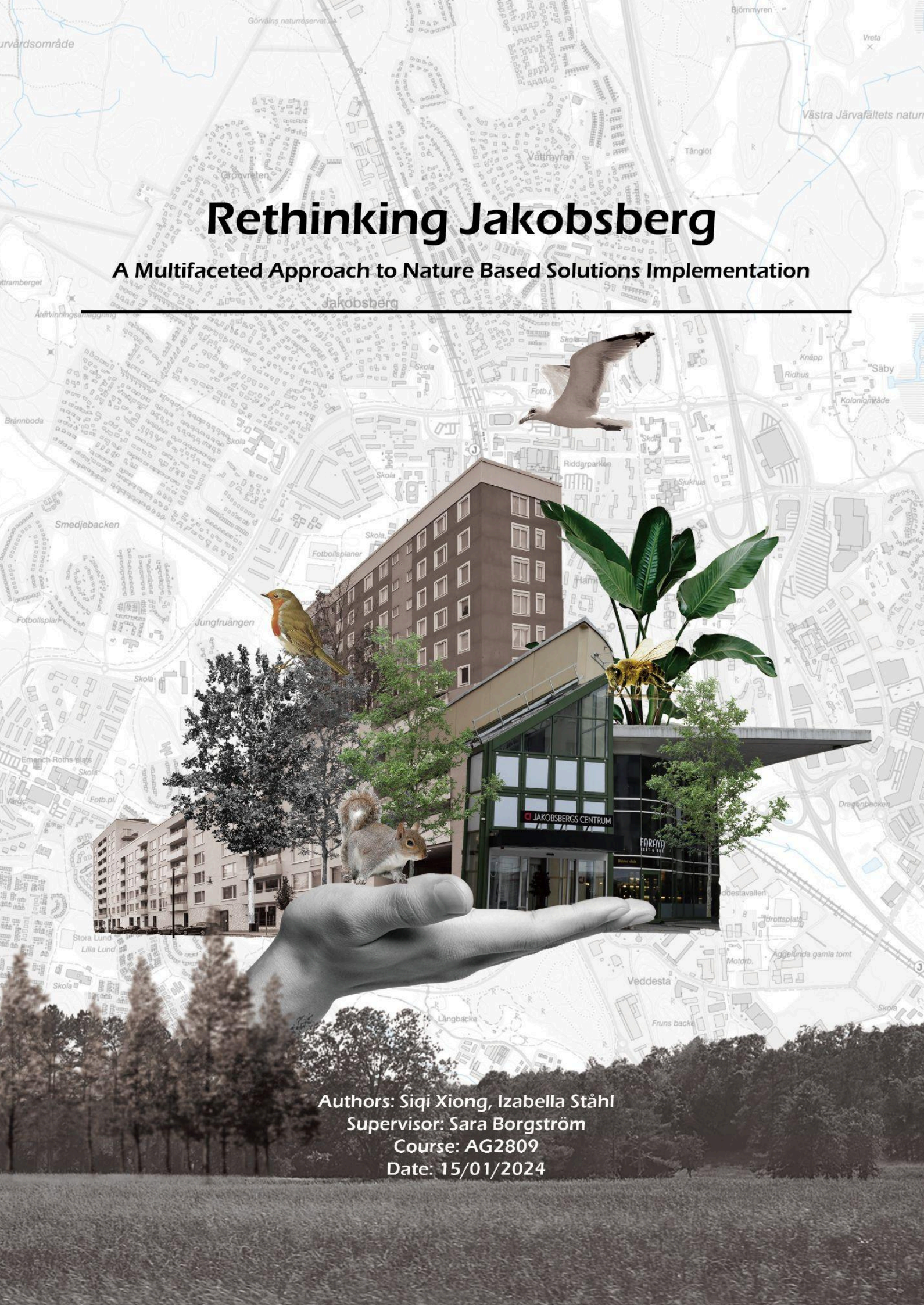
Rethinking Jakobsberg

A Multifaceted Approach to Nature Based Solutions Implementation



Authors: Siqi Xiong, Izabella Ståhl
Supervisor: Sara Borgström
Course: AG2809
Date: 15/01/2024

Abstract

Due to climate change cities will face challenges such as heat stress, flooding and biodiversity loss. A possible way to mitigate these challenges is to retrofit Nature Based Solutions (NBS). This project was conducted in the Autumn term of 2023 at KTH in liaison with Järfälla municipality. The aim of the project was to explore how NBS are currently used in the municipality in Jakobsberg, what NBS could be added to mitigate challenges created by climate change, and finally to explore the perspective of citizens living in Jakobsberg. These three aspects were assessed using a multi-modal methodology. Firstly, looking at previous research on how NBS can be implemented to help the urban adaptation to climate change. Secondly, a site visit was conducted to better grasp the implementation of NBS in Jakobsberg. Thirdly, a policy analysis was conducted in order to assess how the municipality was using NBS in Jakobsberg and Järfälla. Finally, a Facebook survey was conducted in order to collect the perspectives of people living in Jakobsberg. The results showed that NBS played a focal role in some of the municipal plans, yet that there was a gap with implementation and citizen expectations. We suggested that this could be remedied with the application of other types of NBS as suggested by citizens and previous literature. Citizen involvement in both the planning process and the implementation and maintenance of NBS was also found to be a possible source of community engagement that could be better utilised by the municipality. As a final note, Jakobsberg and Järfälla seem to have nature at the heart of their policy, and the citizens were very clear that nature is an integral part of their home. By using NBS the municipality could better protect nature crucial to Jakosberg, while also benefiting the citizens living there, creating an urban area where humans and non-humans thrive alike.

Sammanfattning

På grund av klimatförändringar kommer städer att ställas inför utmaningar som värmebelastning, översvämningar och förlust av biologisk mångfald. Ett möjligt sätt att mildra dessa utmaningar är att uppgradera naturbaserade lösningar (NBS). Detta projekt genomfördes under höstterminen 2023 på KTH i samarbete med Järfälla kommun. Målet med projektet var att utforska hur NBS för närvarande används i kommunen i Jakobsberg, vilka NBS som kunde läggas till för att mildra utmaningar skapade av klimatförändringar och slutligen undersöka medborgarnas perspektiv som bor i Jakobsberg. Dessa tre aspekter utvärderades med hjälp av en multimodal metodologi. För det första undersöktes tidigare forskning om hur NBS kan implementeras för att hjälpa stadsanpassningen till klimatförändringar. För det andra genomfördes ett platsbesök för att bättre förstå implementeringen av NBS i Jakobsberg. För det tredje genomfördes en policyanalys för att bedöma hur kommunen använde NBS i Jakobsberg och Järfälla. Slutligen genomfördes en Facebook-undersökning för att samla in perspektiv från personer som bor i Jakobsberg. Resultatet visade att NBS spelade en central roll i vissa av kommunens planer, men att det fanns en klyfta mellan implementering och medborgarnas förväntningar. Vi föreslog att detta kunde åtgärdas med tillämpningen av andra typer av NBS som föreslagits av medborgare och tidigare litteratur. Medborgardeltagande både i planeringsprocessen och implementeringen och underhållet av NBS visade sig också vara en möjlig källa till samhällsengagemang som kunde utnyttjas bättre av kommunen. Som en sista anteckning verkar Jakobsberg och Järfälla ha naturen i centrum för sin politik, och medborgarna var mycket tydliga med att naturen är en integrerad del av deras hem. Genom att använda NBS skulle kommunen kunna skydda naturen som är avgörande för Jakobsberg och samtidigt gynna medborgarna där, och skapa ett urbant område där både människor och icke-människor trivs.

