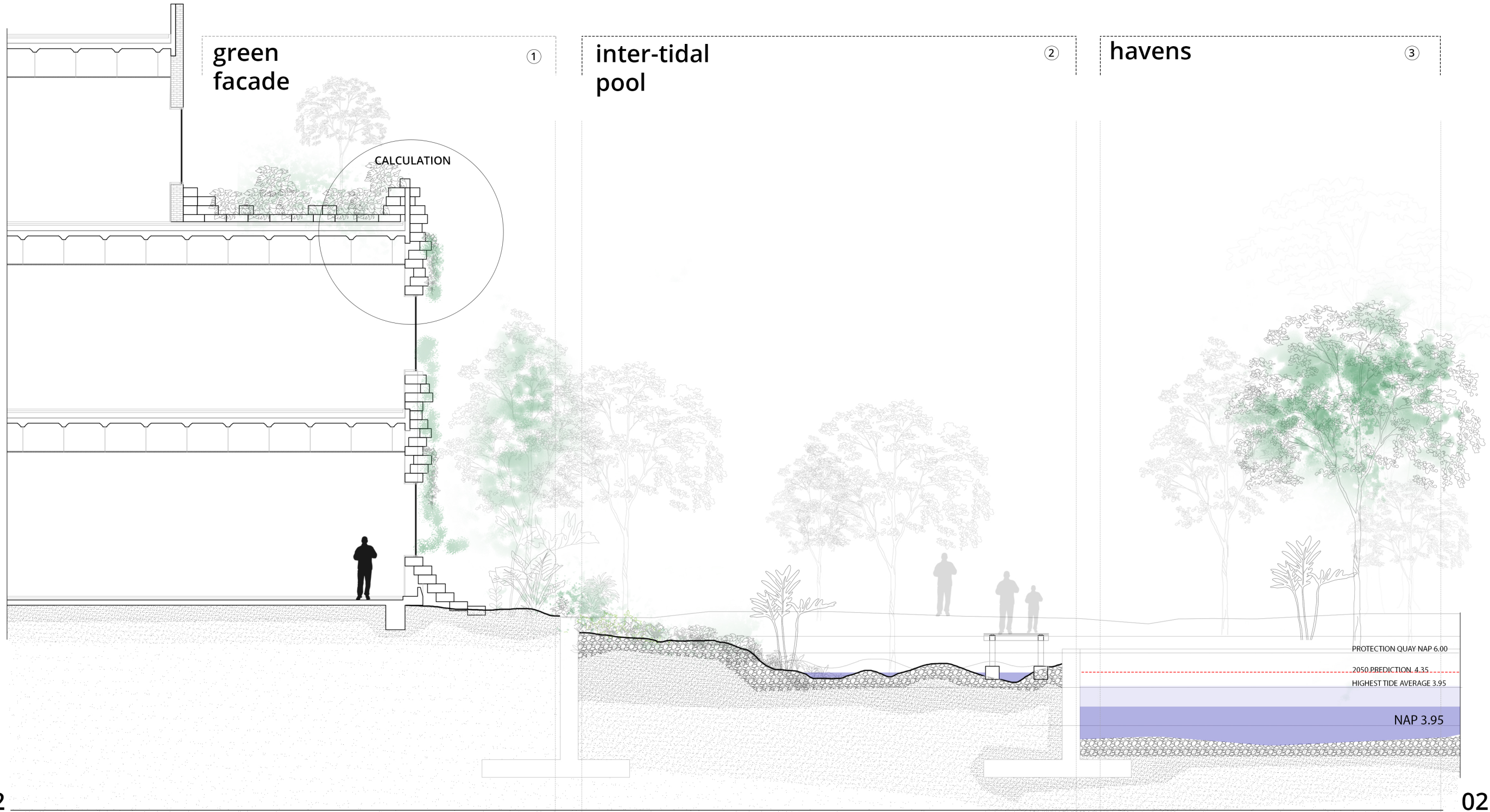
INTERVENTIONS



- 01. QUAY INTERVENTIONS
- 02. BUILDING INTERVENTION
- 03. VEGETATION LAYER
- 04. GREEN ROOF
- 05. WETLANDS
- 06. BIOSWALES

SECTION . 02

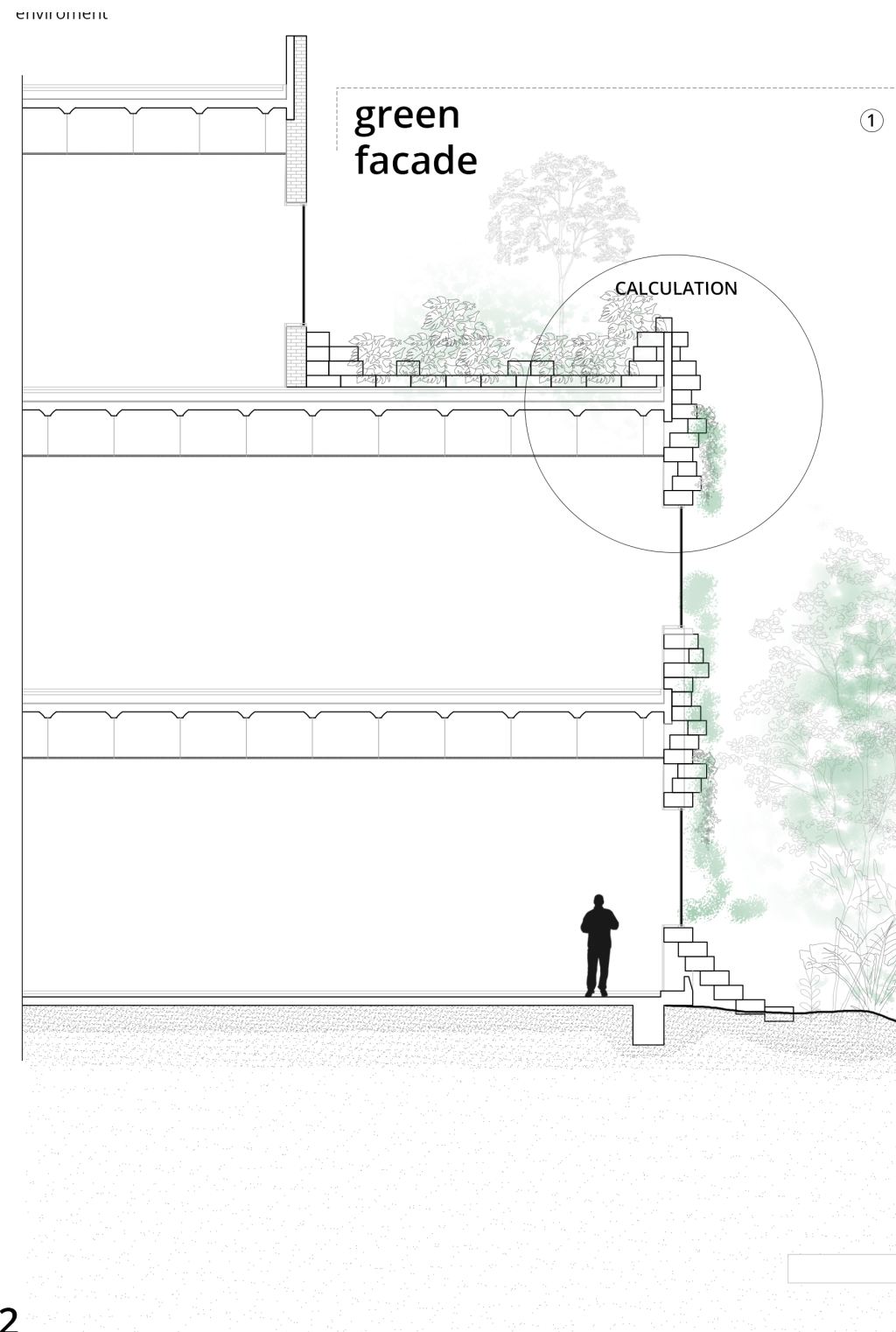
- improving cooling and optimize consumption
- water storage
- reducing heat island and reflection
- creating habitats + nature + built enviroment



