Water-Resilient Järfälla

A dual strategy plan for water resilience

January 2024

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Changing the narrative and restoring the local water cycle in Järfälla through a dual-strategy

AG2129 Project Sustainable Urban Planning
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Acknowledgments

We would like to express our gratitude to our teacher, Jenny Lindblad, for her valuable guidance and mentorship throughout our project course.

Additionally, we extend our heartfelt thanks to the Municipality of Järfälla for their generous provision of information and assistance. Their collaboration has enriched our project, providing essential insights into the local context and contributing significantly to the depth and accuracy of our analysis.

1. An introduction

1.0. Introduction

Urban areas like Järfälla exhibit a paradoxical relationship with water, heavily relying on it as a resource while disrupting the natural water cycle. Simultaneously, this disruption makes these urban areas vulnerable to flooding, drought and therefore also water and soil contamination, which are the three main problems in our research-project. The attitude of the urban towards water is usually a case of 'out of sight, out of mind', mostly dealing with water through a centralized invisible drainage system. This, however, focuses purely on the supply and demand of water as a resource and does not acknowledge water as part of an ecological entity. This report researches urban water management from a new perspective. Currently, water-related challenges, such as flooding, drought, and contamination are all in the first place considered challenges because of the effects of climate change. In this report, however, we argue that water challenges are considered challenges because of the way we live and build our cities, not the other way around (Watson & Adams, 2010). So instead of adapting to heavier rainfall by artificial solutions, this report goes to the origin of the problem, which is a lack of planning and design.

The main problem which Järfälla has recurring is flooding. In a mere biotic landscape, flooding is considered a necessary natural process. For instance, flooding enriches the fertility of the soil, creates habitats, supports biodiversity, and so on. However, because of considering flooding as a disaster, flooding as a natural process is little understood and appreciated within urban planning. These insights thus show how the first shift that needs to happen is a mental one, which understands water as a part of a cycle and thus looks at water from an ecological perspective.

The main objective of this report is to tackle three main challenges regarding water in Järfälla: flooding, drought, and water and soil contamination. This essay argues that these problems are intertwined. Flooding and drought are interconnected through the hydrological cycle. Excessive rainfall can lead to flooding, while prolonged periods of reduced rainfall result in drought. Water and soil contamination can exacerbate these issues. Contaminated soil may not absorb water efficiently, increasing runoff during heavy rainfall and contributing to flooding. Conversely, during droughts, the presence of contaminants in the soil can affect water quality, making it even scarcer and potentially harmful for human consumption. As mentioned, the existing approach primarily involves expelling water from the city using centralized artificial systems. While this method addresses flood risk, it falls short in addressing issues related to contamination, drought, and water scarcity. Moreover, this type of drainage makes it possible to seal the soil further to generate profit. Today, urban development still is mostly associated with expansion and concretization. This essay wants to break through this association by introducing new ways of dealing with these challenges. The question is thus: how can we bridge daily human needs - living, transport, and consumption - in a way they don't disturb the water cycle?

To do this, we firstly have done literature research to find out where the main problems are and what solutions so far have been tested. The main problems have already been explained in this introduction. The solutions we found within the literature research will be shortly explained in the next chapter where we talk about our approach for Järfälla and where we also talk about why we need a new narrative. We need concrete actions and strategies. This report suggests a new planning approach, which is multi-scalar, multi-strategic, and looks from an integrated perspective. We focus on two levels of action. Firstly, the policy-level which deals with strategies focussing on awareness, subsidies, regulations, etc. Secondly, the physical level, which tackles the issues from planning through design.

2. Our approach

2.0. Description of our approach

In this chapter, we will argue our approach by explaining what it implements and why we chose this approach. Our approach consists of two levels, one design level and one policy level. Firstly, the design level is based on our literature research where we looked into all different sorts of innovations concerning urban water management. Secondly, the policy level is based on our idea of 'Changing the Narrative' which has the goal of prioritizing water management in urban planning and design. What these approaches further implements and why we came to these conclusions will be explained in this chapter.

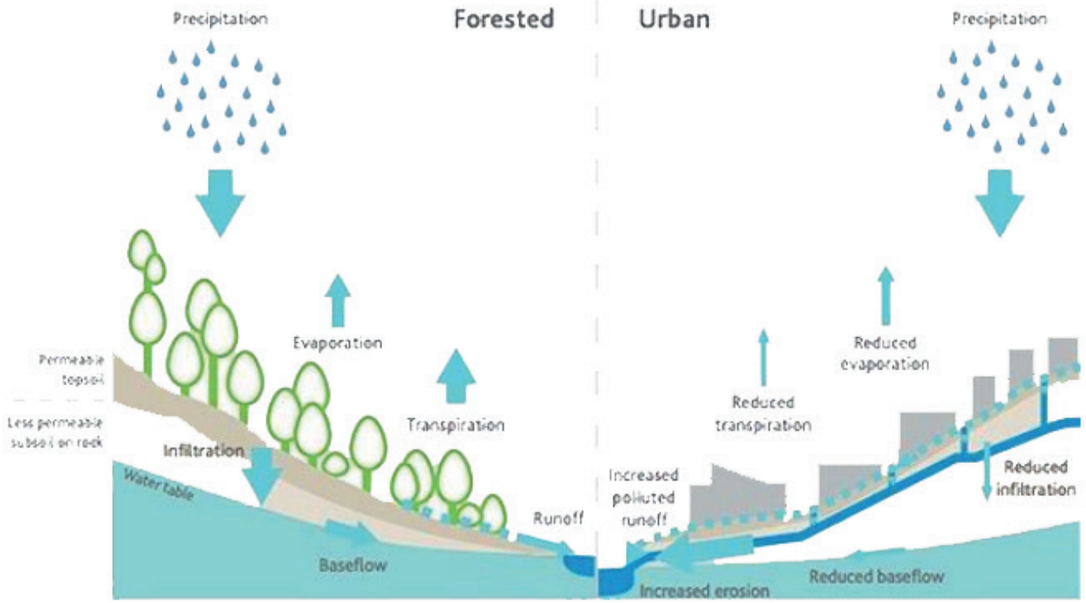
2.1. The Sponge City concept

Schematic diagram of the "Sponge City" concept (Chan et al. 2018)

Hardened built environments with impermeable surfaces like concrete, asphalt, and buildings, have limited natural areas for water infiltration. This can lead to increased rainwater runoff, which can contribute to urban flooding and less groundwater recharge, increasing the risk of water supply shortages. Hardened surfaces can also accumulate pollutants like oil, chemicals, and debris, which can be picked up by rainwater and polluted stormwater runoff. Soil sealing, especially when done with dark materials, can increase drought and contribute to the heat-island effect. In urbanized spaces, a combination of drainage, storage and infiltration is desired according to the Sponge City concept. Runoff water can be transferred to nearby areas where infiltration is possible by designing the topography of the built environment. Alternative urban development methods, such as impermeable bicycle paths, reusing underground parking spaces as water baths, and flood-proof architecture, can be implemented. The Sponge City concept aims to manage water in urban spaces sustainably, focusing on the use of natural materials and processes. The concept was developed from flooding problems in gray infrastructures, which do not allow water to infiltrate the area but merely guide it away. To make the concept successful, it requires temporarily storing, recycling, and purifying stormwater, making drainage systems more flood-resistant by adding underground water storage, and making natural water bodies more multi-functional and integrated into drainage systems (Chan et al, 2018). The Sponge City concept is used in our approach as a guideline towards our design ideas.

2.2. Changing the narrative

There is no denying that urbanization has a big impact on ecosystems. Järfälla has undergone big changes in the past decades and will continue to adapt to its growing population in the coming years. New neighborhoods filled with gray infrastructures and much less space for nature are being realized. The effect of a growing urban space due to a growing population has a real effect on natural processes, in particular the hydrological cycle. The importance of understanding the relationship between the natural hydrological cycle and the artificial hydrological cycle is becoming clearer. The consequences of the growing artificial hydrological cycle have a negative impact on urban space as more problems such as flood and drought come into view (see Figure 1). Next to that, urban runoff water is contaminated and thus has a more negative impact on water and soil quality (WSUD, 2017). Due to climate change, these weather extremes will become more regular and the urban space has to become more resilient. Instead of using more artificial water management to solve these problems, we want to change the way of thinking about the situation by creating different policies. By implementing these policies, we hope to achieve a change in the narrative concerning urban water management. This will create a positive impact for the water and nature in future urban planning and design in Järfälla.



Schematic diagram of the natural water and artifical water cycle (WSUD,

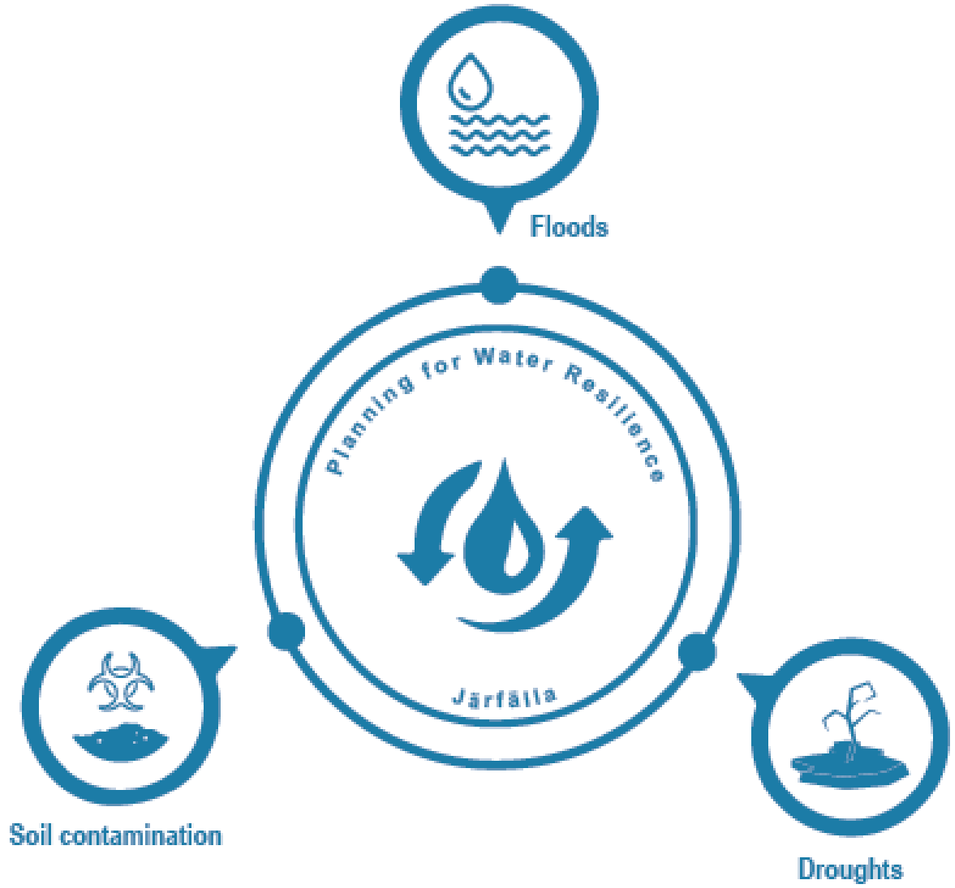
3. Water-spatial analysis

3.0. Conducting a water-spatial analysis

Conducting a comprehensive water-spatial analysis entails delving into the intricate relationships between drought, flooding, and soil contamination. This process involves exploring historical patterns of drought and flooding, evaluating their profound impact on water availability and quality. Furthermore, it requires an in-depth investigation into the sources of soil contamination and an assessment of how extreme weather events exacerbate these issues. Leveraging Geographic Information System (GIS) tools for spatial mapping is essential to identify intersecting zones of vulnerability, paving the way for targeted interventions.