Table of Contents:

1. Introduction

The modern city is plagued with challenges, which will intensify with the increased pressures of further urbanisation and climate change. Across the world, cities are responsible for 70% of the global waste production, 60% of the global energy consumption, and 75% of the global green-house gas emissions (O'Sullivan et al., 2020). Concurrently, many cities are already facing the effects of increasingly severe weather events, such as flooding, drought, wildfires, and mudslides caused by heavy rains (Bai et al., 2018). In many cases, these events are further intensified by how the city is built, with impermeable ground increasing the risks of flooding, mass-use of concrete and high building densities creating heat island effects, and air pollution causing heavier rains (ibid.). In the case of Järfälla and specifically Jakobsberg, NBS will be investigated regarding how the implementation of certain ecosystem-related approaches assuage the challenges of urbanisation. In this project NBS relieving the impact of issues brought about by climate change, such as heat stress, flooding, and biodiversity loss will be assessed in order to show how NBS can be used as a solution to the encroaching environmental issues the future holds for Jakobsberg, an urban area in Järfälla municipality, in north-western Stockholm, Sweden. The following section will primarily focus on describing the challenges of Urban Heat Islands effects, flooding, and finally with biodiversity loss in the urban areas, and then find ways to navigate these challenges and find solutions through NBS.

Initial investigations and discussions with Järfälla municipality have shown a lack of urban greenery in Jakobsberg. These insufficiencies have given rise to pressing issues, such as heat islands and urban flooding, which are particularly concentrated in the Jakobsberg area. As a result, we believe that this city district necessitates the retrofitting of Nature-Based Solutions (NBS) to help alleviate the impact of climate change and rapid urbanisation. Moreover, there is potential to utilise NBS as a multifunctional solution, capable of mitigating the aforementioned stresses while concurrently enhancing Ecosystem Services (ES) in the area. Additionally, we aim to understand the opinions of the residents in the area regarding NBS. Therefore, the intention is to explore NBS from the citizens' perspective and gain insights into how their views are related to official viewpoints. This project will assess the urban parts of Jakobsberg, as shown on map 1.

1.1 Aim and Research Questions

The aim of this project will be to bridge the gap between the citizens and city planners in Jakobsberg by addressing possibilities pertaining to the implementation of NBS in existing urban areas. Through a place-based case study and a literature review, as well as a citizen survey and an assessment of the municipality's current policies, we will identify areas requiring NBS. Ultimately, we plan to show how NBS can act as a multifunctional solution to tackle some of the municipality's issues in the wake of climate change and the pressures of increased urbanisation.

- What is the current status of NBS in Jakobsberg?
- What NBS would be necessary to implement in Jakobsberg in regards to mitigating UHI effect, flooding and biodiversity?
- What is the public opinion of NBS in Jakobsberg, and do the public feel involved in the planning process?

Map 1. Study area

2. Background

Situated in the north-west of Stockholm county, Järfälla municipality stands as a nature-rich, growing municipality with many challenges to tackle in its future. Currently, the municipality has 87 928 residents, and by 2037 the municipality will grow to 117 120 residents (Statisticon, 2023). A central part of Järfälla is Jakobsberg, home to 20 845 of Järfälla's residents (Statistics Sweden, 2022). Jakobsberg is a heavily urbanised area, and is crucial for the municipal plans regarding the future growth of the municipality (Järfälla Municipality, 2015, 4). Jakobsberg is also essential for the polycentric urban development plans in Stockholm County, being named as one of the eight regional city centres in RUFS 2010 (ibid). The municipality and the County anticipate an unprecedented increase in residents, and this burgeoning growth poses sustainability challenges that need to be faced, especially in the wake of future challenges associated with climate change. During a meeting with Järfälla municipality, it became clear that the municipality will face challenges brought about by the past unsustainable planning of urban areas, particularly in Jakobsberg. These challenges were primarily heat stress and flooding, yet it became clear through further research that ecosystem services and biodiversity were also important to the municipal plans for the future. Thus, further investigation into UHI effect, flooding, and biodiversity loss are required to understand how NBS can be implemented to mitigate the municipality's current challenges.

2.1 Urban Heat Islands (UHI)

UHIs, a pressing concern for many cities across the planet. UHI are characterised by higher temperatures in urbanised areas, particularly heavily concreted areas, compared to their less-urbanised counterparts (Marando et al., 2022). The effect of the UHI is likely to worsen with climate change, as the frequency and intensity of heat waves will increase (Milliken, 2018). UHIs pose a significant risk to public health (Marando *et al.*, 2022), primarily affecting the older citizens of cities. In some European cities, the UHI effect is manifested by an extra 10-15 °C in the city centres compared to surrounding urban areas (Joint Research Centre, 2022).

Järfälla municipality, and Jakobsberg, are also predicted to be affected by heatwaves in the future (Järfälla Municipality, 2022, 21). According to the municipality, heatwaves will affect residents in multiple ways (Järfälla Municipality, 2022, 13). Heatwaves are predicted to decrease the amount of drinking water available to residents according to the municipality, as well as threaten the health of the residents that are fragile, such as the elderly and children (ibid). Furthermore, many of the buildings in the municipality are not capable of protecting against hot temperatures, which will especially be an issue in schools (ibid). Extreme temperatures can also affect the recreational abilities of residents, particularly children (ibid). In Järfälla, the urban areas that are more dense will be more adversely affected than other areas in the municipality, this includes Jakobsberg. Significant increases in mortality occur after just a few days where the median temperature is between 22-23 degrees (Järfälla Municipality 2022, 20). Some of the areas of Järfälla, including Jakobsberg, have already seen extreme temperatures, an effect that is expected to worsen in the future (ibid), see figure 1 for a visual representation. Since urban areas tend to be significantly more populated, this puts a great deal of the population at risk. Many of these urban areas are already substantially built up, and there may be little room to mitigate these awaited changes. Thus, NBS could be a way to help create more resilience against the heatwaves, something that could potentially save lives and increase the well-being of Jakobsberg's residents.

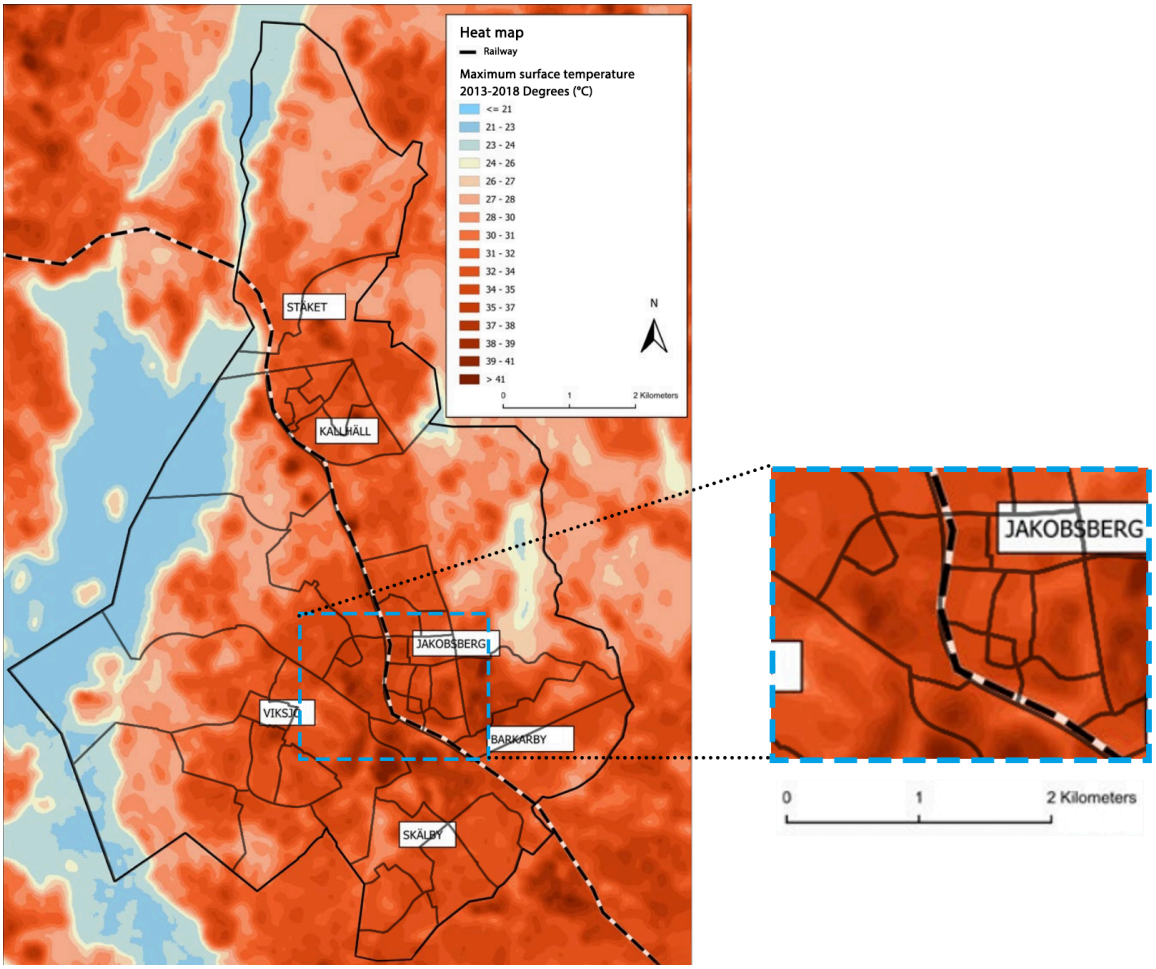


Fig. 1 Heat mapping of Järfälla municipality between 2013-2018 (Järfälla Municipality, 2022, 21)