- improve cooling and optimize consumption
- water storage
- reducing heat island and reflection
- inscrease nature value
- creating habitats

- create conditions to spontaneous vegetation, ferns and bushes
- first layer to protect the building
- soil regeneration, phytohydrauliscs and phytoextraction
- inscrease nature value
- creating habitats

- creating conditions for spontaneous and variated vegetation
- improve biodiversity
- creating spaces for users, landscape + nature + built environment
- improve water management/tides



- improve cooling and optimize consumption
- water storage
- reducing heat island and reflection
- increase nature value
- creating habitats

Roof without plants

Evaluations:

Using $R_c = 0.8 \text{ m}^2\text{K/W}$

$$T_s = (T_a \cdot 1/r_a - T_i \cdot 1/(R_c + r_i) + Q_{\text{sun}}) / ((1/(R_c + r_i) - 1/r_a)) = 30.06^\circ\text{C}$$

$$Q_2 = (T_s - T_i) \cdot 1/(R_c + r_i) = (70.06 - 25) \cdot 1/(0.8 + 0.13) = 48.5 \text{ W/m}^2\text{K}$$

Facade with trees shading

Evaluations:

Using $R_c = 0.8 \text{ m}^2\text{K/W}$

$$T_s = (T_a \cdot 1/r_a - T_i \cdot 1/(R_c + r_i) + 10\% \cdot Q_{\text{sun}}) / ((1/(R_c + r_i) - 1/r_a)) = 19.50^\circ\text{C}$$

$$Q_2 = (T_s - T_i) \cdot 1/(R_c + r_i) = (70.06 - 25) \cdot 1/(0.8 + 0.13) = 11.3 \text{ W/m}^2\text{K}$$

In the situation having the roof shaded by trees, considering 10% of Q_{sun} , the surface temperature decreased from 70.06°C to 35.50°C . The Q_2 has also decreased as the amount of Q_{sun} incidence is lowered by 10% of its total, thus the roof receives a much lower amount of Q_{sun} compared with the situation without shading.

Facade with green roof:

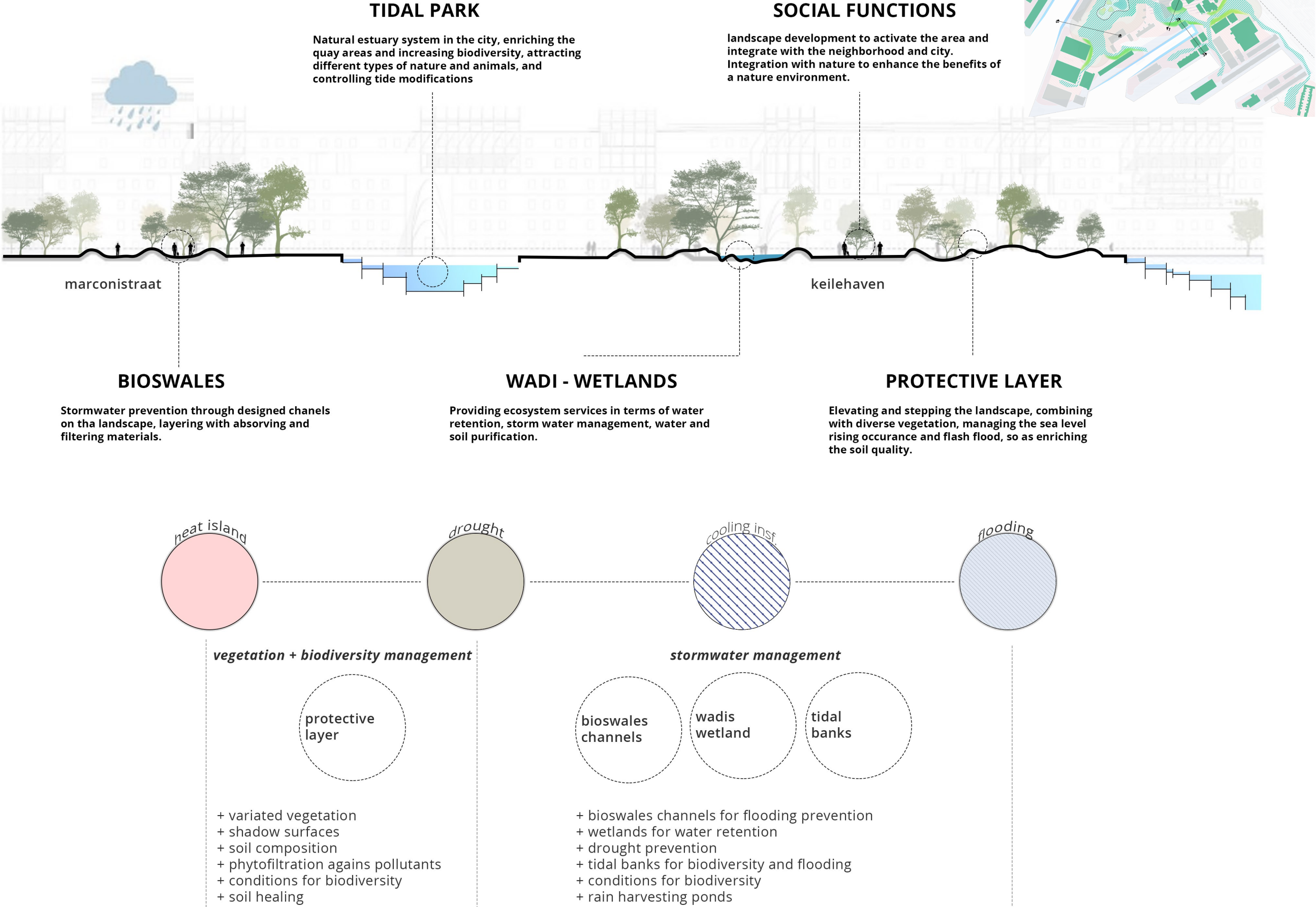
Evaluations:

$$T_s = (Q_{\text{sun}} - XQ_{\text{sun}} + T_a \cdot \alpha_{\text{rad}} + T_a \cdot \alpha_{\text{conv}} - XT_a \cdot \alpha_{\text{rad}} - T_i \cdot 1/(R_c + r_i)) / (\alpha_{\text{rad}} + \alpha_{\text{conv}} - X\alpha_{\text{rad}} - 1/(R_c + r_i)) = 24.66^\circ\text{C}$$

$$Q_{\text{transmission}} = (T_s - T_i) \cdot 1/(R_c + r_i) = 35.48 \text{ W/m}^2\text{K}$$

In the situation of having the roof with plants, both considering RC 0.8 or 1.392 (green roof) the surface temperature dropped from 30.06 to 24.66. Having the heat transfer directly proportional to the amount of heat transferred, we can also conclude that when adding the plant's layer, the heat transfer is lower, implying that the surface temperature is also lowered. Hence adding this layer would help to decrease the surface temperature.