Historically, the exploration of intertwined issues such as drought, flooding, and soil contamination in water-spatial analysis has been uncommon (Watson and Adams, 2010). However, recognizing the interdependencies among these challenges over an extended period is now imperative for achieving a comprehensive understanding and formulating effective mitigation strategies.

In addition to examining environmental factors, our analysis delves into governance issues related to water management. This includes assessing policies, regulations, and institutional frameworks influencing drought, flooding, and soil contamination responses. By scrutinizing governance, we aim to identify areas for improvement in coordination, resource allocation, and stakeholder engagement to enhance overall water resilience.



Water-analysis model, made by ourselves

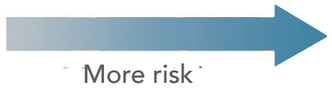
3.1. Flooding in Järfälla

To study historical flood events and their frequency, intensity, and spatial distribution in the area, we consider both riverine and urban flooding. We want to explore the contributing factors to flooding, including heavy rainfall, stormwater management, topography, and land use changes.

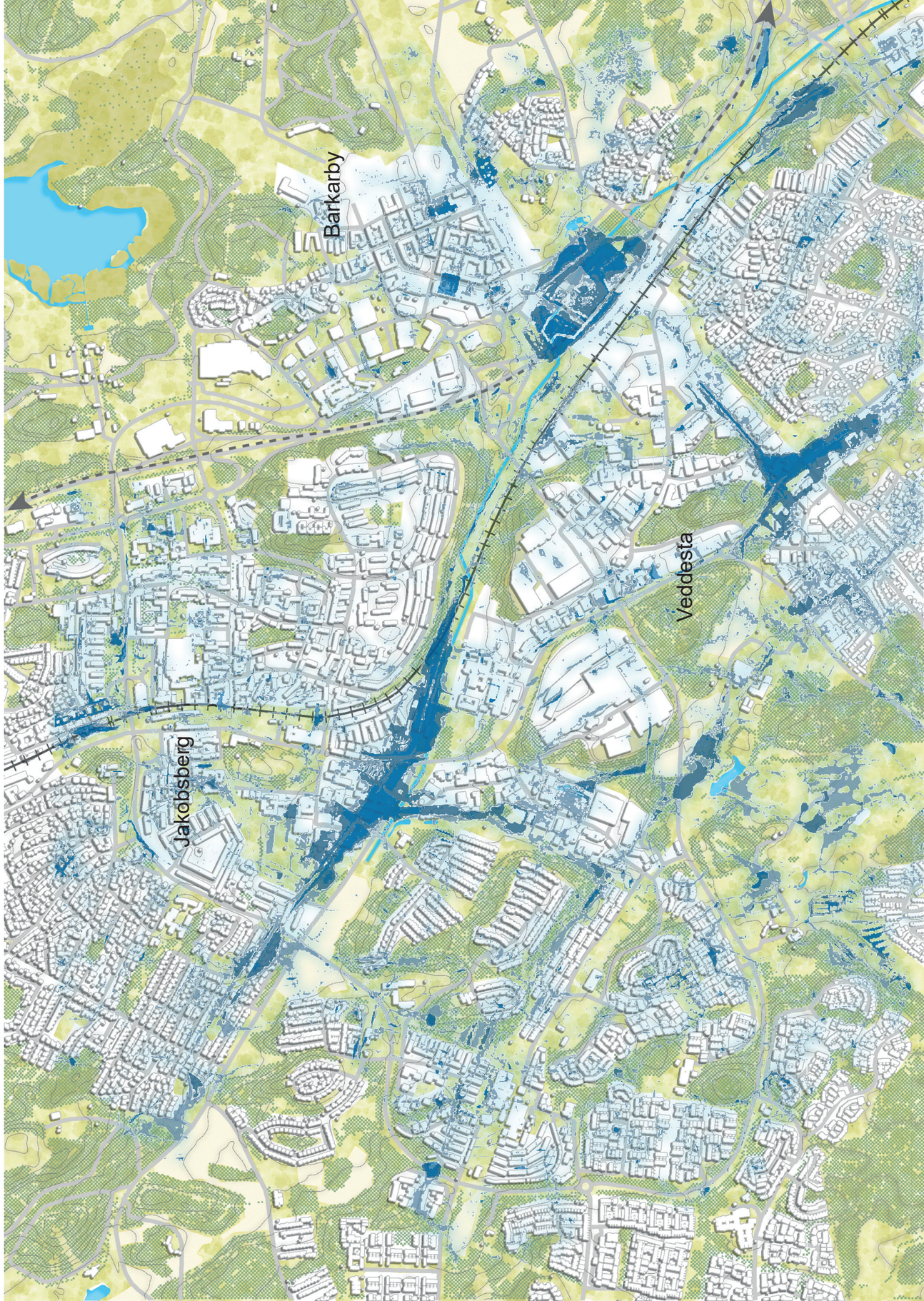
3.1.1. Flash flooding

If we analyze the flood risk due to rain (flash flooding) in Järfälla, we can determine two main variables that influence whether an area is vulnerable to flooding: topography and soil-sealing. Topography refers to the natural physical features of the land, such as its elevation, slope, and relief. In the context of flood risk analysis, topography is essential because it influences how water moves across the landscape. Areas with low-lying terrain or depressions in the land may be more prone to flooding because water can accumulate there. On the other hand, areas with higher elevations or well-drained slopes are less likely to experience flooding. Soil-sealing is a term used to describe the process by which natural soil and permeable surfaces are covered or sealed with impervious materials like concrete, asphalt, or buildings (European Environmental Agency, 2015). When an area has a high degree of soil sealing, it means that rainwater cannot be absorbed into the ground, but instead runs off the sealed surfaces. This can lead to increased surface runoff during heavy rainfall, potentially causing flooding or water accumulation in low-lying areas. Areas with limited soil sealing (more green spaces, open soil) are better at absorbing excess water, reducing the risk of flooding. In the context of Järfälla, the interaction between these two variables is crucial. For example, a low-lying area with poor drainage (due to the topography) and a high degree of soil-sealing is more likely to experience flooding during heavy rain events because the water has no place to go, leading to potential inundation. Conversely, an area with favorable topography and limited soil-sealing may be less vulnerable to flooding.

The following map shows the flash flood risk levels due to rainfall (T20) (Bällstaåmodellen, miljobarometern stockholm) in Järfälla's main centers:



**All maps are made by ourselves through QGIS and ArcGis software and where finished in layout programs*



3.1.2. Waterbody flooding

Next, we can analyze flood risk due to river line (water body) flooding. Riverine flooding occurs when rivers, streams, or other water bodies overflow their banks and inundate adjacent land areas. This type of flooding typically develops gradually over some time, often days or weeks, as a result of prolonged rainfall, snowmelt, or a combination of both. It is thus essential to indicate that river line flooding and flash flooding are closely intertwined. In Järfälla two major water bodies are going through the urban fabric. The first one is Bällstaan. Bällstaån starts in Viksjö and flows southeast, passing Veddesta and Barkarby, then flows into the field between Hjulsta and Tensta on one side and the Lunda industrial area on the other. The second waterbody is Veddestabäcken, which merges with Bällstaan around Barkarby.

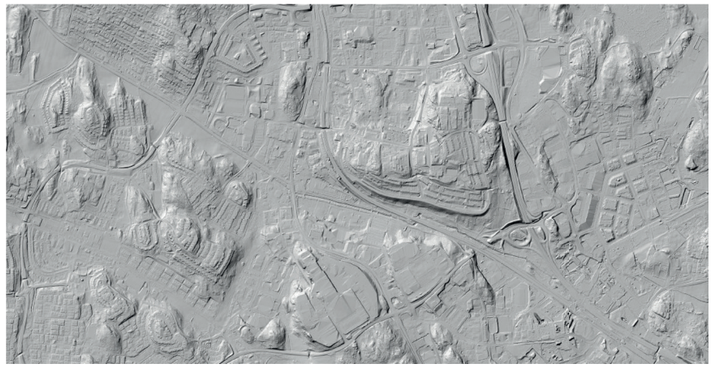
The following map shows the river line flood risk levels at the highest calculated flow (Bällstaåmodellen, miljobarometern stockholm) in Järfälla's main centers:

**All maps are made by ourselves through QGIS and ArcGis software and where finished in layout programs*

3.1.3. The valley

In Järfälla, flood risk is intricately shaped by the interplay of topography, extensive soil sealing, and the proximity of water bodies. Significantly, these contributing factors converge within Järfälla's valley, forming a critical area susceptible to heightened flood vulnerability. Recognizing the urgency and complexity, we have dedicated a distinct chapter to comprehensively address the challenges specific to the valley's unique conditions.

The following map shows Järfälla's Valley:



Snapshot of topographic map: https://eu.opencities-planner.bentley.com/jarfalla/jarfallaportal

This map shows how the main problems are concentrated in the area that we can call Järfälla's Valley. This valley is the lowest point of the municipality, while also the flattest. As a consequence, it has lots of underground water and underground waterways. It is surrounded by some of Järfälla's highest points, which creates run-offs towards the valley. However, the valley contains lots of critical infrastructure such as schools, offices, sports, and cultural facilities, which demand a certain amount of soil sealing. Furthermore, Järfälla's valley is an area of conflictual interest. All the major developments are happening in or around the valley, while the valley is marked as an ecological corridor in the comprehensive plan (Järfälla Kommun, 2030).

Järfälla originated around its rivers and waterways, especially around its valley. Many urban areas originally developed around water sources, such as rivers and lakes, as they provided essential resources. These locations often coincide with lower topographic areas. Initially, farmers settled there, later - during the 30s and 40s - the city developed and Jarfalla's valley became concretized (Bornhäll, 1996). Low-lying areas tend to have flatter terrain, making it more convenient for construction and urban development. The flat terrain is easier to work with for building infrastructure, roads, and structures.

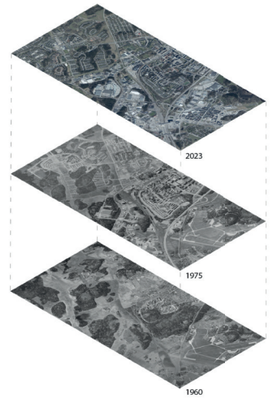


Diagram made by ourselves, based on GIS-data

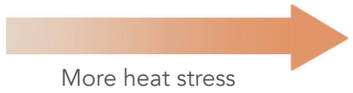
If we look at the municipality's current approach to flooding, we see different perspectives applied. In the first development of Barkarbystaden water sensitive-planning was not included in the planning process. We see a rather conventional kind of development, where most surfaces are concretized. However, in the development of Barkarbystaden II, we see stormwater management was applied in providing space for new waterways to exist. A first example is the Bällstaan waterway that was re-meandered around the new development. Kyrkparken, for instance, serves multiple functions, including climate change mitigation. It features ponds, a stream, a water garden with water meadow plants, bridges, and a limestone embankment that cleans, slows down, and stores water while fostering biodiversity. Plans for the park include an alder marsh, noise protection, play areas, and barbecue spots to enhance its offerings as Barkabystaden continues to grow.