2.2 Flooding

As the climate crisis worsens and extreme weather becomes more frequent, severe rainfall events will wreak havoc on cities, leaving many urban areas open to the effects and damages of flooding (European Commission, n.d.). Flooding is perhaps one of the most devastating natural phenomena to affect cities (Mabrouk et al., 2023). Flooding also disproportionately affects areas with a lower socio-economic status, and cities in developing countries (ibid). There are different types of flooding. The type of flooding that is caused by increased rainfall is called pluvial flooding. It is estimated that the cumulative damage from pluvial flooding is just as much as fluvial flooding (river or tidal flooding), and it is primarily caused by a lack of sufficient infrastructure (Prokić et al., 2019). Insufficient sewage systems, poor drainage systems, and inadequate channels to water drainage basements and water bodies are primarily the cause, as well as the increased risk for extreme rainfall events that will be brought on by climate change (ibid). This type of flooding has the potential to be mitigated, helping cities to become more resilient, and minimising the risk for flood-related expenditure in the future. Flooding and the pollution of water bodies is also an issue for Järfälla municipality. The municipality predicts that flooding could potentially negatively impact transportation, wreak havoc on pump stations, and other traffic infrastructure (Järfälla Municipality, 2022, 10-13). They also predict that flooding could have a large impact on private property, and municipal lands (ibid). The municipality claims that areas that are highly impermeable, as well as areas at lower topographical points will be more susceptible to future flooding (Järfälla Municipality 2022, 16). The areas that are most susceptible to flooding are pictured below, in figure 2. The municipality also outlined that due to flooding there is a risk that water bodies could become polluted, posing risks to both the environment and health of the residents of Järfälla. These include the spreading of pathogens as well as toxic chemicals to watersheds, swimming grounds, pastures, and eventually drinking water (Järfälla Municipality, 2022, 20).

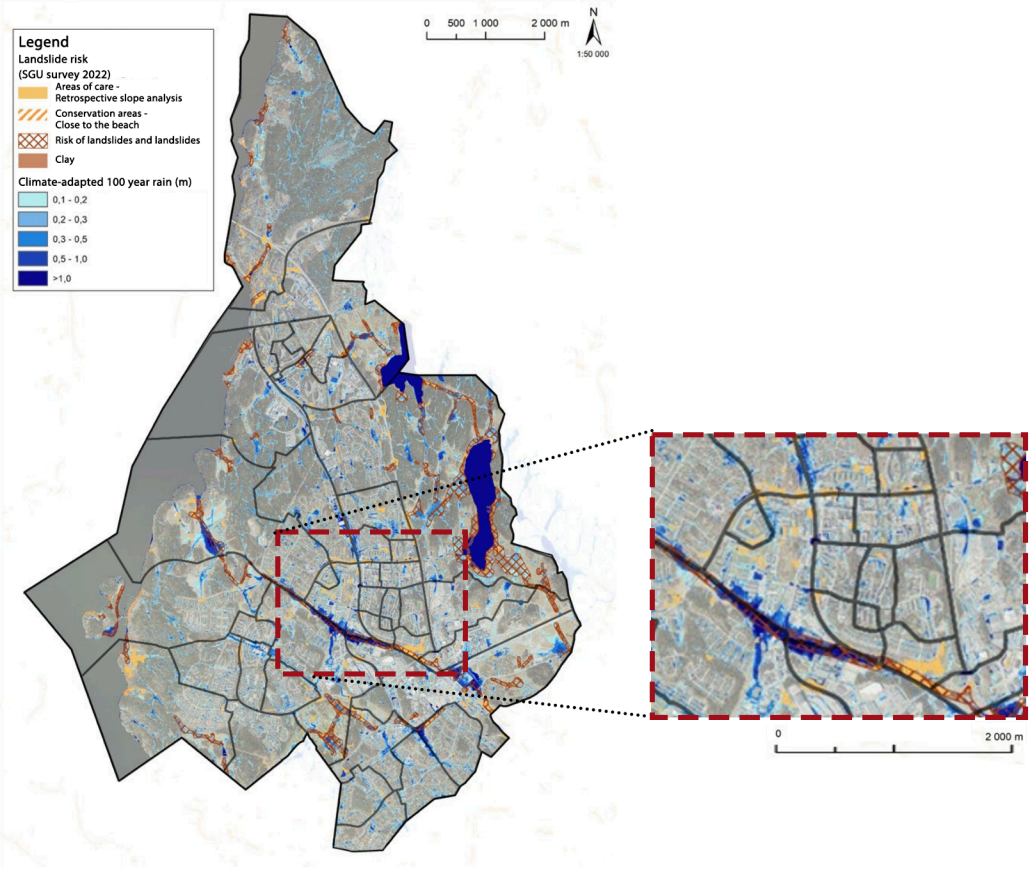


Fig. 2 The risk of flooding and landslides 2022(Järfälla Municipality, 2022, 17).

2.3 Biodiversity Loss and importance of ecosystem services

By 2050, a predicted 9.9 billion people will live on the planet, with an estimated 78% of them living in urban areas (Li et al., 2022). This anthropogenic expansion has led to habitat fragmentation, loss of quality and diversity of ecosystems, and habitat conversions and degradations (ibid). Studies show a 38% loss in species abundance in urban areas, compared to their more rural counterparts (ibid). Moreover, future land expansion will see the loss of 11-33 million hectares of natural habitats by 2100, causing large scale habitat fragmentation and destruction (ibid). This severe habitat fragmentation brings to light a need for urban areas to act as a catalyst for change.

Järfälla municipality has high awareness for nature and its importance to human health and well-being, as well as the intrinsic value of nature. In 2018, 33% of the municipality's total land areas consisted of protected nature reserves, with plans to increase the amount of protected land by 75 hectares by the year 2025 (Ekologigruppen, 2018, 10). Despite a large amount of protected forests, the parks in Järfälla are in need of care specifically directed towards supporting biodiversity (Ekologigruppen, 2018, 24). In the same report, it was suggested that the municipality focus on the maintenance of their key biotopes to protect their current value (Ekologigruppen, 2018, 30). In figure 3 below, the areas with the highest natural values are mapped. In Jakobsberg there are parks with a variation of different natural values, meaning areas of high biodiversity, according to the study by Ekologigruppen these parks should be preserved and better in order to promote more biodiversity. There is potential to increase the amount of parks and the biodiversity in them, helping to bolster the natural values of Jakobsberg and the municipality.