In a conclusion, decreasing the solar direct incidence to the roof through shading would be the most economic and efficient option, as we marked in the calculations (lowest T_s temperature), merely because the highest parcel of Q_{sun} is now intercepted by the trees, nevertheless, in a real situation, encompassing other circumstances, such as orientation, the most efficient option would be to integrate both strategies and throughout the day having a reduction in the overall temperature through different appliances.







Temperature predictions:

avarage from 22.1 to 23.5
>30c from 1 to 5.12 days
from 48 to 20 days of froost
from 20 to 35 summery days



01. GALILEISTRAAT

01. current status/scanning

intervention \ soil regeneration ``oasis``, a protective layer encompassing green infrastructure, in order to prevent drought and elevate the quality of soil, improving vegetation variety and creating more conditions for flora.

this area is an opportunity to also propose different ideas, that combine could be able to tackle most of the problems of the area.

intervention \ this green field that lands at a strategic point at the Galileistraat, seems to be part of a dockyard property that is not currently in use, however, encompassing the green corridor project, this point has a clear connection with the inner land to the waterways, so it could be a strategic point to create social functions to activate the area.

The idea is to propose a selected area, that would be isolated for some certain time, within this perimeter, the soil can't be touched by humans or interfered with. Specific species are used in order to provide natural phytofiltration of the soil, at the same time, spontaneous vegetation should occur, creating different conditions for animals, so as providing shade, seeding, and other characteristics to the area.
- current use: no use

02. problematization/biodiversity & climate

intervention \

PROBLEMS:

- LOW BIODIVERSITY LEVELS, IMMEDIATE PRONE TO DROUGHT
- MEDIUM-HIGH CONTAMINATION OF THE SOIL
- HEAT STRESS AND FLOODING ZONE

PROPOSAL:

- the creation of soil regeneration ponds
- variated vegetation to improve nature values
- water management systems
- the creation of new social activities to activate the area

parameters/references

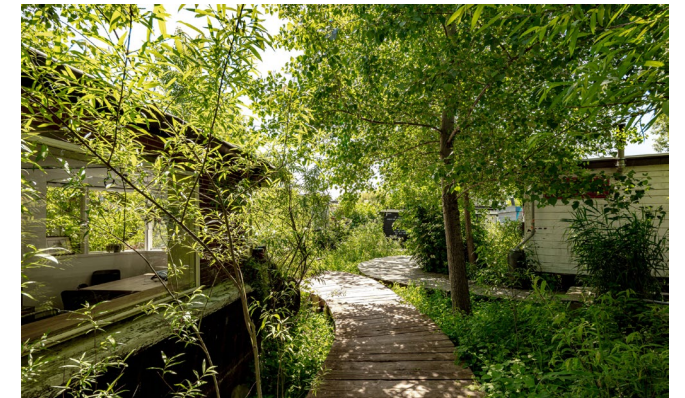


Figure : Delva (2022) soil untouched

Figure : The Klausing Group (2022) bioswales

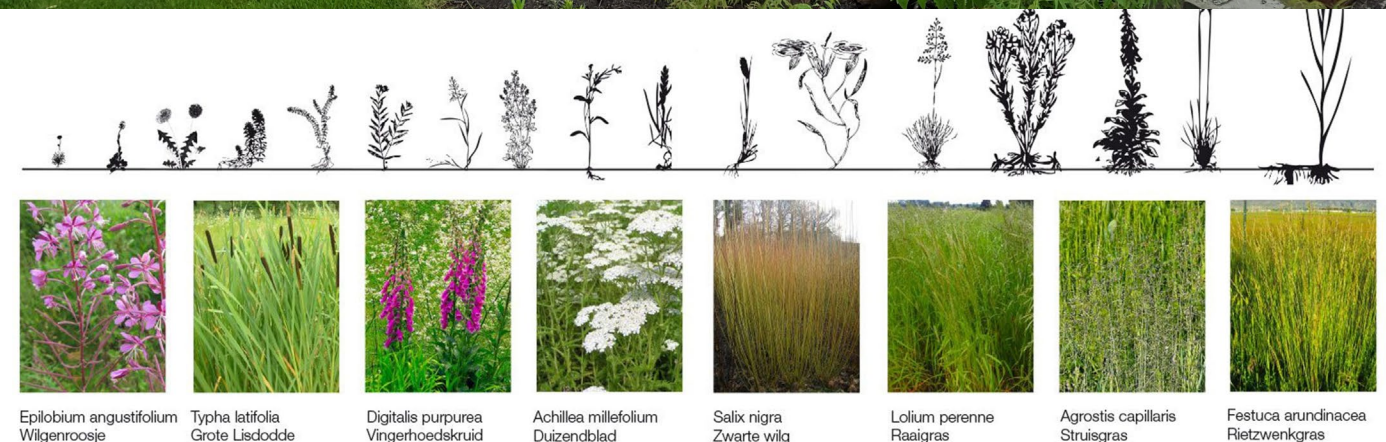
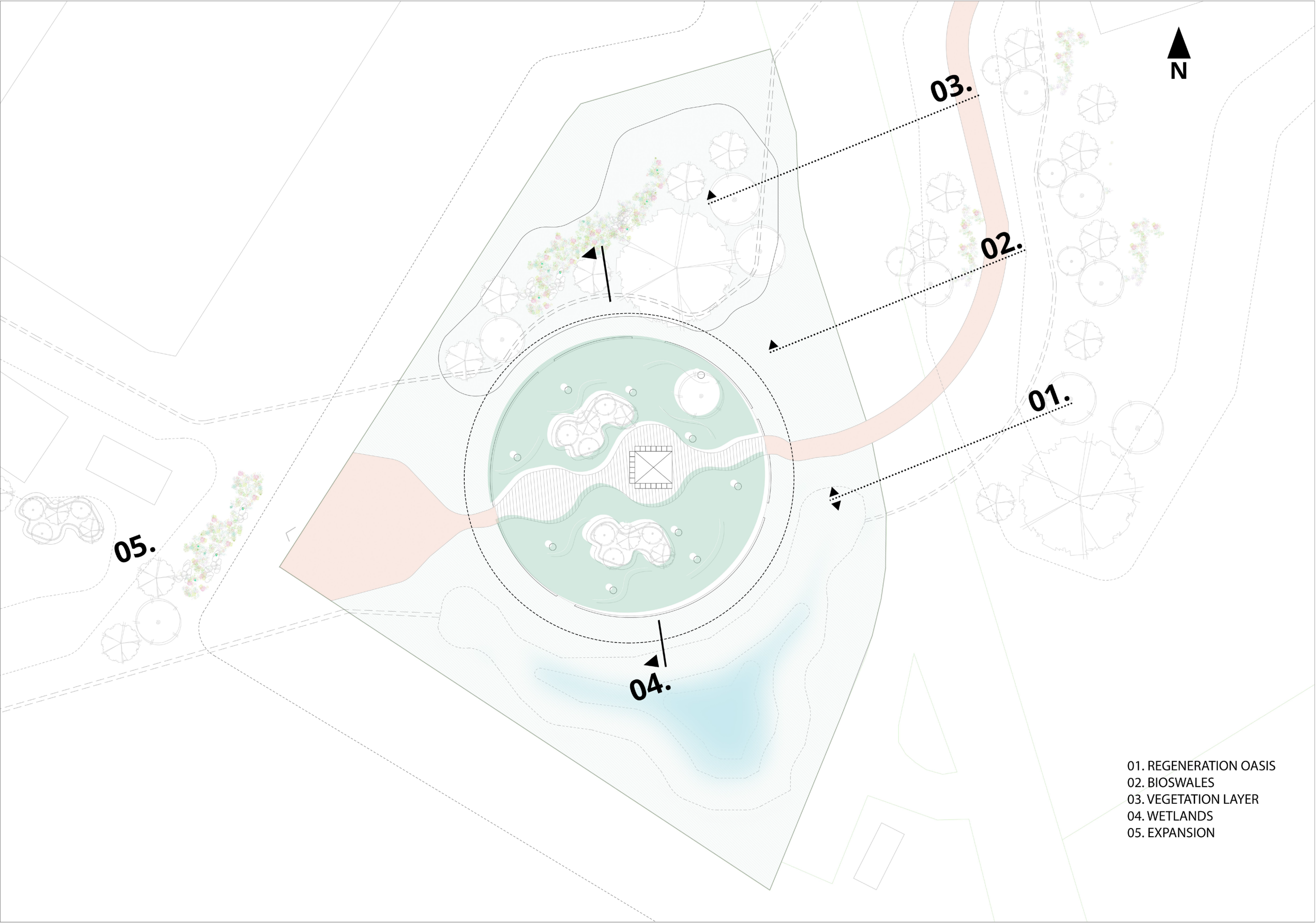