According to a civil servant, working for the municipality of Järfälla, the reason flood- and water management was heavily included in the development of Barkarbystaden II, was because it regarded a regional waterway (Bällstaan) that created lots of risks in terms of pollution and flooding (Interview Erika Fagerberg Lewenhaupt, 2023). However, it remains unclear whether the proposed - and in-construction measures - will be sufficient to deal with the determined risks. In the case of Barkabystaden II, we ask ourselves whether it wouldn't have been better to not develop this piece of land and leave it open. However, the interview with the municipality explained that to implement water measures, large budgets are needed (Interview Erika Fagerberg Lewenhaupt, 2023). The everyday budget of the municipality is not able to cover these costs. So it is due to new - profitable - developments, that budgets for water measures within those developments can be allocated. This also explains why the measures regarding water concentrate on the development of Barkarby, rather than the existing urban fabric.

3.2. Drought in Järfälla

As the map shows, the heat islands are situated around the valley, where the areas are mostly sealed. As already stated, urban drought and heat are not only consequences of climate change and different weather patterns but also consequences of the way cities are designed and developed. As cities grow and expand, natural landscapes are replaced with impervious surfaces such as roads, buildings, and parking lots. These surfaces prevent rainwater from infiltrating the ground, leading to reduced groundwater recharge. Consequently, less water is available to support vegetation, and the city becomes more susceptible to drought conditions. If we focus on Järfälla's valley, then we see the areas most vulnerable to drought are the most soil-sealed areas around Järfälla's valley. However, lots of these islands are sealed for a reason. They offer critical functions such as education, daily shopping, industry and shopping, dense housing, etc. Furthermore, they depend on good connections and mobility. Within these areas, water could function as a means to cool. The question is thus whether space can be used multifunctional, in a way that doesn't obstruct daily life but is impermeable. Some of the measures have begun, such as mapping heat stress vulnerability to investigate which locations in the municipality are particularly vulnerable to heat during heat waves. However, since the heat islands were determined, no concrete measures have been taken.

The following map shows heat zones in Järfälla:



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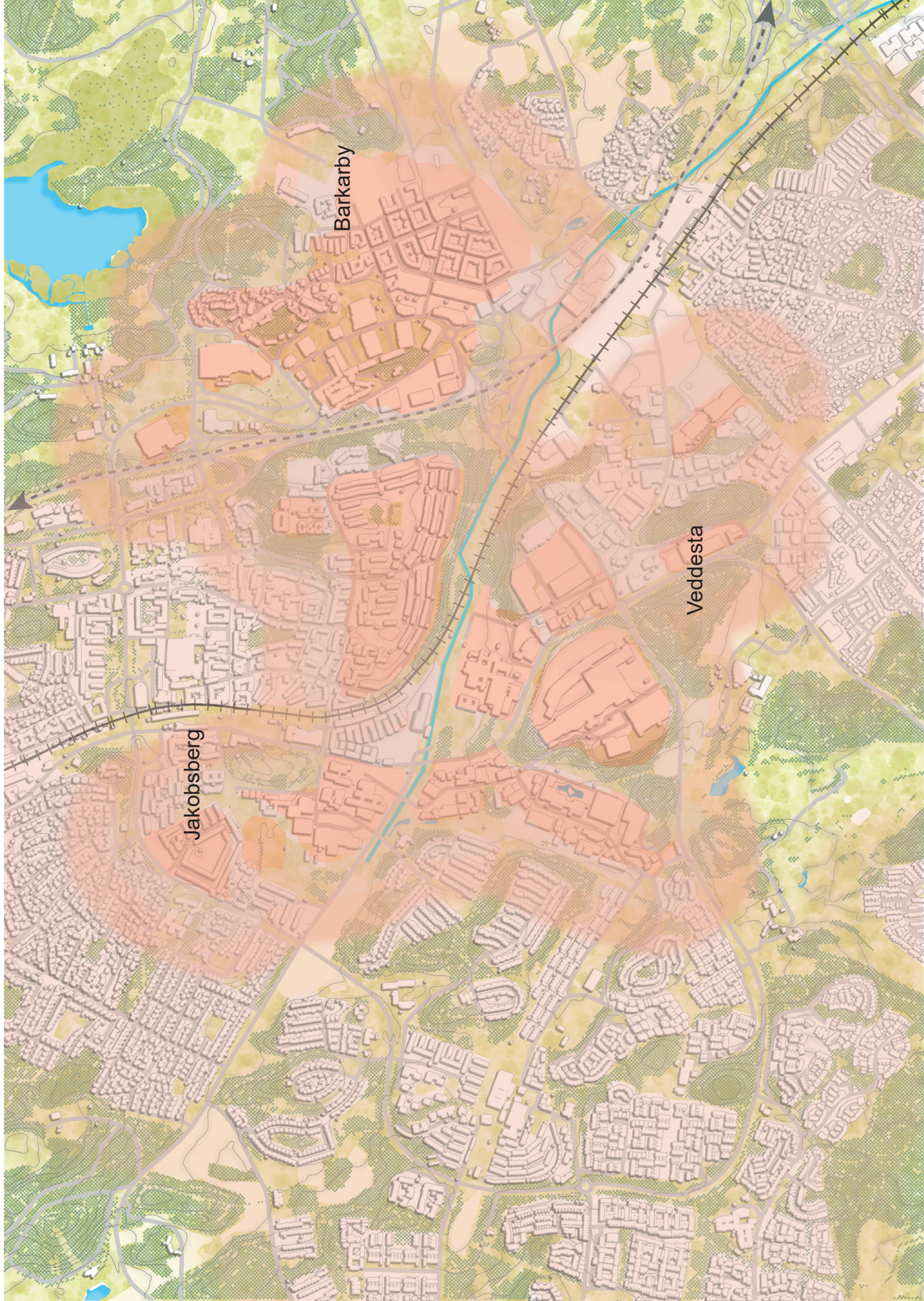


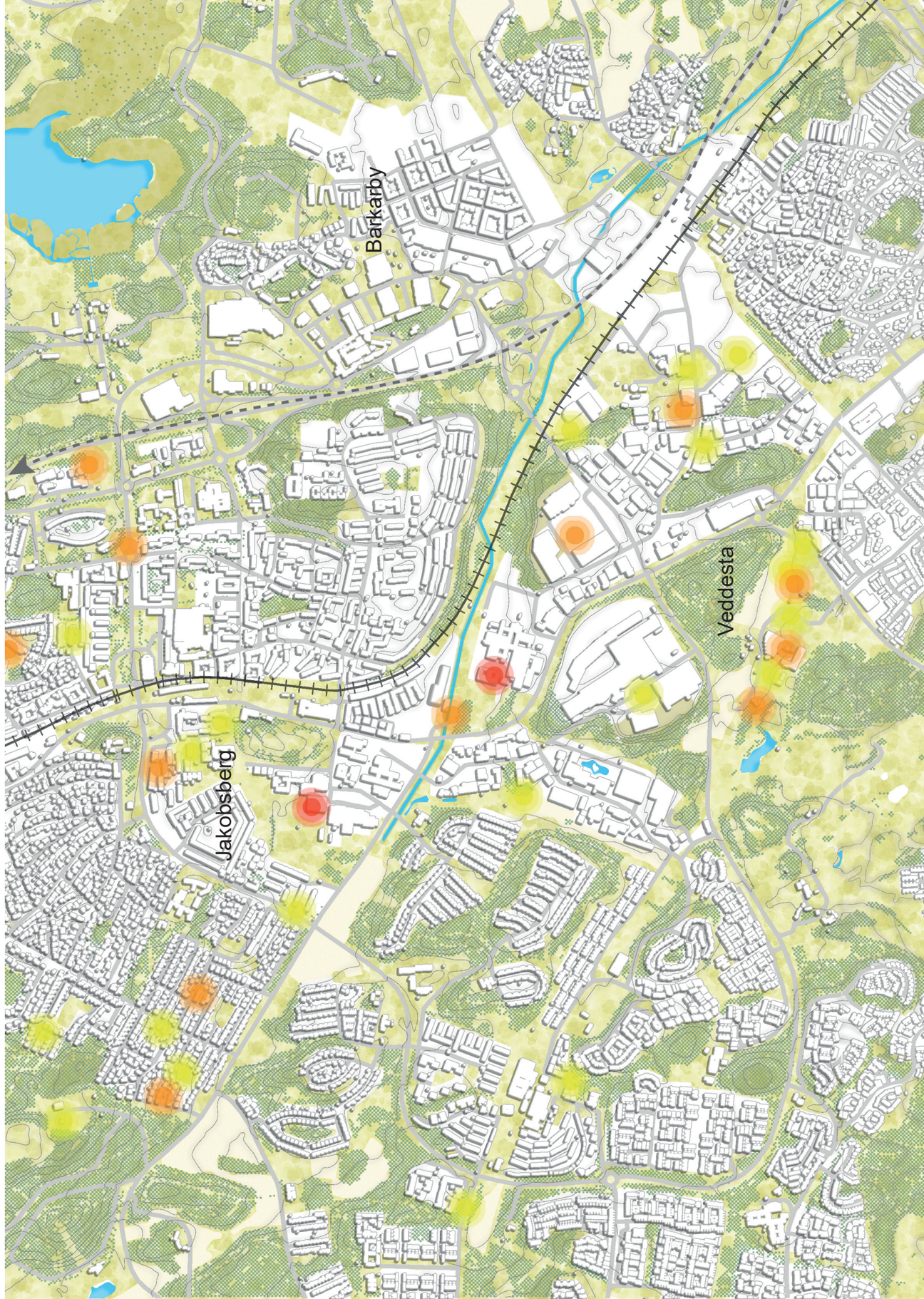
3.3. Water and soil contamination

In the region of Järfälla, there are several areas with a history of environmentally hazardous activities that have the potential to release harmful pollutants into the surrounding environment. The influence of these chemicals can be observed in both the watercourses and the land areas, highlighting the pressing concern for public health and the well-being of the environment. A map has been created to identify specific locations where pollution is mostlikely to pose a significant threat (Järfälla Kommun 2019). The map underscores the need for a comprehensive approach to address these environmental challenges, with a focus on both water and land contamination. Here, we enlist a range of contaminants and their respective sources to provide a clearer picture of the threats faced in this area. Water contaminants of particular concern include:

Pesticides chemicals
Chemical weed control and fertilizers
Drugs
Microplastics and nanomaterial
PFAS (polyfluorinated alkyl substances)

According to the municipality, when it comes to addressing soil and water contamination, governance and budget allocation play a crucial role in driving action. A key driver for tackling these issues is the transformation of specific areas into residential zones. It is at this point that municipalities become obligated to take action regarding the remediation of contaminated lands. Similar to the challenges encountered when dealing with flooding, the effort to combat soil and water contamination relies heavily on decisions and budget allocations within other policy domains. A pertinent illustration of this intricate interplay can be found in the case of Veddesta.

In the context of Barkarbystaden, a noteworthy endeavor is underway involving the re-meandering of the water body of Bällstaan. This initiative aims to address the contamination of the water, though it is essential to recognize that this water body requires sufficient space and dynamic conditions to effectively purify itself. The question arises whether the available area will prove adequate to cleanse the water before it reaches its destination. Moreover, specific types of contamination, such as phosphorus, can only be effectively remediated in still-standing water. This underscores the necessity for diverse dynamics within water bodies. Therefore, the strategy for water purification must encompass both the prevention of contamination before it enters the water body and the implementation of treatment processes in still-standing water. Regarding the situation concerning Veddestabäcken and the development of Barkabystaden II, there exists a contamination risk related to “sulfur-clay”(Levin et al. 2023).