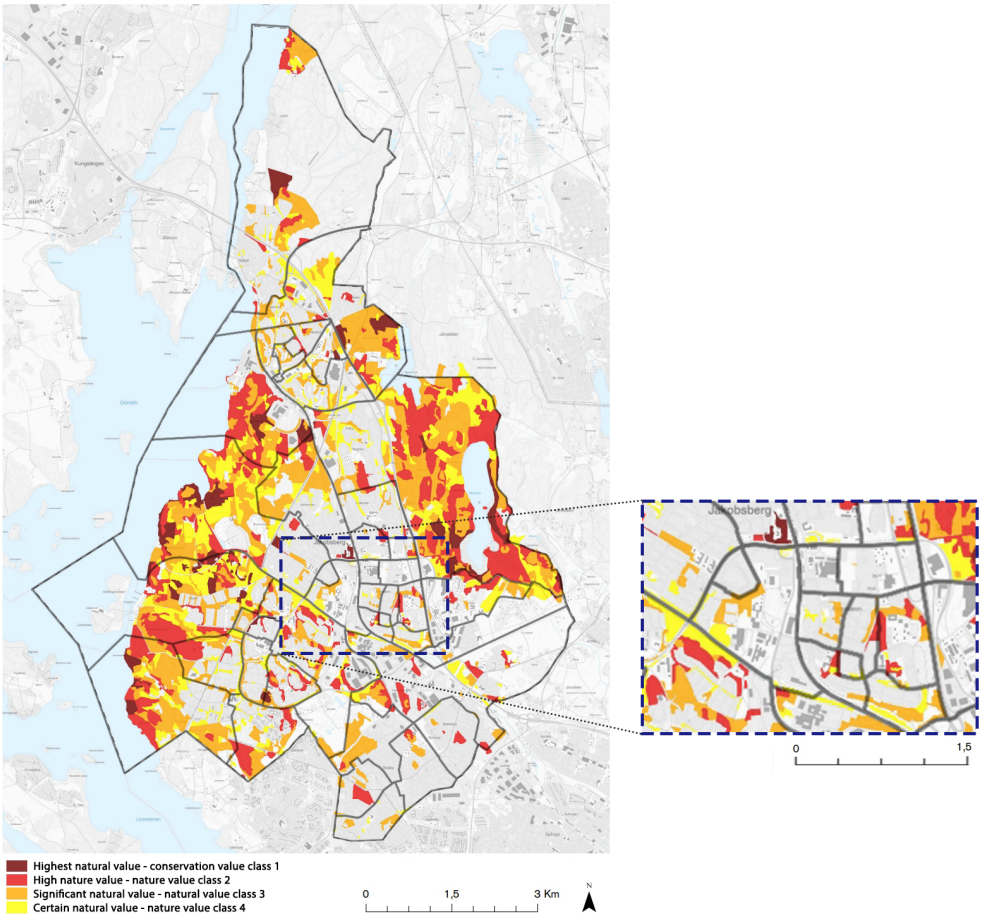


Fig. 3 Mapping of the "natural values" of Järfälla (Ekologigruppen, 2018, 13)

2.4 Nature Based Solutions: a multifunctional solution to multiple urban challenges

Nature Based Solutions as a term has arisen in the attempts to create a more sustainable and resilient future for cities. The idea is based upon how nature can be mobilised to create healthier cities, and incite resilience against climate change and other urban challenges (O'Sullivan et al., 2020). This multifunctional solution is often seen as a panacea to modern urban issues such as climate change, biodiversity loss, the UHI effect, noise pollution mitigation, air pollution, and as a buffer for the risks the future will bring (O'Sullivan et al., 2020; Xing et al., 2017; Therese Fallast et al., 2021). NBS itself is an "umbrella term" (IUCN, 2020, 10), covering multiple other "ecosystem related approaches" such as Green Infrastructure (GI), and Ecosystem Services (ES) (ibid). These approaches ultimately help to alleviate "societal challenges", generating well-being and biodiversity benefits within the urban landscape (ibid).

Owing to the relative newness of the term NBS, there are many definitions that aim to capture the diversity of the concept. Perhaps the most clear being, "NBS are defined as actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and diversity benefits" (IUCN, 2020, 4). Being an umbrella term, NBS covers many solutions that aim to provide a multifunctional solution to the negative impacts that cities and urban areas encounter, especially in the wake of climate change. When it comes to Jakobsberg, these NBS could be used to not only solve each of the individual issues listed above, but they could be put in place as a multifunctional solution to help combat the issues listed, and many more, simultaneously. The next two sections, 2.4.1 and 2.4.2 are compiled from the Swedish Environmental Protection Agency's (Naturvårdsverket) text "Nature-based Solutions' ' written in 2022. "The purpose of this report is to disseminate knowledge and information about nature-based solutions and to offer guidance on how they can be planned and implemented to meet the challenges that a changing climate brings while creating added value" (Swedish Environmental Protection Agency, 2022, 3). The report also provides Swedish examples of NBS, which we thought was pertinent for discussing the case of Jakobsberg.

2.4.1 Examples of NBS in urban environments: Trees and Vegetation

Vegetation in urban areas can act as a multifunctional solution, critical to tackling flooding, heat stress, and biodiversity loss. Parks, individual urban trees, small forested areas, tree allées, gardens, and shrubbery can all be counted as NBS, and can help alleviate the effects of heavy rain falls, provide noise reduction, sustain habitats for increased biodiversity, mitigate UHIs, and help reduce energy consumption as shade is provided, cooling the city (Swedish Environmental Protection Agency, 2022, 96). Not only can they help to support traditional infrastructure in mitigating these issues, the listed NBSs are also essential for human well-being, providing spaces and scenery which allows for relaxation, whilst boosting regulating ecosystem services such as minimising air pollution where people live (ibid).

Strategically placed trees and vegetation in particular can potentially play a large role in heat reduction in cities. Cities are typically covered in paving and tall, concreted buildings. Larger trees provide shade, and block UV radiation from reaching paving and asphalt, inhibiting the sun's ability to heat up urban areas (ibid.). Canopies that are more mature and larger provide the greatest amount of heat reduction, as they typically provide a denser shade (ibid.). In Sweden in particular, deciduous trees are more preferable in the urban environment, and

should be placed where they will have the most benefit to citizens in need, such as the elderly and children (ibid).

Concurrently, trees and vegetation also play a large role in stormwater management. There are multiple ways in which trees can decrease the volume of stormwater in an urban area (Swedish Environmental Protection Agency, 2022, 99). Firstly, the transpiration process of trees absorbs rainwater (ibid), holding the water in the roots, trunks and canopies of the tree. Trees also collect the water on its way down to the ground. The water essentially gets stuck on the leaves, branches, and bark, slowing the descent of the water and lowering the total amount of water on the ground (ibid). Another important role trees play is phytoremediation, where trees and vegetation remove harmful chemicals from the water passing through the ground (ibid).

Besides the direct benefits that trees and vegetation give to human beings, they can also support biodiversity in urban areas (Swedish Environmental Protection Agency, 2022, 96). For example, they can improve the conditions for insect pollination by providing abundant resources such as food and shelter for species like bees and butterflies (Swedish Environmental Protection Agency, 2022, 96; Barth et al., 2015). Research indicates a positive correlation between the number of mature trees preserved within urban streets and the richness and abundance of some species, such as birds (Barth et al., 2015, 127). Scattered trees and vegetation give the living and nesting spaces to birds, and enhance connectivity between fragments of habitats (ibid.).

2.4.2 Examples of NBS in urban environments: Permeable solutions

Increased rainfall is only one aspect of a larger problem when it comes to flooding in urban areas. An excess of impermeable ground increases the flow and volume of water, often overwhelming existing grey infrastructure (Swedish Environmental Protection Agency, 2022, 105). By decreasing the amount of impermeable ground in cities, heavy rains and flooding can be managed more efficiently (ibid). One way to tackle this issue is by increasing the coverage of greenery and vegetation, as aforementioned. However, there are certain aspects of the built environment that cannot be replaced by urban parkland such as roads crucial to transport, parking lots, bicycle lanes, and walking paths (ibid). In this case, technical, engineering-based solutions such as permeable asphalt, permeable paving stones, and gravel surfaces can offer an alternative to impermeable ground cover (ibid).

A city can also be planned to strategically reduce the flow of stormwater by increasing the amount of green roofs and green walls. Not only are these structures efficient in reducing stormwater, they also can decrease the amount of solar radiation soaked up by the building, helping to mitigate heat stress for inhabitants (Swedish Environmental Protection Agency, 2022, 115). Previous studies mentioned that green roofs and green walls can reduce the indoor temperature by up to 3°C, and reduce the stormwater flow from between 25-100% depending on the slant of the building (ibid). Solutions such as these can help to decrease flow of stormwater, an essential solution to decreasing the risk for flooding.