Figure 22: Purifying plants species
Delva (2022)

INTERVENTIONS







SECTION . 03

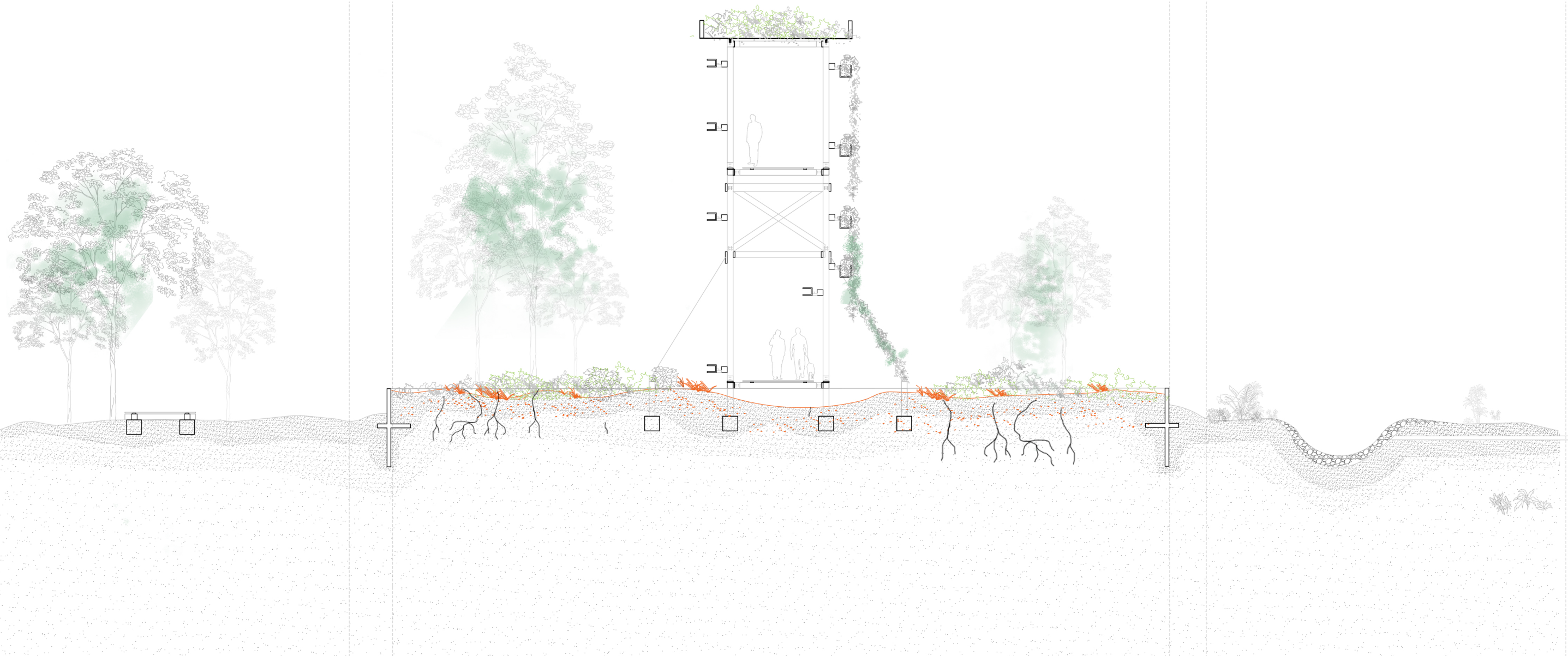
- water storage and management
- reducing heat island and reflection
- creating habitats + nature + built enviroment
- reduce drought and regenerate soil

social function ②

protective layer ①

soil regeneration ③

bioswales ①



- creating circumstances for spontaneous and varied vegetation
- improve nature value
- shading and soil quality
- creating spaces for users, landscape + nature + built environment
- place for green infra

- create conditions for spontaneous vegetation, ferns, and bushes
- soil untouched to be regenerated
- phytoremediation to clean contaminated soil

species:
-sorghastrum nutans
-brassica juncea L.