Very high risk contamination

High risk contamination

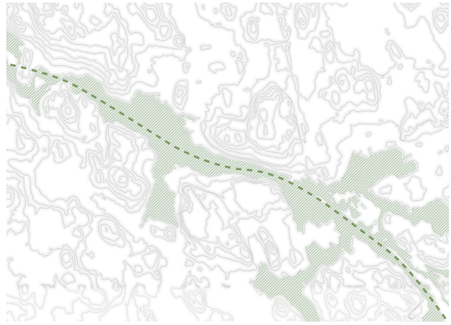
Medium risk contamination

3.4. Summary

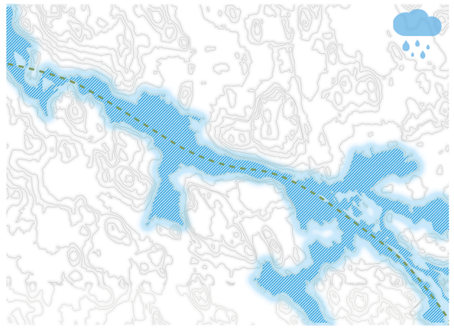
Following maps show that the three water challenges we encountered are intertwined. Flooding and drought are interconnected through the hydrological cycle. Excessive rainfall can lead to flooding, while prolonged periods of reduced rainfall result in drought. Soil contamination can exacerbate these issues. Contaminated soil may not absorb water efficiently, increasing runoff during heavy rainfall and contributing to flooding. Conversely, during droughts, the presence of contaminants in the soil can affect water quality, making it even scarcer and potentially harmful for human consumption. The following scheme visualizes this process in six steps.

The challenge is thus to restore Järfälla's valley into its biotic sphere, so it can function as an asylum for water. In time, this can strengthen its ecological value and become a corridor - as drawn on the Översiktsplan - between Järfälla's green edges. Furthermore, this corridor can become multifunctional and still offers the infrastructure it does today, but in harmony with the water cycle. Secondly, the heat island around the valley forms the major run-offs, not only because of their topography but also because they are mostly soil-sealed. It is thus necessary these areas become more impermeable so that water can be stored (partly) locally to reduce the flood risk within the valley. Furthermore, by installing green infrastructure and water bodies, the drought can be countered. Thirdly, the contamination should be tackled by applying NBS. If rainwater can be stored locally, pollution can be spread by rainfall. By using the new green infrastructure in combination with bioremediation and phytoremediation, contamination can be countered.

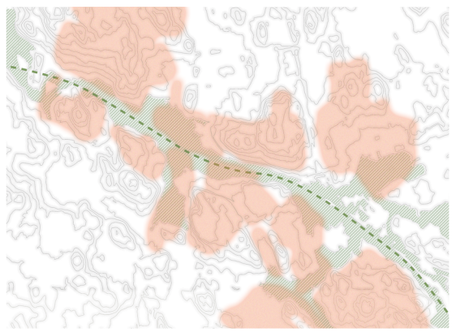
It thus seems that the major solution to the problems all starts with unsealing and installing green infrastructure. However, if the answer is known, the question remains why these measures haven't been broadly implemented. The answer is complex. The first explanation is the scarcity of grounds. Budgets within municipalities are limited, furthermore, there exist conflicting interests between policy fields when it comes to water management. This way, water within policy becomes very dependent on decisions and budgets within other policy fields. Furthermore, lots of the ground within Järfälla is also privately owned. It is thus necessary to appeal to individual responsibility to treat water sensitively. However, citizens and companies don't see the benefits for themselves. Lastly, in terms of governance, the effects and solutions nature-based solutions bring, are difficult to calculate. Whereas the conventional drainage system can be easily calculated in terms of volume, size, and so on… Within the current governance culture, municipalities have to stand accountable for their actions. This is why they prefer conventional solutions as they can calculate the return on investment, rather than nature-based ones (Nikhil Anand, 2023).



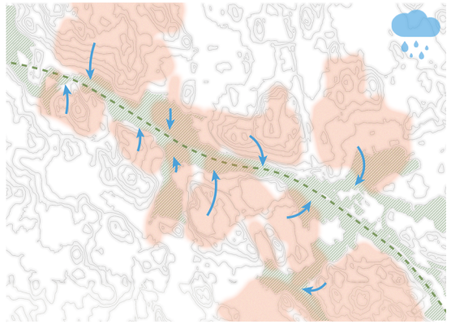
1. Järfällas valley



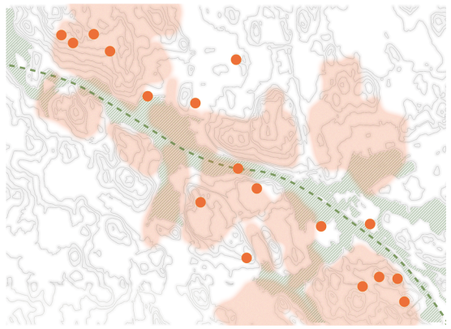
2. Järfällas valley holds water because of it's limited ability for infiltration



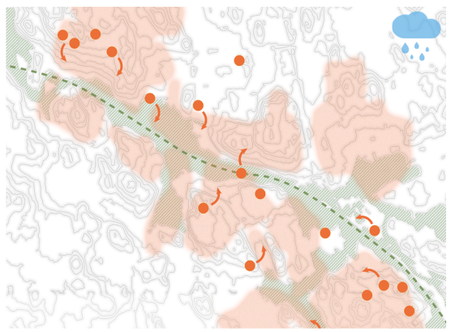
3. Surrounding heat islands and desserts



4. Run-offs going towards the valley, due to limirted local infiltration ability and topography



5. Areas of soil-contamination



6. Rainfall spreads the contamination towards the valley through run-offs

**All maps are made by ourselves through QGIS and ArcGis software and where finished in layout programs*

Jakobsberg

Barkarby

Veddesta

4. Water-Resillient Plan

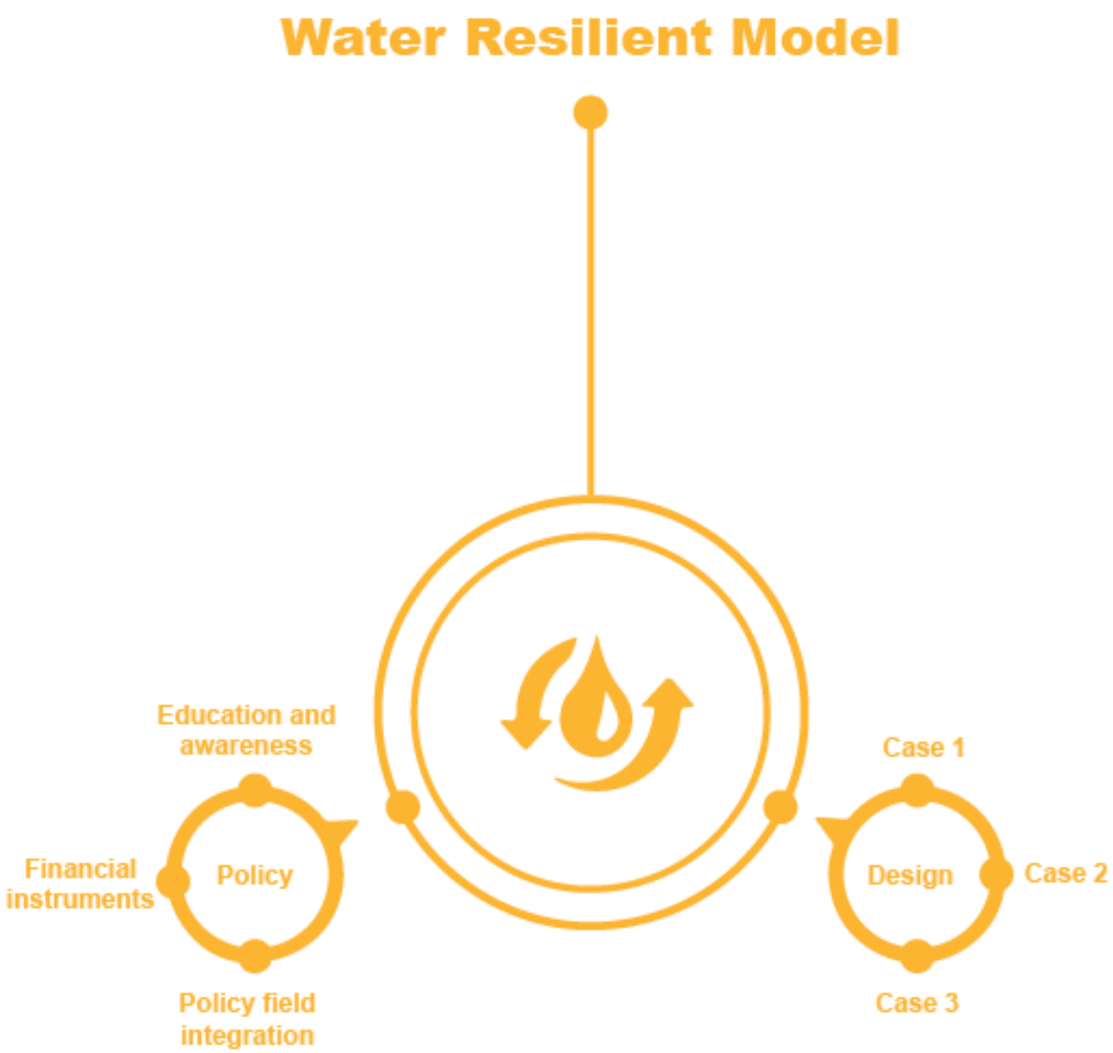
A dual-strategy for a water resilient Järfälla

4.0. A dual-strategy for water resilience

The literature review underscores the significance of adopting a successful planning approach that is multi-scalar, multi-strategic, and integrated (Watson and Adams, 2010; Hoyer, 2011). Accordingly, our operational framework aligns with this approach. Recognizing the complexity and interconnected nature of urban water challenges, a multi-scalar approach becomes crucial, acknowledging the diverse levels of governance involved, from local to municipal. Each scale introduces distinct actors, perspectives, and approaches. For example, at the municipal level, our focus will be on governance, policy, and building codes, while at the local level, attention will be directed towards concrete design and planning actions.

Simultaneously, the adoption of a multi-strategic approach emerges as essential, as indicated by various case studies. The synthesis of policy, planning, and design is identified as the most effective way to bring about positive change. Building on existing literature, political support is recognized as a crucial factor for the success of water-related measures (Hoyer, 2011). Additionally, Metz and Glaus advocate for integrated water resources management, emphasizing the importance of aligning policies over time into a coherent regime for efficient water resource management (Metz and Glaus, 2019). This integrated approach has the potential to optimize resource utilization.

Furthermore, the chapter stresses the need to balance conflicting interests, such as the demand for water in agriculture for irrigation versus the requirement for water in environmental conservation to sustain ecosystems. The outlined approach in this chapter delineates the various scales and levels at which we will formulate concrete strategies, ensuring a comprehensive and effective response to urban water challenges.



Water-resilient model, made by ourselves

4.1.Through Policy Implementation

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Scheme for policy implementation, made by ourselves.