NBS as a term, as previously defined, are not just solutions to singular problems. When applied with careful thought and proper planning, these solutions can help to create a buffer against many issues, working as a multifunctional way to adapt cities to changing climates and improve the health and well-being of citizens. There are a plethora of NBS, the solutions covered above are only a fraction of what they have to offer. In figure 4 below is an image produced by Naturvårdsverket showing how many solutions can be used to create a city that

tackles multiple issues at once. Moreover, the fundamental point is that these solutions should be used in synergy with each other as a way to tackle problems in a resource-effective approach.

Fig. 4 A vision of NBS (Swedish Environmental Protection Agency, 2022, 94)

2.4.3 Limitations of NBS

While NBS seem to have plenty of benefits, they still have challenges. One key concern is the potential obstruction of visibility by plants, which raises safety concerns (Nasar & Jones, 1997, 316). Another challenge is the efficacy of NBS is tied to the seasonal lifecycle of vegetation. Given the climate conditions in Sweden, there is notable reduction in the effectiveness of these solutions during the winters. Moreover, the implementation of NBS requires substantial resources, which brings a challenge for the municipality's finances.In addition, measures within urban areas need sustained, long-term maintenance. This ongoing commitment not only entails continuous financial investment but also needs dedicated power and strategic planning to ensure the enduring efficacy and viability of these ecological interventions

2.5 Importance of public participation

The NBS criteria as developed by the IUCN advocate for NBS to be predicated on governance processes that are inclusive, transparent, and empowering (IUCN, 2020). This necessitates the involvement of stakeholders in a collaborative manner throughout the solution's lifecycle. The achievement of sustainable development requires effective communication across various governance levels, and extensive stakeholder involvement in decision-making processes at every level (Arlati et al., 2021), with a particular emphasis on citizens who embody local knowledge. Therefore, the involvement of citizens is indispensable in the NBS framework.

Citizen involvement is not merely essential; it plays a significant role in the efficacy of NBS, offering multiple benefits. The incorporation of citizens in interdisciplinary governance processes is recognised for enhancing the relevance, acceptance, equity and consequently, the sustainability of these initiatives (Kiss et al., 2022). Research by Baycan-Levent and Nijkamp (2009), after interviewing departments in 23 European cities, reveals that insufficient citizen participation correlates with diminished success in green space planning. Similarly, Sarabi et al. (2019) found that citizens can substantially elevate the success probability of NBS by ensuring adaptability to specific contexts through their local knowledge. Furthermore, they highlighted that collaborative, face-to-face interactions and open dialogues amplify citizens' acceptance of NBS (ibid.). Engaging citizens in projects instils a sense of ownership and belonging, invigorating their civic identity (Puskás et al., 2021). Although the nexus between citizen participation in NBS and environmental and social sustainability outcomes is not always straightforward, participation itself is a method to ensure social equity (Kiss et al., 2022).

3. Methodology

Several methods have been chosen for data collection and the collected data sets were then triangulated to assess the research questions of this project. Firstly, a site visit was conducted to grasp a better understanding of the area and also to make observations from the perspective of researchers. Then, a review of several policy documents from Järfälla municipality was conducted to understand the municipality's position on planning in regards to NBS. After that, a literature review of academic literature was conducted, allowing for a better understanding of how NBS can help to mitigate heat stress, flooding, and biodiversity loss through looking at cases in the Clever Cities project. Finally, a Facebook survey was conducted to be able to understand the viewpoints of the Järfälla citizens regarding NBS and green areas near them.

3.1 Literature Study

In order to make an assessment on the NBS plans and the observations, we need to know what constitutes a successful plan, especially in Sweden. What types of NBS would work in Jakobsberg? What strategies around NBS have worked in the past? Thus, a literature study was conducted. This study primarily focused on the results of searches done on SCOPUS. Searches were conducted to first find specific information about NBS, then to find information about retrofitting NBS and the environmental benefits of these solutions. Then searches such as "Heat stress/flooding/biodiversity" AND "NBS" were conducted. The literature was then synthesised to create an understanding of the topic, highlighting how NBS can be a solution to the sustainability issues of Järfälla municipality. We then used the examples from the Clever Cities project as cases, as well as from some other studies, to further exemplify ways in which NBS can be used in cities, and what effects they can have. Clever Cities was a major project conducted within the European Horizon 2020 program 2013-2017 and it assesses how NBS can mitigate environmental challenges in cities ((Horn et al., 2023, 6). We chose to primarily use this document as it was a comprehensive study conducted with 27 partners, spanning over 13 European countries. The European perspective was seen as relevant to the case of Järfälla and Jakobsberg.

3.2 Site visit

A site visit was made to Jakobsberg on the morning of 26th of October 2023, as on-site assessments are valuable for evaluating site quality and gathering information about the area (Lawrenz et al., 2003). The main purposes of this site visit was to conduct superficial investigation of the current state of green-blue infrastructure in Jakobsberg or the lack thereof, collecting information on their types, distributions, forms and other relevant aspects. As Patton (2015) emphasised, a deeper understanding of an area could be achieved through an in-depth on-site exploration, attentive observation and systematic recording of occurring events. The visit started at Jakobsberg centrum and the residential area of Jakobsberg was explored on foot and followed the path mapped in Fig.5. Key points along the route were marked and photographed, which the following analysis was based on, along with the observations during the visit.

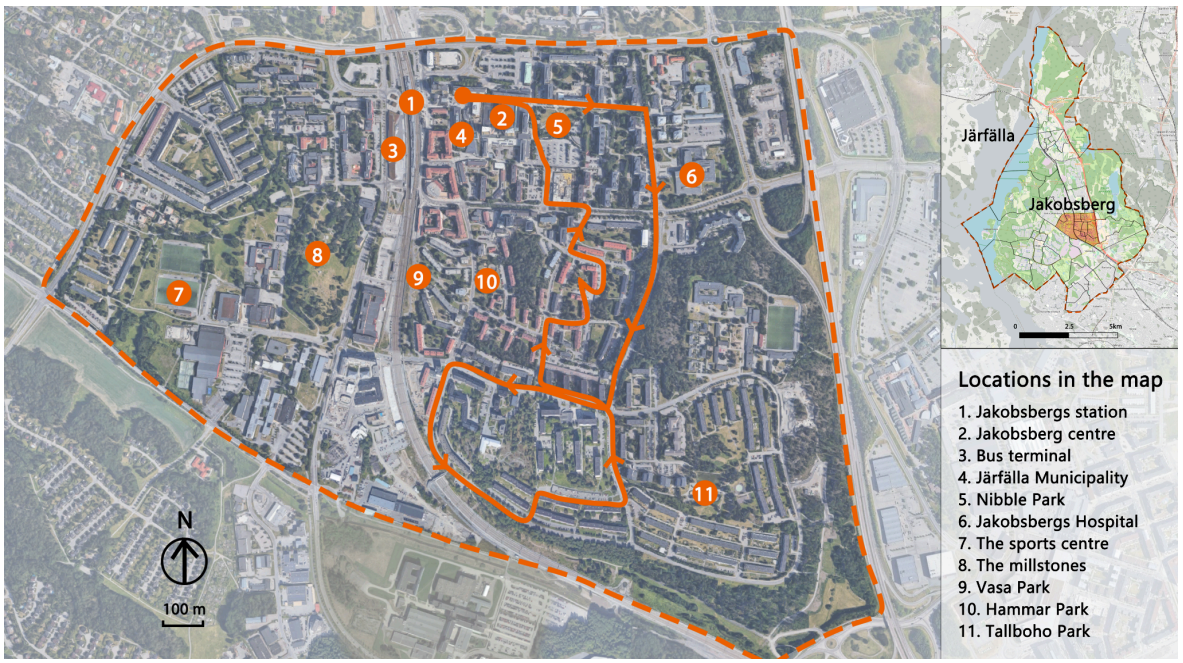


Fig. 5: Site visit track in Jakobsberg (Edited by author, base map data © Google[2024]).