- social functions to interact with the "regeneration oasis"
- activating the area, point of meeting, and sightview
- these functions can also be used to creade habitats

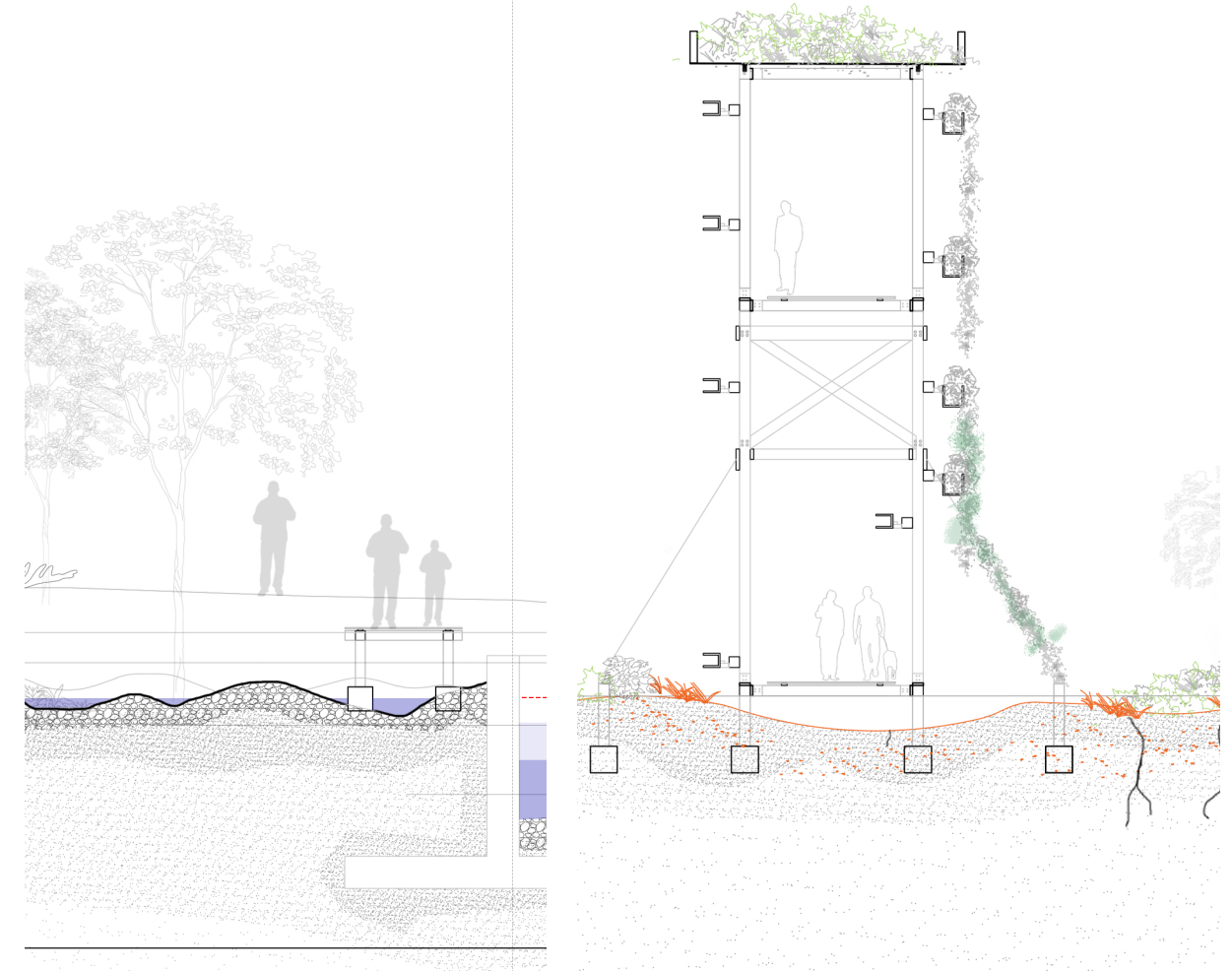
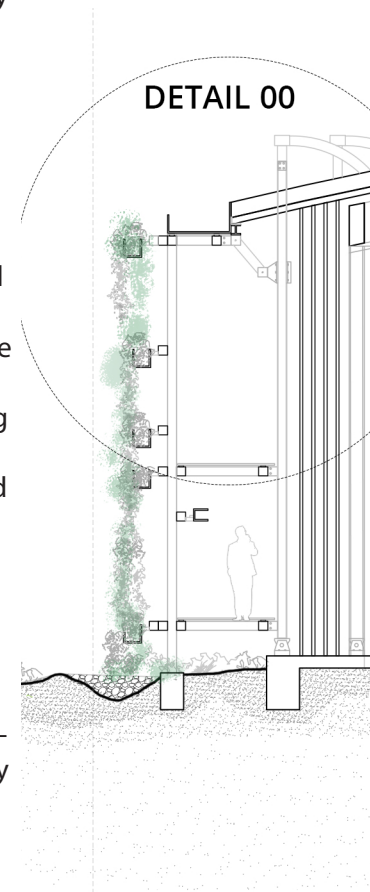
- green infrastructure strategy
- water collection
- stormweather management

From the social aspect, the users can benefit from an area that is restored, offering a healthy and friendly space. The paths along the way invite the users to explore the areas of the corridor, it could lead to a sports court or an observation tower that gives a clear view of the Maas river. The concept is to bring the users to utilize the areas from different perspectives, for the companies that surround it, walking meetings, or a pleasant lunch sitting in one of the several green layers that occur along the path. Ball players can utilize the court near the Ferro dome during dry days because, during rain, the court is also gathering and managing storm weather. The users can go for a run, walk along the path and discover new points. The relationship between walking through nature and a healthier space can improve the life quality of the users, apart from all the benefits regarding air purification and etc.

The paths along the green corridor are placed in order to invite the users to discover the hidden points, or just simply to go through an area that they would never explore if there was not an "inviting path", then mixed with green infrastructure can be also a lesson on how to develop urban spaces along with natural functions. One of the examples that could be a strategic point is the called purifying area, that oasis that cannot be touched in the ground by humans, however, an elevated platform can let them go over it, observe and understand that this specific part is being healed, or for instance the platform for walkers along the tidal pool. Those combinations create an experience for the users, and this is one of the key points of this project.

The green interventions on the buildings are also an example to clarify that our methodology can be changed, and those strategies are applied more currently because they bring most benefits.

Another point attached to this research, is that all these transformations are able to improve the value market of the area, initially because its an area without a pattern or with a mixed typology, however, a planned area, with good infrastructure can have elevated value for the market and its users.