4.1.1. Awareness and Education

4.1.1.1. Creating public support and institutional capacity through awareness, education and cooperation

As we undertake the development of a strategic framework for fostering water resilience in Järfälla, this chapter is dedicated to laying the essential groundwork and building a robust support system. Through an awareness program and active participation, we aim to address the pressing need for effective water management in the face of a changing climate, emphasizing the significance of collaborative and inclusive approaches. The overarching objective of this chapter is to formulate a strategy that provides the residents of Järfälla with a comprehensive understanding, empowering them to engage actively in water management and conservation initiatives.

4.1.1.1.1. The need for public support

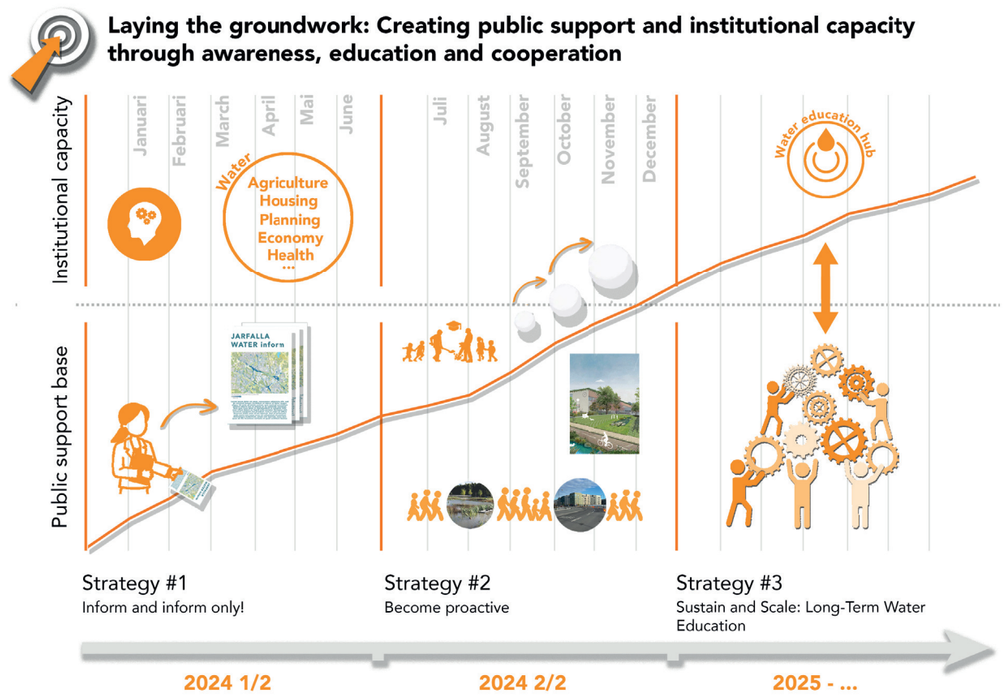
Public awareness of the risks associated with water related challenges has increased in many regions due to factors like media coverage, scientific research, and the visible impacts of extreme weather events. However, despite this heightened awareness, addressing these issues can still be challenging. For instance, controlling flood risk is not a priority for many people because it still seems somewhat distant and unrelated, with the attitude of 'oh that won't happen here' (Watson & Adams, 2010). However, the recent floods (2021) in Belgium and Germany have shown this is untrue. But still, Governments, businesses, and individuals may be hesitant to allocate resources for preventive measures, especially in cases where immediate benefits are not obvious, which is also the case in Järfälla (Interview Erika Fagerberg Lewenhaupt, 2023). As planners or designers, we should thus not underestimate the importance of creating a support base. Jacqueline Hoyer (2011) argues that local participation can enhance the capacity for dealing with flood risk management. Another reason for the limited support base for sustainable water-measures is the lack of education and knowledge regarding water and water-cycles. Watson and Adams (2010) also underscore the critical role of education, noting that a lack of knowledge about the local water cycle prevails among various groups, encompassing citizens and businesses. For instance, when it comes to drinking-water, Bendz et al. (2019) state that citizens view provisioning of drinking water as a taken for granted service, and also lack knowledge of and interest in drinking water issues.

The report already made clear we want to break with conventional water-management and introduce other sustainable water-design and governance approaches. However, this shift makes public support even more crucial. Navigating water management and conservation in densely populated urban regions like Järfälla, marked by substantial private land ownership, poses considerable challenges. This complexity arises from various factors. Nature-based and water-sensitive strategies emphasize creating additional space for water, a critical consideration in both privately and publicly owned lands (Hoyer, 2011). Notably, artificial drainage systems, being 'invisible' infrastructures, historically may not have required democratic legitimation, as they do not directly impinge upon people's private property. The contrast lies in the perceived invisibility of these drainage systems, allowing them to operate without overtly affecting private property. In contrast, nature-based and water-sensitive solutions demand a reconsideration of traditional approaches, highlighting the need for democratic legitimation even in the face of seemingly inconspicuous interventions (Anand, 2017). Thus, when focussing on an approach building on water-sensitive water management, nature based solutions and decentralized water-management, public support becomes even more crucial.

Järfälla already makes its interventions and actions clear by placing information boards. Besides that, citizens, if wanted, can use conventional participatory channels to make objections or ask questions (Interview Erika Fagerberg Lewenhaupt, 2023). However, we believe that the municipality can play an even more proactive role in this. While there is a top-down regulatory framework, we want to emphasize the need for a more collaborative, participatory approach (Dawson et al, 2018). Certainly in Järfälla, where various stakeholders hold significant influence within the critical places, getting them on board is essential. Solving everything with public funds is unaffordable, leaving everything to the citizens is reprehensible (Albrechts, 2010). However, if we want to address individual responsibility and co-creation, people need to be informed. The first strategy that has to be unrolled is thus an educational and awareness program. The reason this program has to be outpolled first is because of its capacity to enhance other measures, such as financial incentives-programs.

4.1.1.1.2. How to create public support

The approach to developing our education and awareness strategy stems from an interview conducted with the municipality, wherein we inquired about their existing efforts in this area. Additionally, our methodology includes a review of literature on participatory and co-creative practices related to water management and conservation, extending to similar practices in other domains. Lastly, a thorough analysis of case studies has been undertaken.



Scheme for creating public support through awareness and education, made by ourselves.

Action 1 - Inform and inform only!

In drawing from the insights of Watson and Adams (2010), it becomes evident that authentic participatory viewpoints are crucial in ensuring that education goes beyond mere information dissemination. To avoid the common misconception of participation as merely communicating policy, we will adopt an approach inspired by agonistic theory. This theory emphasizes the importance of open and respectful dialogue, acknowledging diverse perspectives, and fostering healthy debate. As emphasized by King, Feltey, and Susel (1998), encouraging participation and interest-building should respect individuals' autonomy and align with their values. In this chapter, we aim to facilitate a genuine exchange of ideas, leveraging the authentic participatory viewpoints of community members. The initial step, as proposed by King, Feltey, and Sussel (1998), is to offer citizens the opportunity to educate themselves voluntarily. Recognizing the significance of accessible information, we will utilize various channels, including the municipality's website, social media platforms, community bulletin boards, and local newspapers. A pivotal component of this initiative involves the development of visually engaging materials, such as folders featuring maps and infographics. These visuals will vividly illustrate the water cycle in Järfälla, building upon the analytical approach established during our initial analysis. These materials will not only outline existing challenges but also delve into their underlying causes, which are intricately linked to the way the community lives and builds. The intention is to disseminate these maps widely across public spaces, schools, and online platforms, ensuring accessibility for all. Importantly, these materials will maintain a transparent and analytical approach, clearly communicating metadata to enhance understanding. The aim is to acquaint citizens with water-related issues, fostering a sense of awareness without preempting a predefined solution.

Crucially, the language used in these materials will be open and inviting, encouraging individuals to reflect on the water-related challenges facing their community. By utilizing a map that allows residents to situate themselves within the broader context, we hope to generate interest and involvement. This approach aims to go beyond mere information delivery, sparking genuine engagement and participation in the collective effort towards sustainable water management in Järfälla.

Furthermore, this is also a learning process within the various policy fields. Järfälla already established the expertise regarding water within autonomous public servants. However, this knowledge should also ripen within various policy fields. Furthermore, this water management education initiative serves as a continuous learning process within the various policy fields of Järfälla. While autonomous public servants have already established expertise regarding water, it is essential to extend this knowledge to permeate across diverse policy domains. In line with King, Feltey, and Susel' (1998) perspective on authentic participatory viewpoints, this inclusive approach acknowledges the importance of fostering a shared understanding of water-related challenges among policymakers. As we draw from agonistic theory, the intent is not only to inform but to engage policymakers in open and respectful dialogue, encouraging them to contribute to the ongoing learning process.

Action 2 - Become proactive!

This strategy suggests a shift from pure information dissemination (static education) to an active and engaging approach (dynamic education). This strategy thus involves organizing guided walking and cycling tours within the community, with a specific focus on key points in the local water cycle. The intention is to provide community members with a firsthand and interactive experience related to water management. For instance, the tours may include visits to nearby rivers, lakes, drainage systems, and green spaces, allowing participants to observe and understand these elements in the context of the water cycle. The tours can be led by knowledgeable guides or educators who can provide insights, answer questions, and facilitate discussions during the excursion. This strategy aims to encourage proactive engagement and a deeper connection with the local water environment. By physically experiencing and witnessing various components of the water cycle, community members are likely to develop a more profound understanding of water-related issues. Additionally, the interactive nature of the tours promotes a sense of community involvement and empowers individuals to become proactive participants in water conservation efforts. Locations that can be visited are places that already address water-issues, such as Kyrkparken, but also Järfälla's valley that suffers a lot from various issues.

Furthermore, this strategy focuses on leveraging the educational environment to instigate positive change in water management. It involves developing a comprehensive water cycle education program for schools, encompassing classroom lessons, workshops, and practical activities. Collaboration with local schools, environmental organizations, and experts is key to creating engaging and informative content. Given that various schools are situated in flood-risk areas and have predominantly sealed grounds, there is an opportunity to involve students in a meaningful project – unsealing the schoolyard. This project not only educates students about the local water cycle but also provides them with hands-on experience in contributing to sustainable practices.

The envisioned outcome is a transformed schoolyard that incorporates green and blue infrastructure alongside traditional concrete elements. The initiative extends beyond the school premises, as students become ambassadors for change when they bring the project home and share their knowledge with their parents. This ripple effect, or "snowball effect," is anticipated to raise awareness and engagement within the broader community, creating a positive cycle of informed action and environmental stewardship. This action is also directly translated in the design strategy.

Action 3 - Sustain and Scale: Long-Term Water Education

In addressing the imperative for sustained efforts, the third strategy is strategically designed to weave water education into the enduring fabric of Järfälla. This involves the establishment of a central hub, designated as a 'Water Education Hub', envisioned as a dynamic and comprehensive resource center. This hub will serve as a nexus, providing continuous and accessible information on water-related topics, hosting educational programs, and fostering collaborative initiatives within the community. As a centralized repository, Järfällas Water Education Hub aims to become the go-to source for residents, businesses, policymakers, and educators seeking up-to-date and reliable information on water management. It will house a wealth of resources, including educational materials, research findings, and updates on ongoing water initiatives. Additionally, the hub will act as a catalyst for collaborative efforts, bringing together diverse stakeholders to work collectively towards water sustainability.