3.3 Policy review

Policy reviews is a scientific approach to identify and solve problems in policy documents, granting a better understanding of the planning process (Browne et al., 2018). It can also help to understand why certain policies are made in a particular context, by whom, for whom and with what effect (ibid.). Through this method, we aimed to produce a text analysis of three primary municipal texts to be able to understand what NBS exist in Jakobsberg, the plan for their implementation, and their potential success in implementation. A text analysis allows us to map the current policies regarding NBS planning in Järfälla municipality, particularly in Jakobsberg. Through this analysis, the use of NBS and their implementation will be analysed. This will help us to identify potential gaps in the plans, which we can then fill through the literature review. Based on literature on how to conduct a policy analysis and text analysis (Patton et al., 2016; Handler, 2023), we have comprised the following questions to help guide the process of policy analysis:

1. Problem identification i.e. what does the municipality see as specifically important for Järfälla with regards to the implementation of NBS?
2. What are the proposed NBS from the municipality?
3. How does the municipality evaluate the process? i.e. How is the progress being mapped, has progress been made?

The classification of official documents was done through a search on the municipality's website. We searched for current plans that the municipality had produced, then filtered them so that only texts relevant to NBS and environmental planning were displayed. The texts were chosen because of their relevance to environmental planning. The texts chosen have a large impact on environmental planning and have been crucial in the development of how greenery, green-blue infrastructure, biodiversity and ecosystem services are understood and recognised in planning in Järfälla and Jakobsberg. There are some texts that were not reviewed, primarily the climate adaptation plan and the new Viable Cities contracts. In lieu of more time we would have liked to review these as well. The texts that were reviewed are presented in Table 1 below (Appendix 1 to 5 cover some main contents of the documents).

Table 1. Documents reviewed

Document	Dates relevant
Miljöplan, Environmental plan	2023-2030
Översiktsplan, Comprehensive plan	2014-2030
Grönstrukturplan, Green structure plan	Published in 2018
Strategier för hållbar utveckling i Jakobsberg, Strategy for Sustainable Urban Development in Jakobsberg	Published on October, 2023

3.4 Public Online Survey

To understand potential gaps between municipal plans and citizens perspectives we conducted a survey using Facebook. This survey was not intended to provide a representation of the viewpoints of the population in Jakobsberg, but rather an indication and an initial step to collect data about citizen's perspectives. The survey was posted in the Facebook group "Vi i Järfälla" that has 4103 members, of which N = 66 responded.

The questions in the survey focused on establishing an understanding of what the citizens thought of the green spaces near them, what they would like to improve, and how they felt about the planning processes about NBS and greenery. These questions can be found in Appendix 6. Some questions were multiple choice, for instance, when asked how often they visited green spaces the respondents were given several choices. When asked about what they would like to add to the green spaces near them, the respondents were given multiple choice, as well as the opportunity to write a short answer. Finally, some questions such as "how informed do you feel by the municipality regarding the implementation of greenery in your area" were given a scale from 1 to 5, with 5 being the heist, and 1 being the lowest. Consent to use the collected information was given via a question included in the questionnaire.

4. Results

4.1 Literature Study

4.1.1 UHI

There is a growing consensus that UHIs can be mitigated by NBS. Vegetation has been shown to decrease urban air temperature (Aboelata & Sodoudi, 2019). In the study conducted by Marando et al. (2022), 601 European cities were assessed, showing that vegetation played a substantial role in decreasing urban air temperatures. Greener areas were on average 1.07 °C cooler, with a maximum of 2.9 °C cooler (ibid). The study also found that in order to decrease the urban air temperatures by 1°C, a 16% greenery coverage would be needed in the area (ibid). Another study in Stockholm showed that the urban air temperature was on average 0.5-0.8 °C lower in parks, with a maximum of 2 °C lower (Jansson et al., 2006). Solutions such as green roofs have also been investigated as a means of providing insulation, preventing cooling loss during summer months, and preventing heat from escaping in winter months (Xing et al., 2017; General Services Administration, 2011). Researchers indicate that the temperature of green roofs is approximately 16.7 to 22.2°C lower than that of traditional roofs, and they can reduce the heat transfer from exterior to interior through the roof by about 72% (ibid.).

In high-density urban centres, it is challenging to increase the amount of tall trees. To address this, different NBS retrofitting approaches can be tailored to specific urban contexts to alleviate UHI effect. A key strategy involves using vegetation as a flexible tool through their transpiration and shading effects, to reduce street temperature (Swedish Environmental Protection Agency, 2022). Empirical studies support this approach, for instance, they found the grassland can lower temperatures by an average of 0.6°C compared to paved areas, and green walls have the potential to cool by up to 1.8℃ (Knight et al., 2021). An innovative application of this (see in Figure 6) shows in an ultralight green roof structure employed in Brazil (Ruiz, 2019). This multifunctional structure not only reduces noises but is also operated by an automatic irrigation system for efficient maintenance(ibid.).

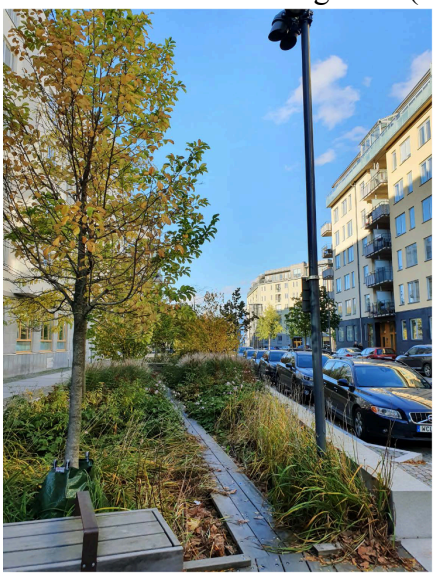
Fig. 6: The ultralight green roof structure LEAFSKYN, Source: Ruiz, 2019

In addition to vegetation-based strategies, modifying urban surface materials is another way for UHI mitigation in city centres. For example, changing surface reflectivity can decrease the ground temperature by 7.9°C at noon, while the use of porous materials that absorb water and help evaporative cooling can further reduce temperature (Makido et al., 2019; Hayes et al., 2022). In summary, the strategic integration of natural elements in urban environments provides a flexible and effective way of UHI mitigation.

4.1.2 Flooding

Cities can be retrofitted with NBS to help minimise the risk of flooding, creating spaces that will be more resilient to the risks of damages from heavy rains. A study in Alexandria, Egypt suggests that the implementation of a combination of Low-Impact Development (LID) tools such as rain gardens, green roofs, permeable asphalt, and vegetation/rainwater troughs reduced run-off by up to 73.7% (Mabrouk et al., 2023). Individual components of LIDs showed varying levels of effectiveness (ibid). Permeable pavements provided a 48% reduction of rainwater, green roofs combined with rain barrels saw a 43% reduction, and bioretention wells combined with vegetation troughs saw a 55.1% reduction (ibid). However, it is the combination of all of the LIDs together that provided a 73.7% decrease in total volume of rainwater, the author even suggests that these systems could never fully mitigate flooding, and a combination with pre-existing greywater systems in the city would provide the most resilience against flooding.

Another example in Sweden is the multifunctional rain gardens in Munka Ljungby (Ängelholm Municipality, 2021, 13). In this area (see in fig. 7), rain gardens are strategically placed along roadways, serving to manage rainwater while simultaneously slowing down busy traffic (ibid.). Similarly, in the residential area of Norra Djurgårdsstaden in Stockholm, the integration of gardens into sidewalks serves to manage floods and alleviate heat stress (Swedish Environmental Protection Agency, 2022). Another applicable example(see in fig. 8), from Hamburg, is suitable for places lacking sufficient space for constructing ditches or channels (Horn et al., 2023, 24). They utilise standard roadside planting beds with hollow plastic crates instead of concrete troughs (ibid.). They also consider the climate adaptability, water resistance, and shallow root systems of different species. Notably, these various types of retrofitting not only prevent floods but also provide habitats for organisms, highlighting the multifaceted benefits of retrofitting NBS (ibid.).