CORRIDOR OF INTER-VENTIONS

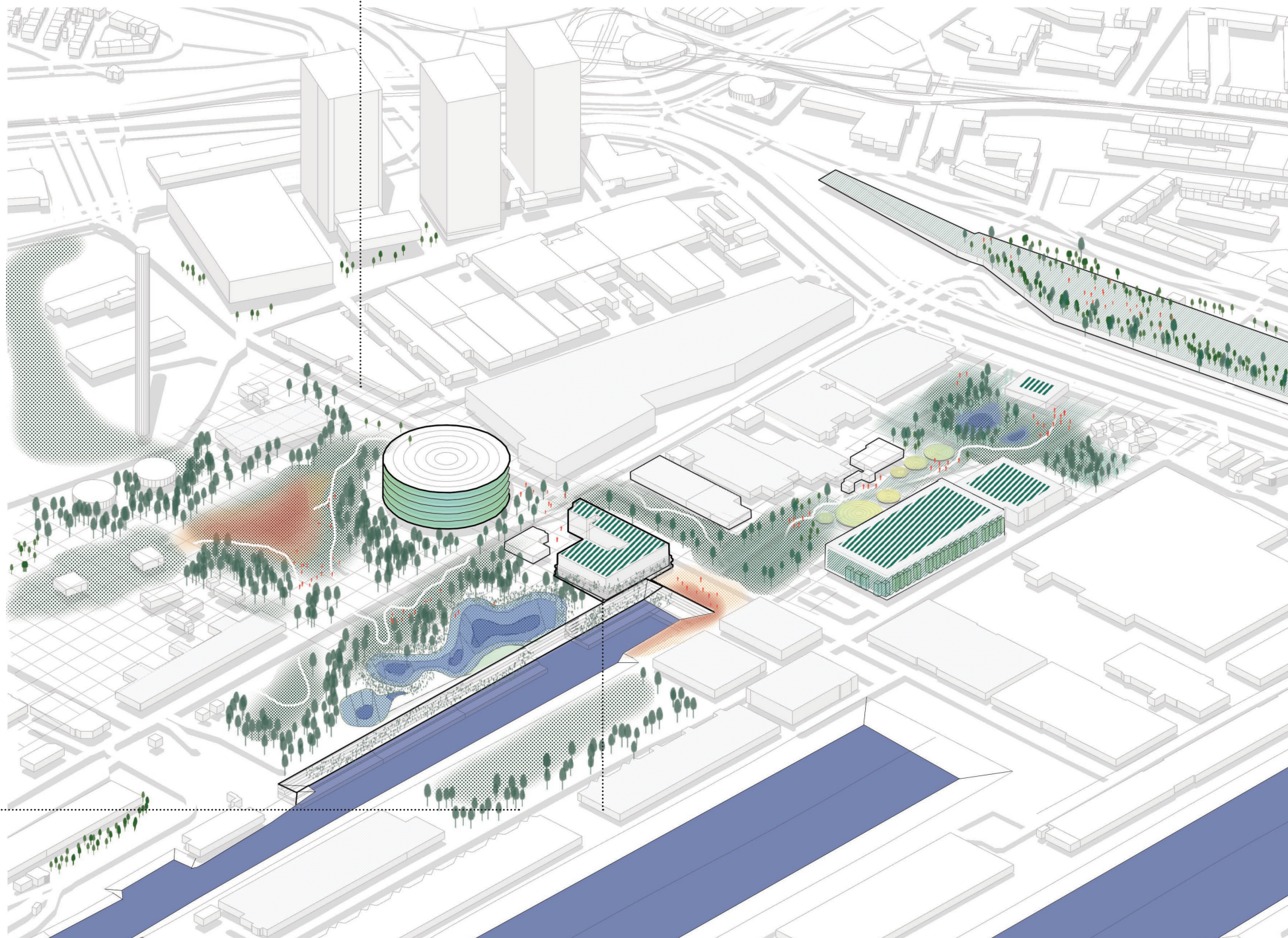


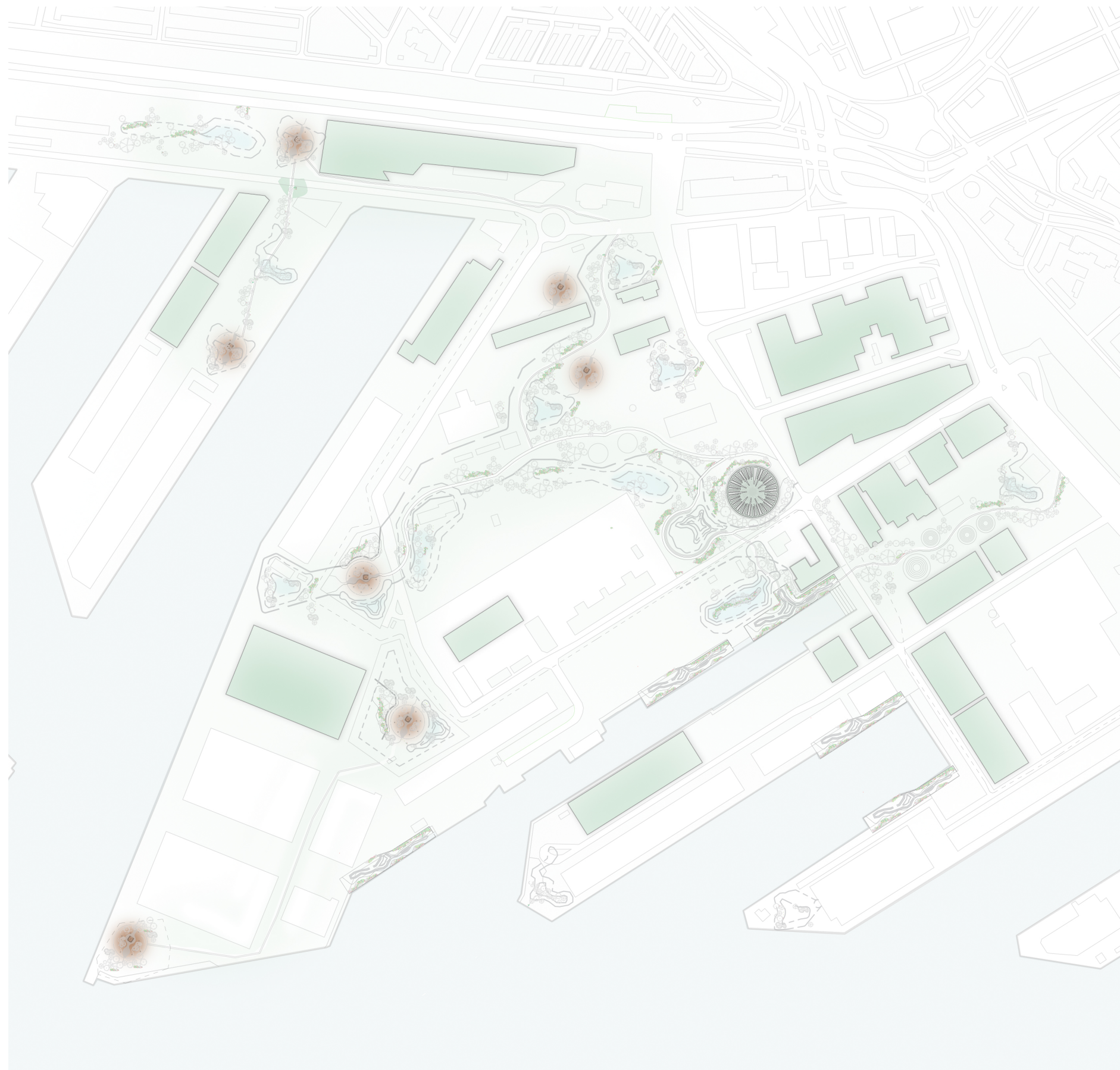
Figure: Author (2022)