Simultaneously, the long-term strategy extends its influence into the education sector. This deliberate infusion ensures that every generation of students receives a foundational understanding of the importance of water conservation, embedding responsible water practices into the cultural mindset of Järfälla. Lifelong learning programs emerge as a critical component, offering a continuous and scalable approach to water education. These programs extend beyond the classroom, providing opportunities for residents of all ages to engage with evolving water-related topics through workshops, seminars, and community events. This approach recognizes that learning is a lifelong journey and aims to cultivate a community that remains informed and empowered to adapt to changing water challenges. The creation of community engagement platforms serves as a virtual space where residents can actively participate in discussions, share experiences, and stay informed about ongoing water initiatives. These platforms foster a sense of community ownership, encouraging individuals to contribute ideas and actively engage in shaping the sustainable water future of Järfälla. Partnerships with local organizations become integral to the long-term strategy, ensuring that the municipality taps into diverse expertise and resources. Collaborative efforts with environmental organizations, businesses, and community groups enable the development of innovative programs, events, and projects aimed at addressing emerging water challenges. Eventually, this must lead to a more horizontal kind of governance, as these strategies all align with the principles of inclusivity, transparency, and responsiveness that are essential for effective urban water management.

In summary, our comprehensive approach to water management in Järfälla extends beyond conventional education, evolving into a collective civic responsibility. By fostering informed participation through transparent communication (Action 1), promoting dynamic engagement with firsthand experiences (Action y 2), and establishing a Water Education Hub for continuous learning (Action 3), we aim to embed water conservation as a way of citizenship. These strategies, grounded in inclusivity and responsiveness, signify a shift towards a horizontal governance framework. In this collaborative paradigm, diverse stakeholders actively contribute to decision-making, ensuring a sustainable water future shaped by the collective efforts of the Järfälla community.

4.1.2. Financial Instruments

Subsidies and financial incentives can be offered by the municipality to encourage sustainable water management practices. Economic instruments recognize and work within the economic system to generate action or drive investment to achieve environmental goals (Brown & Sanneman, 2017). Residents and businesses, for example, could be rewarded for installing rainwater harvesting systems, which reduce demand for municipal water supplies and reduce stormwater run-off. Furthermore, by providing subsidies or tax breaks, property owners can be encouraged to install permeable surfaces in driveways and parking lots. These incentives encourage water-sensitive urban planning and help to reduce stormwater runoff and improve groundwater recharge.

For example, as an incentive, the Emscher municipalities in Germany provide free inspections of stormwater facilities to property owners (Nickel et al., 2014). Simultaneously, they have implemented stormwater fees based on the impervious surface area of properties. With the money saved from impervious surface fees and the lower costs for the gray infrastructure system as a result of stormwater management at the source, they were able to establish a grant program for green infrastructure-based stormwater projects (Nickel et al., 2014). As a result, both sticks (such as taxes and fees) and carrots (subsidies and free services) can work in tandem to encourage positive behavior.

Another case in point is The Coca-Cola Company, which has conducted hundreds of projects under the banner of replenish, including measures to restore and regenerate the local water sources that they use in their products in collaboration with communities (Larson et al., 2012). In the same way, other enterprises may be eligible for subsidies if they undertake similar projects that can both boost their end products or allow them to use clean water in their processes, or reduce their harmful contamination of the water.

There are two ways to use financial incentives. Either in a more general sense that applies to a larger scale, or in a strategic sense that only applies to critical areas. In order to increase Järfälla's water resilience, 'critical areas' must be identified in terms of flood risk, contamination, and drought. Certain areas, however, are not at risk of flooding, contamination, or drought. These measures instead have a general impact on water-related ecosystem services, such as improved water quality, increased groundwater recharge, and biodiversity conservation. The municipality's choice of strategic or general policy is determined by its budget and the problems it wishes to address. If funds are limited, a strategic approach may be the best option.

Currently, there are no general financial incentives for unsealing for citizens and companies in Järfälla. The financial stimuli regarding water management of the municipality mostly focus on new developments like Barkarbystaden. Additionally, as the municipality has a limited budget for water challenges on their own, most new projects (apart from the new development areas), are led and sponsored by the companies on the land. For example, SAAB had initiated a project for water infiltration before they moved location.

Action 1 - Incentives through subsidies and free services

a. The primary step to Action 1 is to provide subsidies to incentivize companies to improve their businesses and their business sites' impact on the water cycle. Subsidies are a so-called direct payment based upon a specified action between two parties. Therefore, we suggest to give citizens and companies access to subsidies for making their grounds water-sensitive. This includes actions like (partly) unsealing, installing vegetation and watersheds, bioremediation in the case of soil contamination, etc. However, in order for subsidies to drive the adoption of water-sensitive infrastructure, the associated cost savings need to provide a sufficiently attractive financial incentive (Brown & Sanneman, 2017). If the cost of installing and maintaining the infrastructure is higher than the subsidy or reduced fee, companies will lack the motivation to adopt it. Therefore, it is vital to make a cost-benefit analysis and gather information from the local companies about what would be sufficient incentive for them to implement these actions. Thereafter, the actions would need to be adequately monitored and maintained.

b. An additional step would be to focus subsidies and financial incentives on critical areas within the municipality. Identify these areas based on flood risk, contamination concerns, and drought vulnerability. Prioritize interventions in locations where water-related challenges are most pressing. This could act like an Insurance Premium Discount/ Risk Reduction incentive, based on the premise that reducing the incidence and significance of flood-related damages will be worthwhile to the companies as it will lower their costs in the case of an incident (Brown & Sanneman, 2017). This step would require awareness programs for the local companies to incentivize such actions.

c. Another step would be to offer free consultation to citizens and companies regarding water-sensitive design, or free inspections of water facilities on their premises. Removing this additional cost for businesses might incentivise them to install them.

Action 2 - Discouragement through fees

a. In Action 2 we suggest that the municipality install fees based on the amount of impervious surface area on businesses' land where it is not deemed necessary to have an impervious surface due to safety reasons, etc., similar to what was done in the Emscher municipalities. This is because impervious surfaces is the leading reason for abruption in the water cycle and uncontrolled amounts of stormwater runoff, causing flooding.

b. The income generated from this fee would then be put into the subsidies and any excess money could be used for a grant program that sponsors the education and awareness program mentioned in Strategy 1. The mobility of businesses and property owners makes implementing financial instruments difficult. Moving location, as in the case of SAAB, can derail or completely halt plans for water-sensitive designs, as these are very lengthy processes that take time to plan, install, and maintain before you begin to see any results. As a result, the municipality has an advantage over private actors because it can plan more long-term and reap the lasting advantages of water resilience strategies. This may deter businesses from investing in these measures, or funds received from subsidies may not be realized before the company moves.

Financial incentives are also strongly tied to awareness. One example in practice is the German Green Roofs Association. This is an NGO that advocates to increase the green building market by advocating for more green subsidies in policy (Gebaeudegruen, 2024). This way the organization has pushed Germany, Austria, and Switzerland to the world top when it comes to Green Roofs. Therefore Strategy 1 and 2 need to work in synergy.

4.1.3. Integration in Policy Fields

Sensitive water management necessitates an integrated approach encompassing multiple policy areas, including planning, agriculture, the environment, housing, and health. Metz and Glaus (2019) promote Integrated Water Resources Management (IWRM), which emphasizes the importance of integrating policies over time into a coherent regime for effective water resource management. They argue that this could lead to more efficient resource use and ensure that all uses of water coexist harmoniously. Nickel et al. (2014) agree that an integrated planning approach aids in the integration of environmental and urban development.

Today, various policy fields concerning space and land use are present including agriculture, water, urban planning, urban development, housing, industry, energy, and so on. As a result, these policy fields develop a level of expertise in the areas in which they operate. However, because of this specialization, the objectives and goals of these policy fields differ. This can lead to actions in one policy area having a negative impact on another. According to Metz and Glaus (2019), this occurs when it comes to water. Other policy areas do not fully consider water when making decisions. In this way, conflicting interests must be balanced. For example, agriculture may require significant water for irrigation, whereas environmental conservation may require water to maintain ecosystems. Water problems can be solved at the source by looking holistically.

This is also true for science-policy integration. In many cases, a lack of communication and clear coordination results in research outputs that are not used by policymakers and policy needs for research that are not communicated to scientific communities. "The development of environmental policies is a complex process, which mixes legal requirements with issues of technical feasibility, scientific knowledge, and socio-economic aspects, and which requires intensive multi-stakeholder consultations" at every stage of policy development, according to Quevauviller et al. (2005, p. 203).

Järfälla's water budget prioritizes new developments such as Barkarbystaden and Veddesta. This is because water measures are heavily reliant on the budget and policies in other policy areas. However, as our analysis revealed, many critical areas are located in areas that are already built and require measures. Thus, more radical integration of sensitive water management and conservation into daily urban renewal and development is required.

"From gray to green" in Portland, USA, is a case that serves as a model. Portland implemented an ambitious sustainable water management program that included multiple strategies from 2008 to 2013. One of the strategies was to take a fresh look at existing roads, sidewalks, and bike paths to see if they could be designed in a way that contributes to more sensitive and sustainable water management. As a result, they considered how wide sidewalks needed to be, where they could gain space, and how to make it more permeable. This created a massive amount of open space that could be used to build new green infrastructure and capture and infiltrate water. Municipalities, including Järfälla, are constantly renewing their infrastructure. They frequently fail to consider new - better - methods of renewal in their designs. As evidenced by the literature review, urban renewal and development are still associated with concretization rather

Järfälla municipality believes that water management is sufficiently integrated into urban planning (Levin & Taeckens, 2023). However, the municipality admits that it lacks the voted documents required to create a legal foundation for water measures.

Furthermore, there are only a few people in the organization who are knowledgeable about water, making it difficult to incorporate water knowledge into every decision. Water-related incentives, on the other hand, are integrated into the green-area factor (GYF), making it possible to include it in new urban developments. When you develop a property, you must collect green points. This is a way to motivate increasing ecosystem services.

Action 1: Incorporate science-based water-sensitive design into daily practices and policies.

a. Alternative designs for conventional infrastructure such as roads, sidewalks, bike lanes, parking, facilities, and amenities are needed. In practice, these can be taken into account whenever infrastructure is renewed or added.

b. Implement projects and exchange knowledge with nearby educational and research institutions.

c. Järfälla should aim to integrate their "water plan" with the overall "comprehensive plan" in the long run to demonstrate that water is an essential component of any plan, both for new developments and for restoring and revitalizing built areas.