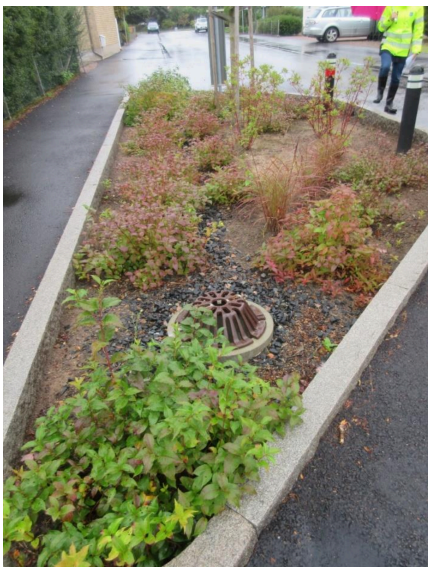


Fig. 7(left): Rain gardens in Norra Djurgårdsstaden in Stockholm (Swedish Environmental Protection Agency, 2022, 109); Fig. 8(right): Multifunctional rain gardens in Ängelholm (Ängelholm Municipality, 2021, 13)

4.1.3 Biodiversity

Urban areas can become a pathway for nature, connecting fragmented habitats so that organisms can migrate through urban spaces. An example of this is through the creation of green corridors. Green corridors provide an example of how cities can plan for ecological connectivity, and mitigate fragmentation caused by urban exploitation (Dover 2015, 13). Using "stepping stones" of habitat spread through the city, planners can connect larger green spaces together, providing more resilience in the face of stochastic events that could impact a fragmented ecosystem (ibid). By considering biodiversity in planning, cities can become richer than their monocultural rural counterparts, and even provide a habitat for endangered species (Xing et al. 2017). Specific examples of how NBS can be incorporated into green corridors are green roofs, which provide habitats for insect and bird species (ibid). The primary concept is to connect green urban areas within the city, i.e. parks, to neighbouring nature (Dover, 2015, 13).

Some case examples of NBS being used to increase biodiversity in cities can be found in the Green Surge project. An example from Milan, Italy boasts a project that turned an abandoned lot into a "biodiversity friendly park" (Horn et al., 2023, 16). This project not only incorporated nature into a previously barren urban space, it also encouraged locals to learn more about biodiversity and contribute where they could (ibid). The abandoned lot was transformed into a space with a bird garden, a meadow with native flowers, an orchard, and a space to grow vegetables (ibid). The aim was to attract native pollinators and birds to a space that the public could also access (ibid). The public was also crucial in the out-scaling of this project. For example, the project handed out fliers about how citizens could increase biodiversity in their cities, and distributed packages with native seeds to be sewn on balconies in the area (ibid).

Another example of increasing biodiversity in smaller urban spaces is through utilising rooftops. A project in Hamburg, Germany implemented bee-friendly rooftop gardens. Typical green roofs usually host green spaces with drought resistant species that have shallow roots such as grasses and mosses (ibid). In this project, a 2400 m^2 green rooftop was retrofitted with NBS to promote bee-health (ibid). The researchers added sand for nesting and habitats, deadwood piles for habitats, and rock piles (ibid). The project noted that this was a low cost alternative that yielded impressive results e.g. 30 wild bee species and 23 wasp species were catalogued (ibid). It was stated that by adding these low-cost solutions, there were significantly more insect species than what would have been found on a typical green roof.

4.2 Site visit

To gain a more comprehensive understanding of the current implementation status of NBS, we conducted a site visit to Jakobsberg on a weekday in the morning. As it was a weekday morning with low autumn temperatures, the presence of both pedestrians and vehicles in outdoor spaces was notably limited. Similarly, the utilisation of blue-green infrastructure (GBI) across various zones appeared to be quite modest. The ones engaging with GBI primarily consisted of elderly people, parents with young children, and individuals walking their dogs. Our observations also brought attention to the following key aspects:

Types of Nature-Based Solutions: In residential areas and the central business area, small clusters of individual trees dominate the landscape (Figure 9, no. 3, 7&8). Near the residential areas, there are small multifunctional green spaces and parks with walkways and recreational

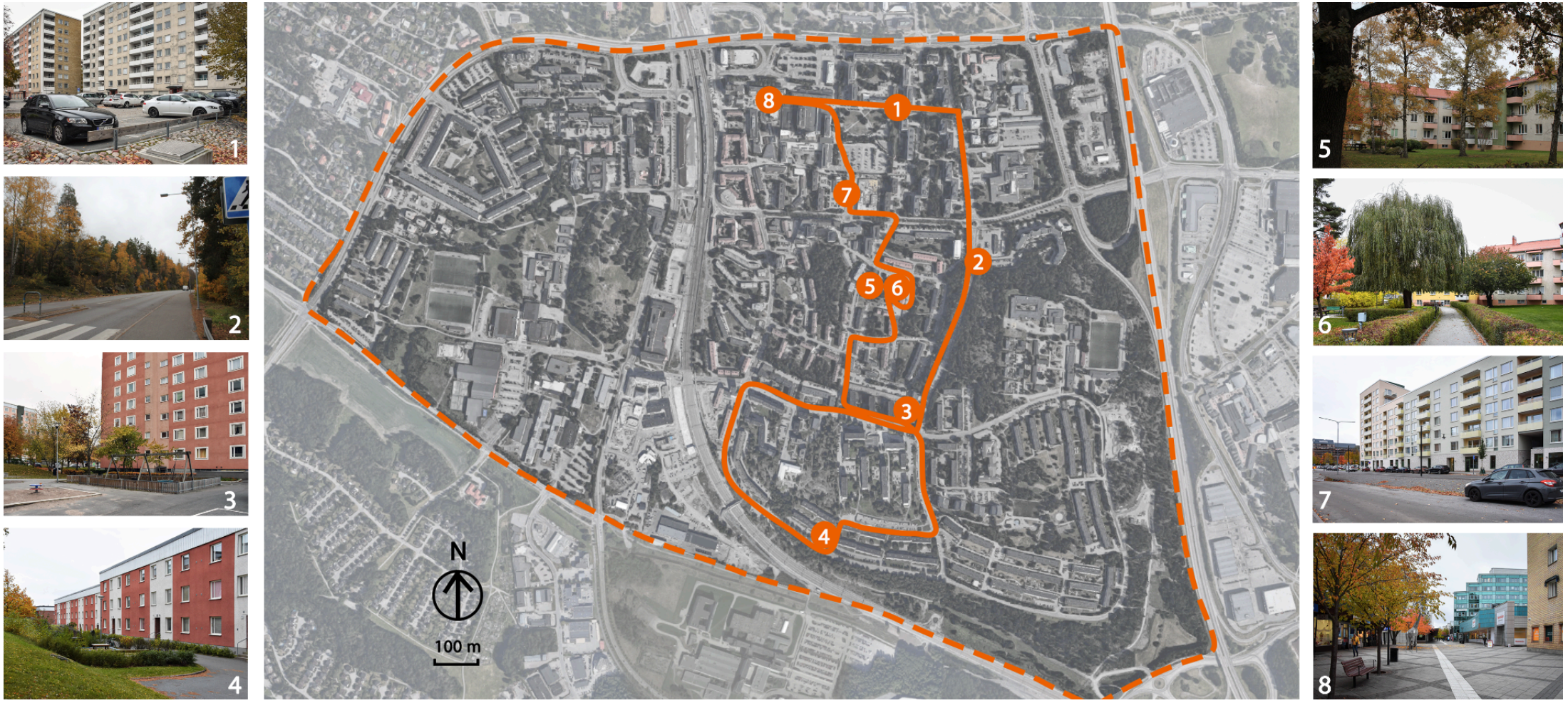
facilities (Figure 9, no. 3, 4, 5 & 6). Furthermore, some areas have extensive forests, some of which incorporate walking trails(Figure 9, no. 2).

Spatial distribution of NBS: The amount of NBS is notably scarce in the vicinity of residential areas, contrasting with more green spaces observed at the further away from the city centre. As shown in Figure 1, open parking spaces beneath apartment buildings lacked plants, and in Figure 2, the extensive forests were on distant hilltops. A noteworthy observation across Jakobsberg was the prevalence of substantial areas of hard surface, particularly in the central areas (Figures 8). In these areas, NBS distributions were constrained, typically manifesting as isolated tree occurrences. The widespread use of hard surfaces poses challenges for soil-nutrient interactions, impeding plant absorption of rainwater, compromising water retention, and reflecting more heat compared to green spaces (Wong & Yu, 2005). Significantly, at a newly-built apartment, merely two nascent saplings were found within an approximate one-hundred-metre street frontage, with one having signs of premature withering. Paradoxically, despite the paucity of greenery, the external walls of this building were painted green. These observations showed a discernible fragmentation of NBS distribution. The central areas manifest inadequacies and imbalance NBS allocations, with newly developed areas having a deficiency in such features.