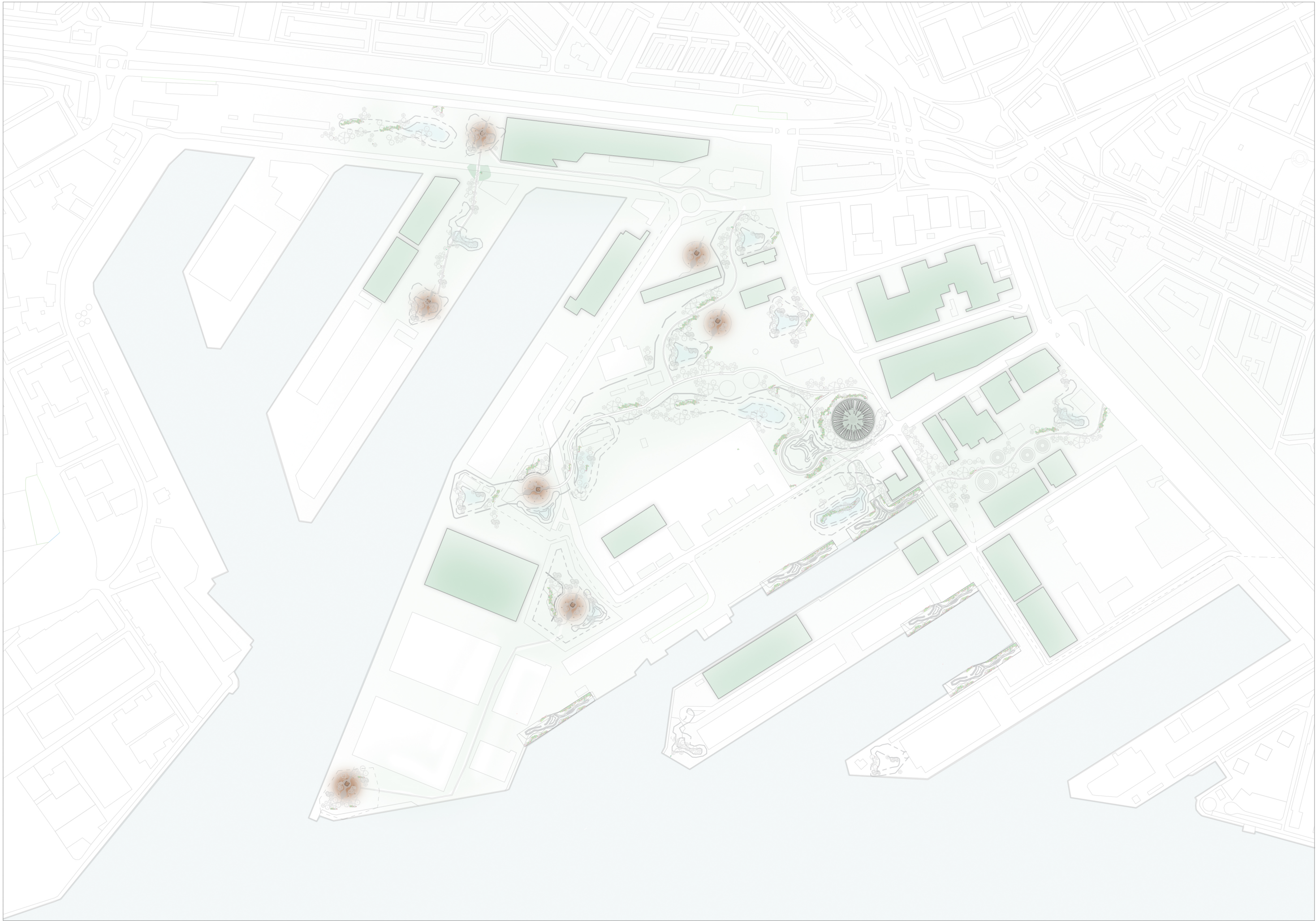
The project then intends to first understand what are the requirements for the area, in terms of the parameters established at the beginning of the analysis of the site, they were mostly concentrated on biodiversity and climate, because those are strongly connected and cannot be separated.

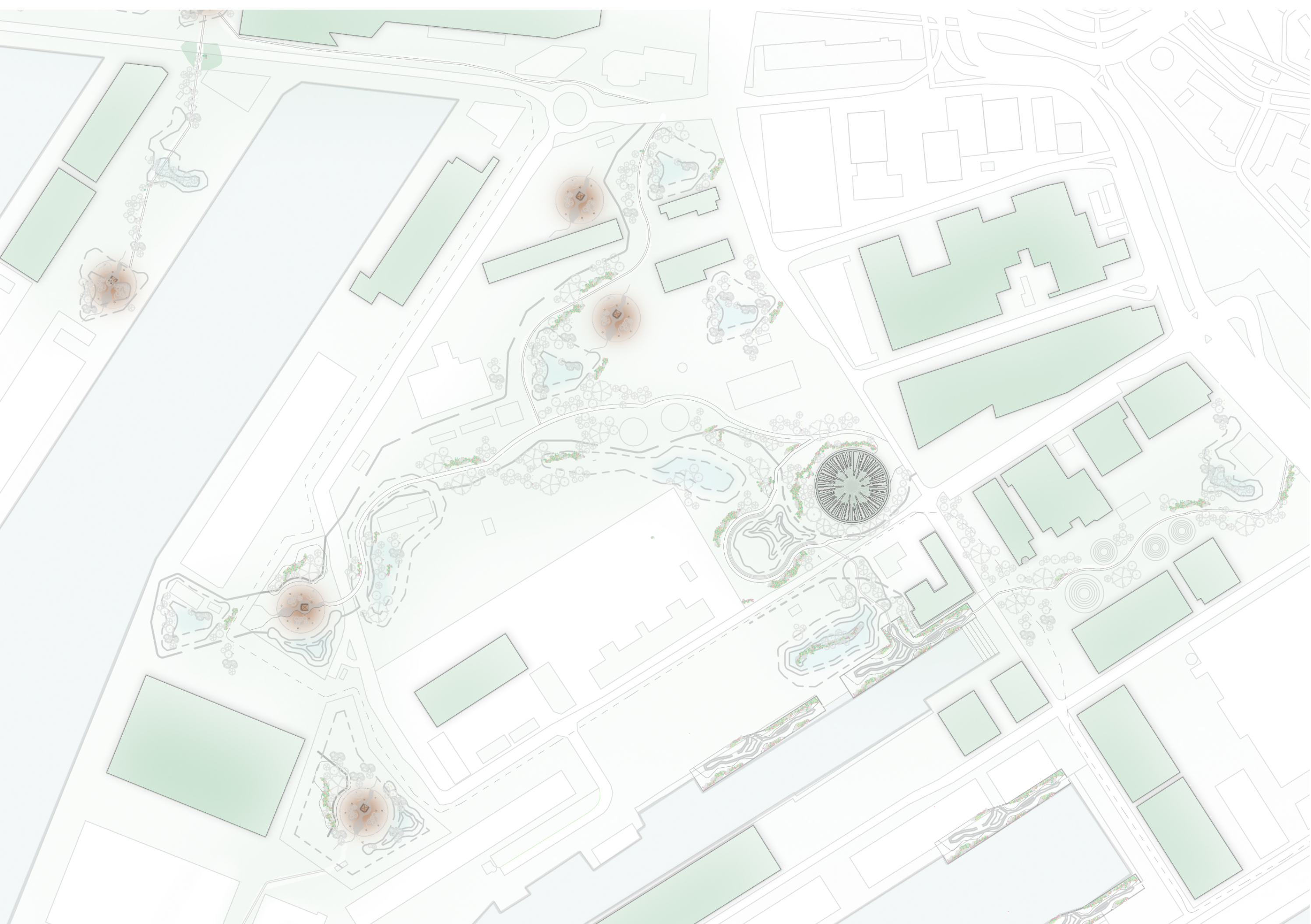
The green corridor goes along the most affected areas, spreading global strategies, to control the main issues: heat-stress, drought, soil contamination, flooding, and overall lack of vegetation and consequently poor nature value. The corridor intends to transform and prepare a resilient area, that can be adapted and prepared for the harsh future ahead, helping to mitigate the pinpoint problems and increasing the overall value of the area.