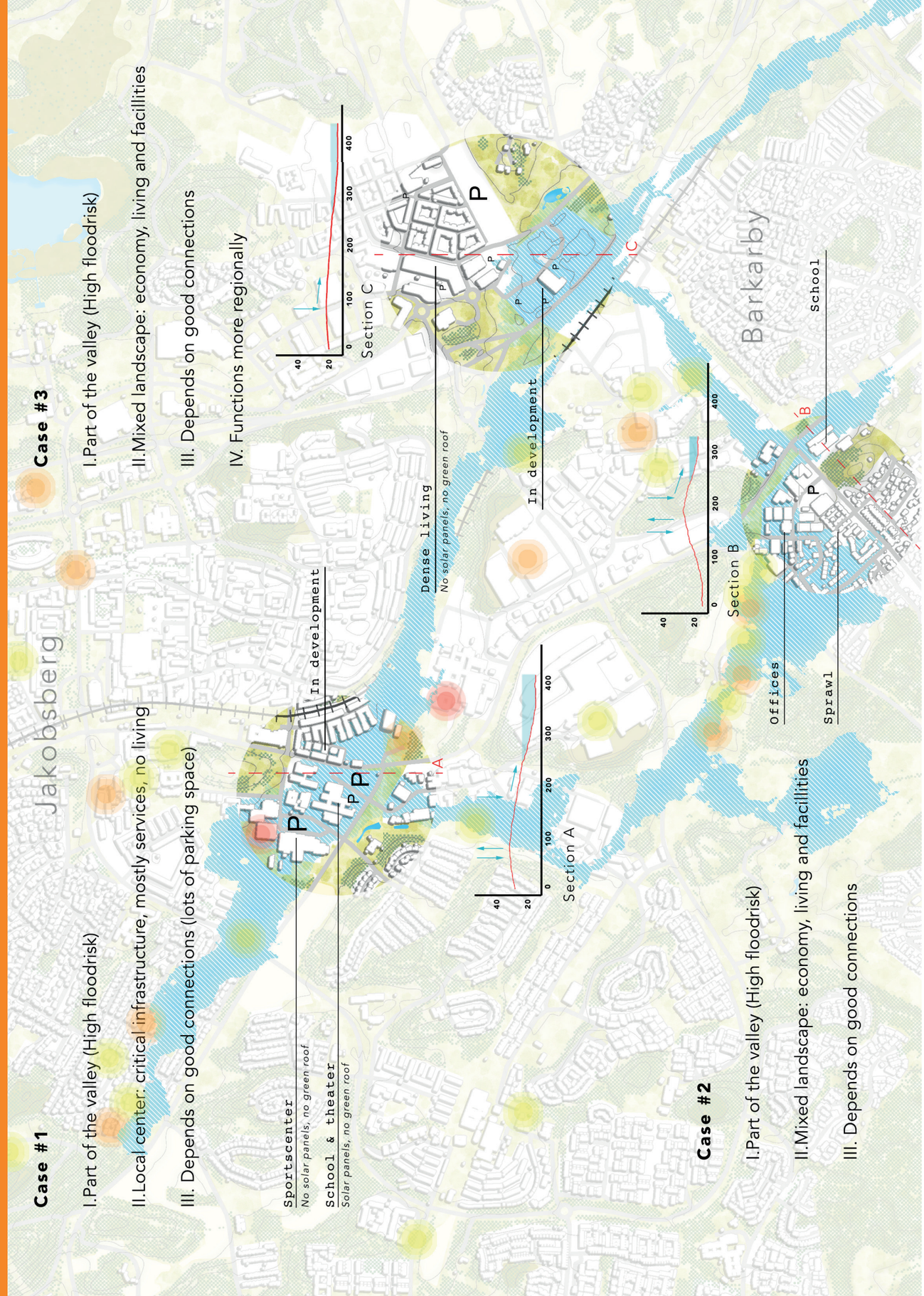
4.2. Through Design Intervention

We advocate for design as a strategic approach in Järfälla due to its potent ability to visualize, shape, and adapt vital processes of change. Design seamlessly translates abstract ideas into tangible spatial opportunities, making the impact of potential interventions immediately visible. This approach excels at bridging different scales, enabling intelligent interventions at the local level to resonate across regional contexts and vice versa. Its inherent integrative capacity emerges from a continuous interplay across policy domains, stakeholder interests, and various constraints.

In alignment with this strategy, we propose strategically planning and designing three specific high-risk areas in Järfälla to address identified challenges. These spaces will be crafted contextually, integrating human needs and infrastructure with nuanced water management and conservation measures. Building on Watson and Adams' perspective (2009), our approach emphasizes that water management and flooding can extend benefits beyond conventional outcomes. We prioritize the combination of functionality and aesthetics in implementing measures, achieved through the integration of urban planning, ecology, and landscape design for a comprehensive and visually pleasing solution.

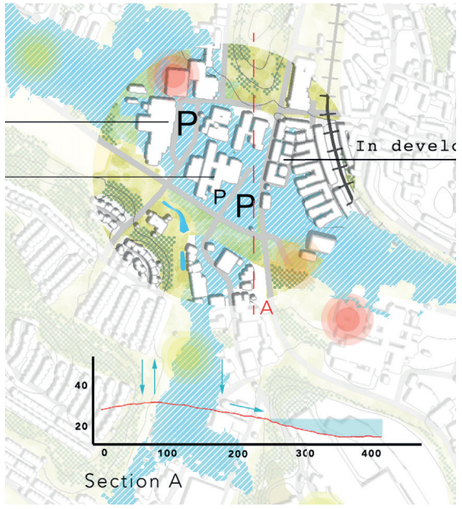
Following this, we have developed a comprehensive composition to overlay the diverse challenges. Notably, three specific locations have emerged as focal points from our analysis, deserving special attention. Aligning with our design-centric strategy, these areas will undergo meticulous planning and design interventions.

**All maps are made by ourselves through QGIS and ArcGis software and where finished in layout programs*



4.2.1. Case 1: A community-center

Case one can be categorized as a community center in terms of being a crucial place of facilities and amenities for the municipality. Gymnasiums, primary schools, theaters, sports facilities, and restaurants are all located there. All these facilities bring the need for easy accessibility and lots of parking spaces as well. However, this area lies in both flash-flood risk and waterbody-flood risk. Furthermore, it is indicated as a heat island on the drought and heatmap. Not to mention the severe soil contamination. Although the area lies in Järfälla's valley, which was indicated as an ecological corridor on the översikt plan, the infrastructure around it blocks the possibility of really creating a smooth ecological passage. Across the street, the SAAB factory and offices lie. SAAB just announced to move out of Järfälla, leaving a whole piece of land in the heart of the city and the critical water valley empty.



Snapshot comprehensive map

Topview Google Earth

Our overarching objective is to bolster resilience in the designated area without displacing existing human activities. Specifically, in the case of the area surrounding the school, we have developed a comprehensive masterplan that incorporates a multifaceted approach. This involves reorganizing the space by removing non-essential structures such as streets and parking lots and replacing them with bike infrastructure and pedestrian pathways. We are introducing vegetation to enhance greenery, employing bioremediation techniques to improve soil quality, and creating multifunctional spaces such as football fields and agroforestry areas.

Addressing water management, we have implemented a versatile water system that operates at both micro and meso scales. Decentralized water bodies have been strategically introduced, while the underground ballstaan has been expanded to accommodate a larger central water feature. This integrated approach not only enhances the resilience of the area to environmental challenges but also contributes positively to the overall well-being and functionality of the community, ensuring a harmonious coexistence of human activities and environmental sustainability.

1. Decrease soil-sealing

To reduce soil-sealing, we employ criteria for assessing sealed infrastructure maintenance. We prioritize functionality, considering the essential roles of structures in community well-being and connectivity, and evaluate economic impact, weighing the cost-effectiveness of alternatives. Environmental considerations focus on minimizing negative impacts, while community input provides insights into local perspectives. Urban design and aesthetics are crucial, emphasizing alternatives that enhance visual appeal and sustainability. In the plan we chose to drastically reduce the amount of sealed space by chosing for a new mobility plan that choses to promote biking.

2. Install vegetation

As the second step in our strategy, we focus on installing vegetation strategically to enhance waterproofing in targeted areas. This involves planning green infrastructure, selecting appropriate native vegetation, and implementing permeable surfaces and green roofs to reduce runoff. Due to the unsealed surface new vegetation can be installed in the plan.

3. Start bioremediation

In the next step we implement bioremediation, utilizing microorganisms, plants, and their enzymes to transform or degrade contaminants in soil and water (Barbato and Reynolds, 2021).

Our chosen approach, "biotransformation," not only reduces pollutant concentrations but also modifies compounds, aiding in ecosystem restoration (Sharma, 2020). Specifically, we adopt in situ phytoremediation, using plants like fast-growing poplar and willow trees, sunflowers, Indian mustard, water hyacinth, alfalfa, vetiver grass, and bamboo. This eco-friendly method minimizes soil disturbances, efficiently removing, degrading, or stabilizing pollutants. Phytoremediation, with its diverse plant options, is a cost-effective and environmentally friendly choice for our remediation efforts, contributing to the overall sustainability of the project. In the plan the bioremidiation process focusses on the centerright area where the football fields where. By giving them a new location, the chemical contamination (Järfälla Kommun 2019) can finally be solved.

4. Give space to water

In the fourth step of our strategy, we prioritize creating space for water. This involves preserving natural flow corridors (Bällstaan), designating decentralised retention areas and wetlands, integrating permeable surfaces, implementing green infrastructure along water bodies, and promoting the naturalization of riverbanks and floodplains. These measures aim to mitigate flooding, support groundwater recharge, and enhance water resilience. Sustainable Urban Drainage Systems (SUDS) and community engagement initiatives for water stewardship complement the strategy (Hoyer, 2010).

Furthermore the location of the decentralised waterbodies where carefully chosen. One of them is placed strategic to store the contaminated run-offs around the contaminated area. The Bällstaan can now be finally transformed into a proper water-body and by offering enough space, meandering processes can be created. This creates new biotopes and also cleanes the water from contaminations.

5. Install argoforestry

In the fifth step of our strategy, guided by Wolde (2015), we implement agroforestry principles to optimize water collection and enhance the ecosystem. This involves creating water-harvesting agroforestry systems, combining tree and crop species for multi-functional land use. The integration of windbreaks and erosion control enhances soil health, while promoting biodiversity supports ecosystem resilience.

6. Sustainable mobility

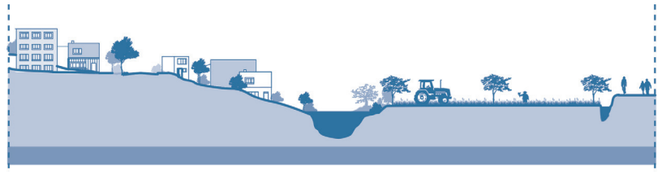
In the next step we proceed with the installation of bike and walking infrastructure, acknowledging the importance of essential car and bus mobility for school buses, transport, and logistics. This involves creating dedicated paths and facilities to encourage cycling and walking, fostering sustainable transportation choices. By integrating these initiatives, we aim to enhance connectivity and reduce environmental impact while recognizing the continued necessity of essential vehicular mobility for specific functions such as school transportation and logistics within the project area.

7. Make buildings multifunctional

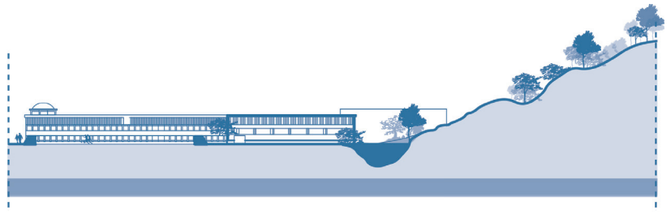
In our final step, we focus on optimizing the surface of buildings by integrating multifunctional elements such as green roofs. This involves incorporating agriculture and other practices beneficial for water management. Green roofs not only enhance aesthetics but also contribute to water retention, improve insulation, and support urban agriculture. This multifaceted approach aims to maximize the positive impact on water resilience while making efficient use of available space for sustainable and environmentally friendly practices.