The act of global strategies has had some exemplifications, such as the 3 areas of interventions that were selected to be projected and planned, but intended to be spread out through the site.

In the end, an area that was unused and under transformation can be led through a different future, having new opportunities for a more intelligent environmental prospection, encompassing fauna and flora and aspiring society demands.







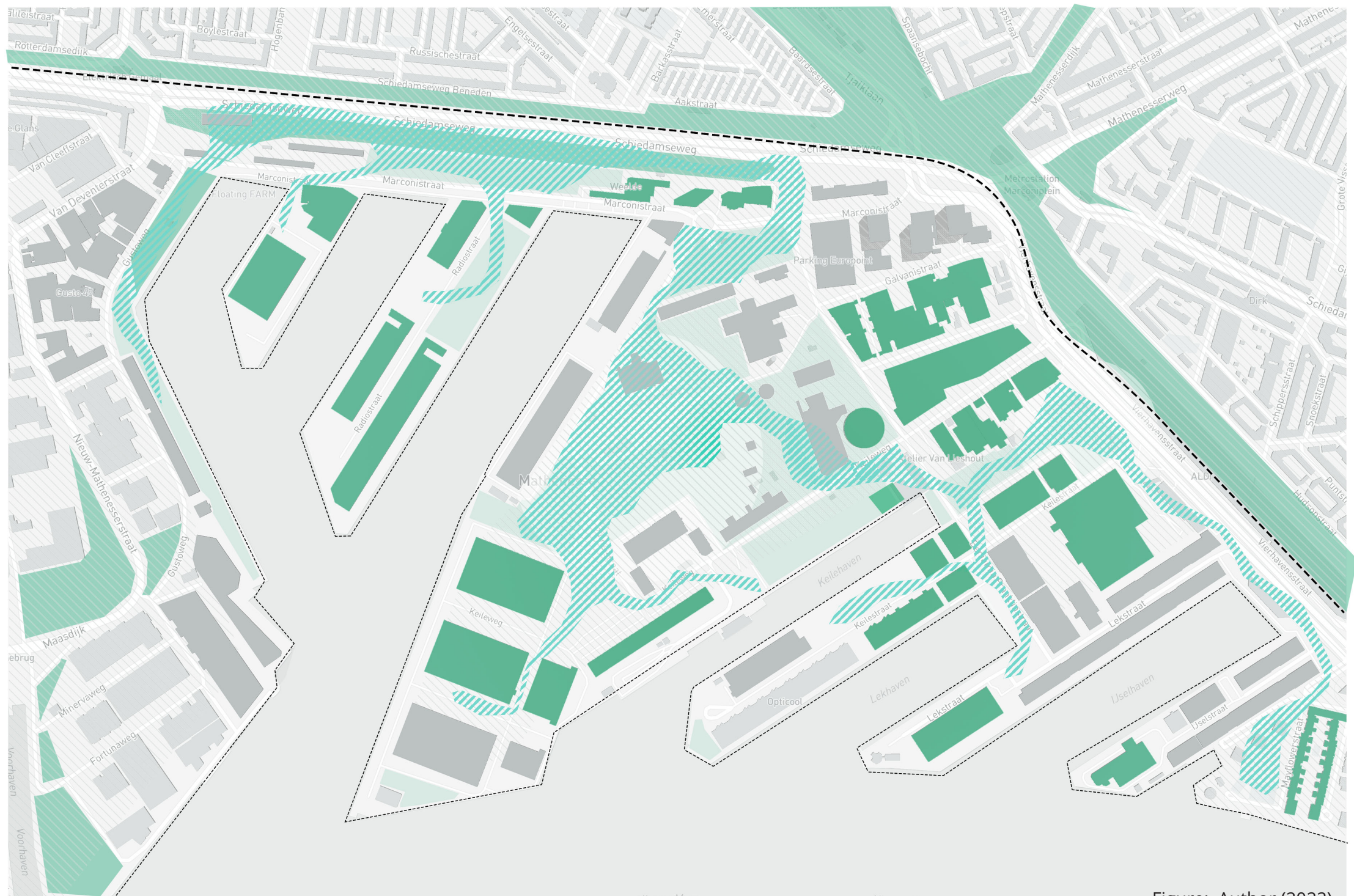


Figure: Author (2022)

legend gteen areas



Figure: Author (2022)

6.0 CONCLUSIONS

6.1 - Answering questions
6.2 - Conclusion
6.3 - Links and References

06.01 - Answering to main question:

How Nature-based solutions (NBS) can help to redevelop, and add nature value while responding to climate change and societal demands to the current M4H area in Rotterdam?

This research desired initially, after absorbing the principles of nature inclusive approach, to replicate the methodology process as the report exercise. This first part of the research was essential to understand the prevalent topic and to place parameters to be more assertive in the analysis. The vision then was to select a topic, set parameters, and an object of study, the M4H was the area selected to execute the method.

The overall predictions for the weather in Rotterdam guided the research in terms of background for the initial analysis.

The city is changing so as the climate is becoming harsher, as observed in the analysis, the M4H is described as a sensible area for many topics relating to the climate and biodiversity, not only to mention the social use that is currently under transformation. The harbor shows weaknesses in terms of soil quality, heat stress, drought, flooding, and lack of biodiversity, and through the analysis, those topics were confirmed, and they gave indications on what are the needs.

The scenario suits a broader approach that could enable the site to become more resilient in terms of climate. The overall biodiversity in the city and the area has been also affected by urbanization levels and climate change, therefore every effort is valid to assist to reduce it.

From the analysis, it was possible to identify the weaknesses of the area and therefore trace a plan to respond and work these scenarios out. The research and the case studies served as a background to understand what actions could've been taken in order to respond to the demands, so as the several reports on the weather. In that logic, the methodology of analysis, and predicting scenarios helped to answer and work out some aspects of the area. Therefore, the research can answer the main question, showing that is possible to achieve good results when analyzing the defects of the area. In terms of climate, is possible to improve and reduce the heat-stress, by displaying more shadowing structures and reducing reflection, shadowing can also help improve the soil quality and decrease the drought, this can happen with the placement of green infrastructure, some of them were proved by literature and also for instance through calculations supported by the building physics methods, showing that the plants attached to the facade and roof, or simply the arrangement of trees could help to reduce the inner temperature considerably.

Water management was a sensitive topic that can be controlled by many strategies so as, wetlands, bioswales, wadis, and tidal structures, that can increase the resilience of the area for the future.

What is interesting to observe is that in multiple different situations, the strategies placed could aid not only one but many dissimilar problems, for instance, the structures attached to the buildings, as second skins, would help to decrease temperature and manage water and energy, but at the same time create conditions for animals and insects, so as producing different experiences for the humans, connecting all the topics.

In the widespread, the set of strategies combined, form a corridor of global interventions that respond to the main issues in the area, achieving different goals at the same time. The area through the analysis and collection of interventions intends to be climate resilient and become a more suitable location, where nature can develop and through that biodiversity increase. The series of improvements revive the area, activating it socially, creating experiences for the users but also increasing the market value and attaching weight to the site, where its users could also benefit from the experience of a pleasant balanced area, in conjunction with nature.

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