General masterplan ^N

100 m



Section 1

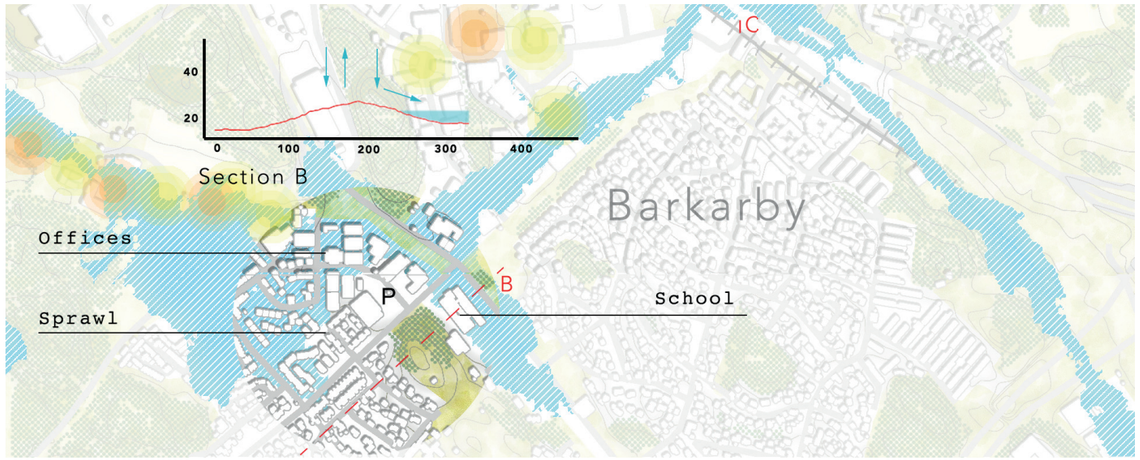


Section 2

Water-harvesting plan ^N

4.2.2. Case 2: A mixed-use landscape

Case 2 is a typical endpoint for daily commuting, characterized from our analysis with a mixed-use nature that encompasses three primary landscapes: housing, services, and education/recreational spaces. Within this area, a variety of productive service buildings, including storage facilities, factories, and small businesses, coexist alongside significant features such as Björkebyskolan, the main school in Veddesta, and an adjacent green space dedicated to golf with Viksjö Golfklubb.



Snapshot comprehensive map

Additionally, Case 2 presents another layer of complexity, with conflicting interests between developers and the municipality. The land across the school was sold to private developers, however, the municipality does not allow them to build there, as the land is vulnerable to flooding. This conflict underscores the challenge of balancing development goals with environmental considerations.

Similar to Case 1, Case 2 faces high vulnerability to the three water challenges outlined in this project. Situated in the valley prone to flooding and extending across the areas where the three water challenges intersect, it makes these design interventions imperative to adopt a comprehensive and multifunctional approach to formulate effective strategies for addressing water-related issues in this location. Recognizing the diverse purposes and interactions within the mixed-use landscape becomes essential in navigating the complexities associated with water management in Case 2.

Besides green infrastructure and nature-based solutions, the strategic design actions proposed for Case 2 are tailored to its unique character. These actions aim to address the mixed-use nature of the area, conflicting interests, and the susceptibility to water challenges:

1. Mixed-use zoning regulations

Due to a mixed-use of land in this area, special attention should be place to zoning regulations. These should be implemented in order to prioritze mixed-use developments while also considering the susceptibility to flooding. This can involve creating specific guidelines for construction and land use to minimize the impact on water vulnerability.

2. Flood-Resilient Infrastructure

Design and advanced infrastructure to face potential flooding, which can include structures such as elevated building designs, flood barriers, and water-resistant materials. This approach should ensure that essential structures for daily life in the city remain operational during and after extreme weather events.

3. Collaborative Planning and Design Workshops

A joint effort should be induce by involving different kinds of actors like developers, municipality representatives, environmental experts, and community members to think up design solutions that balance development goals with environmental considerations. This collaborative approach can lead to innovative and mutually beneficial strategies.

4. Green corridors and buffer zones

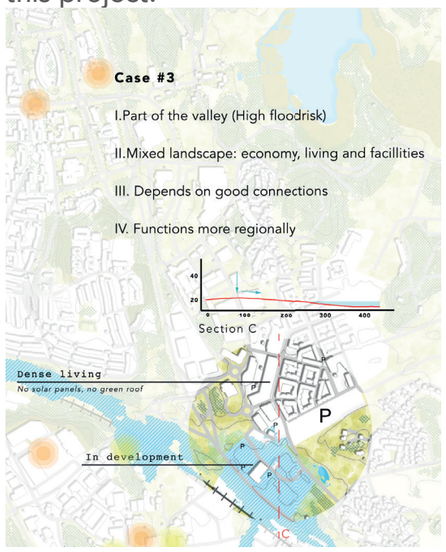
As part of a masterplan, green corridors and buffer zones should be provided. These areas should be located along waterways to provide a natural barrier against flooding. Moreover, these areas can have a multifunctional nature that can serve as recreational spaces or posses other qualities that can both be benefitial for the community and contribute to the overall resilience of the ecosystem.

5. Adaptive land use planning

Develop a flexible land use plan that adapts to recurrent changing environmental conditions. This plan should involve the identification of areas more suitable for development and those better preserved for their ecological value, considering the shifting dynamics of water challenges in the future.

4.2.3. Case 3: A new development, Barkarbystaden

Case 3 focuses on Barkarbystaden, where water management and conservation have been incorporated in specific areas. However, the overall approach to water in this region appears to lean towards an artificial method rather than adopting a nature-based strategy. Similar to the preceding cases, Barkarbystaden is situated in Järfälla's valley and faces vulnerability to the three challenges identified in this project.



Snapshot comprehensive map

One prominent concern is the presence of sulfide soils, leading to the formation of acidic sulfate soils in certain areas. This often results in periodic negative effects on the water chemistry of waterways, with high metal concentrations and low pH potentially causing fish mortality, exemplified by the Bällstaån in Barkarbystaden. During droughts, low water levels can expose the acidic sulfate soils to surface air, leading to oxidation and sulfate creation, resulting in active acid sulfate soil.

Subsequent heavy rainfall can activate environmentally harmful metals, impacting the surrounding environment.

To address this, it becomes crucial to regulate the flow of Bällstaån, ensuring a consistent, steady water flow. The municipality attempts to mitigate the issue by artificially meandering the river to slow down water flow. However, due to limited space resulting from surrounding developments, the meandering is not sufficient. Ongoing investigations in Sweden and Finland explore artificial methods to maintain groundwater levels during drought periods through regulated drainage, aiming to prevent further exposure of potential acid sulfate soils.

An alternative solution involves restoring wetlands, as many cases of sulfate soil formation occur in areas where groundwater levels have been lowered for construction or farming. These areas would otherwise naturally function as wetlands, potentially reducing the impact of active acid sulfate soils. This restoration approach extends to ditches or other non-productive lands, emphasizing a nature-based strategy for long-term water management in Barkarbystaden.

To enhance water resilience in Barkarbystaden, a nature-based approach is proposed to address its unique challenges associated mainly with sulfide soils and the vulnerability to the three identified water challenges. The design actions are tailored to harmonize with the ecological characteristics of the region:

1. Wetland restoration and creation

Design a comprehensive wetland restoration program in areas susceptible to sulfate soil formation. This involves restoring natural wetland features and creating new wetlands where groundwater levels have been altered due to construction, farming activities or any other nature.

2. Eco-friendly river banks stabilization

Utilize eco-friendly methods for river banks stabilization, incorporating natural materials and vegetation to prevent erosion. These types of approaches contribute to maintaining a stable river ecosystem, reducing the risk of harmful metal activation during heavy rainfall.

3. Regulated drainage systems

Research should be done to further design and implement regulated drainage systems to maintain groundwater levels during droughts. This solution, despite being artificial is a strategic intervention that can help prevent further exposure of potential acid sulfate soils, ensuring the long-term health of other ecosystems.

4. Strategic meandering enhancement

Enhance the artificial meandering of the river by optimizing its design and alignment providing more space for water and other activities. This involves designating decentralised retention areas and wetlands, integrating permeable surfaces, implementing green infrastructure along water bodies, and promoting the naturalization of riverbanks and floodplains.

5. Phytoremediation initiatives

Introduce phytoremediation initiatives, using plants to absorb and neutralize contaminants in the soil. This can be particularly effective in areas with high metal concentrations, contributing to the overall improvement of water quality.

6. Monitoring plans

Establish a long-term monitoring program to assess the effectiveness of implemented measures in water management overall. This adaptive management approach allows for continuous adjustments based on the evolving conditions and ensures the sustained success of nature-based interventions around the intervened areas and its adjacent ones.

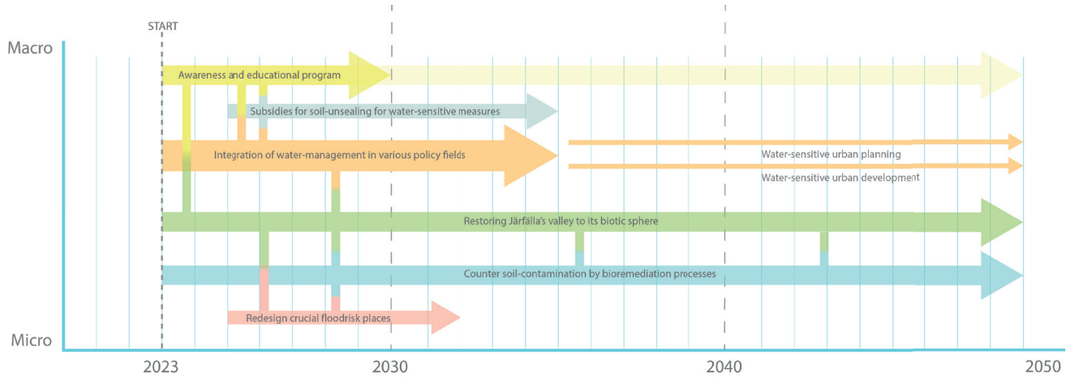
4.3. Timeline

Our meticulously planned implementation timeline unfolds with a strategic choreography. It initiates with a focus on education to lay the groundwork for heightened awareness among the community. This educational phase serves as a crucial foundation, aiming to instill a deep understanding of water challenges, sustainable practices, and the significance of resilience.

Following the educational phase, our implementation progresses seamlessly into the financial program. This stage involves the allocation of resources and funding to support initiatives that address water-related issues comprehensively. It underscores our commitment to translating knowledge into actionable projects, ensuring that the financial aspects are aligned with the identified needs and goals.

The final stage of our choreographed timeline involves design projects. Building on the knowledge imparted through education and supported by the financial program, these projects aim to manifest practical solutions and interventions. Whether in the form of infrastructural developments, policy implementations, or community engagement initiatives, the design projects are crafted to be dynamic and adaptable to the unique challenges of Järfälla.

By orchestrating our implementation in this thoughtful sequence, we envision Järfälla evolving into a truly water-resilient community. The synergy between education, financial commitment, and design endeavors creates a holistic and sustainable approach, fostering a community that is not only aware of water issues but actively engaged in resilient practices.



A multi-strategy for water-resillience

Timeline for implementation of the water-resilience plan, made by ourselves

6. Conclusion

Climate change certainly will make extreme weather events more common, however we should not underestimate our ability to plan our cities in a way they can become resilient towards this. By implementing this proposal, we hope to change the narrative surrounding urban water management and strengthen Järfälla's water resilience. The proposal proposes a variety of strategies and their corresponding actions, as well as design proposals for putting the strategies into practice. The diversity in strategy exists to create a comprehensive strategy that addresses multiple issues at once and can be applied to many different areas of the municipality. This is necessary because water resilience is a complex challenge that goes beyond site-specific measurements and necessitates changing the narrative of water management from artificial solutions such as traditional drainage systems to water-sensitive designs inspired by nature. Doing so will help to restore the natural water cycle, which addresses the three challenges of droughts, flooding, and contamination of water sources.

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