Current structure of NBS: Our observations indicated a relative simplicity in the structure of NBS in various locations, such as singular trees in the city centre and along roadways (Figures 9, no. 7&8). In many instances, the structural composition comprised a two-tier arrangement with ground-level grass and over-branching mature trees (Figure 9, no. 3). A minority of areas incorporated considerations for small-scale bushes (Figures 9, no. 5&6). Moreover, there existed a notable homogeneity in the plant types, commonly featuring a singular species of tree directly planted on the grass.

Biodiversity and Multifunctionality: The NBS in Jakobsberg has a variety of elements, ranging from street-side trees to decorative flowers and public green spaces like parks and forests. However, within residential areas, we noticed a lack of diverse Green-Blue Infrastructure (GBI), for example, the primary types of plants were street trees and lawns, with potentially limited biodiversity and hence provision of ecosystem services. The small park in Figure 5 and 6 was a good example, with varying species of trees, shrubbery, and recreational spaces. This space stands out for its mix of plant types, structured layout, and additional recreational facilities. The unexpected encounter of a squirrel showed that animal life potentially had a space for habitats in the area. It was, however, restricted to enter by a gate, indicating a desire to control visitors and that this green space likely served as an exclusive area for the residents of that particular housing block.

Fig. 9: Green Infrastructure observations and locations in Jakobsberg (Edited by author. Base map data:© Google[2024]).



4.3 Policy Review

In the following section, the policy documents of Järfälla municipality will be analysed according to the method above resulting in a summary of the NBS plans for Järfälla municipality (see in Appendix 1 about the documents analysis and their relevant contents).

4.3.1 Översiktsplan (Comprehensive plan) 2014-2030

The main challenge of Järfälla municipality according to the Översiktsplan is tackling climate change while handling population growth. Claiming Järfälla has a key role in the future growth of Stockholm and Sweden alike, it is asserted that Järfälla municipality is one of the quickest growing areas in Stockholm (Järfälla Municipality, 2014, 8). From a regional perspective, the main environmental issues are the reduction of greenhouse gases, increased efficiency of energy production, and adaptation of urban areas to the effects of climate change (Järfälla Municipality, 2014, 8). In the challenge formulation part of the plan, it is recognised that closeness to green areas is important in Järfälla municipality, as well as creating a built environment where the interplay of green areas, humans, and nature is prioritised (Järfälla Municipality, 2014, 14). Following the challenge formulation, the plan explains how these goals will be fulfilled through “guidelines”. The most relevant to this project are “water and green areas of high quality,""the meeting between urban and nature," and "future-proof and robust technical infrastructure."

In “water and green areas of high quality”, the quality of environments and parks is crucial (Järfälla Municipality, 2014, 34). The guidelines related to these goals are displayed in Appendix 2. In overview, the guidelines display specific concern for biodiversity, focusing on the role of ecosystem services and on the future preservation of green areas and nature reserves (ibid). Urban parks are mentioned as a multifunctional space for recreation, noise reduction, air pollution mitigation, and biodiversity (ibid). In this part of the comprehensive plan many concepts such as ecosystem services, multifunctional areas, greenblue recreation, and biological corridors are used, but without definitions or further explanations. Questions that arise are: How will biological corridors be formed? What ecosystem services are important? What type of greenblue recreational spaces are required? These terms are used ambiguously, yet without much promise as to how they will be fulfilled. It can be noted that this plan is somewhat visionary in its purpose, which could explain the fact that there are not specific, measurable indicators and targets and implementation plans.

The section “meetings between the urban and nature” primarily focused on making nature accessible to people. This section is tailored to the instrumental need for nature to be exclusively for human use, and not for the intrinsic value of nature itself. The guidelines are presented in Appendix 2 (Järfälla Municipality, 2014, 35). Parks and human connectedness to nature were key themes, as well as newly built areas being used to bring people closer to nature and ensuring the availability to grow food in built-up areas (ibid). Although it is unspecified as to how newly built areas can contribute to connecting people to nature, and how many allotment gardens will be added to Järfälla, these guidelines display that nature-based solutions, though not the term used, are crucial to the planning of Järfälla.

The section titled “future-proof and robust technical infrastructure” covers what today can be seen as the precursor to NBS. The guidelines presented in Appendix 2 show a development of using NBS to adapt to a changing climate (Järfälla Municipality, 2014, 40). It is stated that impermeable areas should be compensated by the addition of green roofs (ibid), as well as highlights that the addition of greenery and water in the city can help to mitigate floods and

heat stress (ibid). The document also went into detail on how buildings should be placed to minimise the risk of flooding (ibid), and that multifunctional areas should be introduced, particularly to mitigate flooding (ibid). The vision in this section reflects a city that will use nature to its advantage regarding climate change adaptation. This is further displayed by figure 10 which shows ideas as to how new houses could be built incorporating these ideas. The municipality offers a way to calculate the addition of greenery in the municipality. This is referred to as the "green areal factor" (grönytefaktor), which is calculated by the amount of vegetation covered space divided by the area of the plot (Järfälla Municipality, 2014, 41). The municipality wants to achieve a factor of 0.5 in newly built areas, giving a measurable goal to obtain.

Fig.10, examples of what adding NBS means to the municipality as presented in the Översiktsplan (Järfälla Municipality, 2014, 40)

4.3.2 Grönstrukturplan (Green Structure Plan) 2018

In the Grönstrukturplan, the primary challenge for Järfälla is to address the environmental changes and urbanisation within the city. Järfälla acknowledges its robust green structure, forming part of the regional green infrastructure (Green Wedges) as outlined in the RUFS (Stockholm County Council, 2018). The Regional Development plan for the Stockholm area (RUFS), is a crucial planning document that among other things describes the regional green infrastructure (ibid). This includes the need for green wedges as a place for recreational facilities, cultural value, and biodiversity (ibid). The green structure plan states that nature is important to residents' recreation and health and it particularly highlights their role in ecosystem services, especially climate regulation (Järfälla Municipality, 2018, 6). The municipality notes that this plan should serve as a foundation for other environmental strategies, detailed planning, and related initiatives (Järfälla Municipality, 2018, 7). It identifies seven challenges specific to the planning, development, and management of Järfälla's unbuilt areas, subsequently setting forth seven objectives (Appendix 3)(Järfälla Municipality, 2018, 14).

After outlining the challenges and objectives, the plan describes the current state of the city's green structure and includes several ecological landscape maps. These maps detail the current per capita public open space density, distribution of forest trees, ecological connections for bees and butterflies, distribution of amphibian habitats, land providing ecosystem services,

regional ecological relationships, and cultural ecosystem diagrams (Järfälla Municipality 2018, 18-39).

The future scenario section introduces the municipality's view of how Järfälla's squares, parks, nature and outdoor areas should be developed and planned to create a long-term sustainable and attractive city. It includes various future landscape maps that illustrate valuable tree species areas, green structure distribution, ecological landscape connections, and flood-prone zones (Järfälla Municipality, 2018, 40-41). This section also mentions our focus area - the regional city centre of Barkarby-Jakobsberg is structured into a clear grid city with parks and spaces (ibid.). Building on this, the plan also proposes guidelines for green patterning, encompassing key principles regarding planning, design and management (Järfälla Municipality 2018, 44-50). Appendix 4 includes some of these planning guidelines relevant to NBS and our focus on Jakobsberg (ibid.).

In the last few sections of the plan, several goals and regulations are discussed, including the important global and national agreement and targets related to green structure, relevant legal constraints, and the follow-up mechanisms for green structure. Notably, the document aligns with several Sustainable Development Goals (SDGs), including SDG 3 (Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). And the national goals associated with the Green Structure Plan are Sweden's Environmental Goals, Sweden's Outdoor Objectives, Public Health Policy Objectives, and National Cultural Environment Objectives. The mechanisms involve green model analysis, biodiversity assessment, citizen participation evaluation, and rainwater assessment.

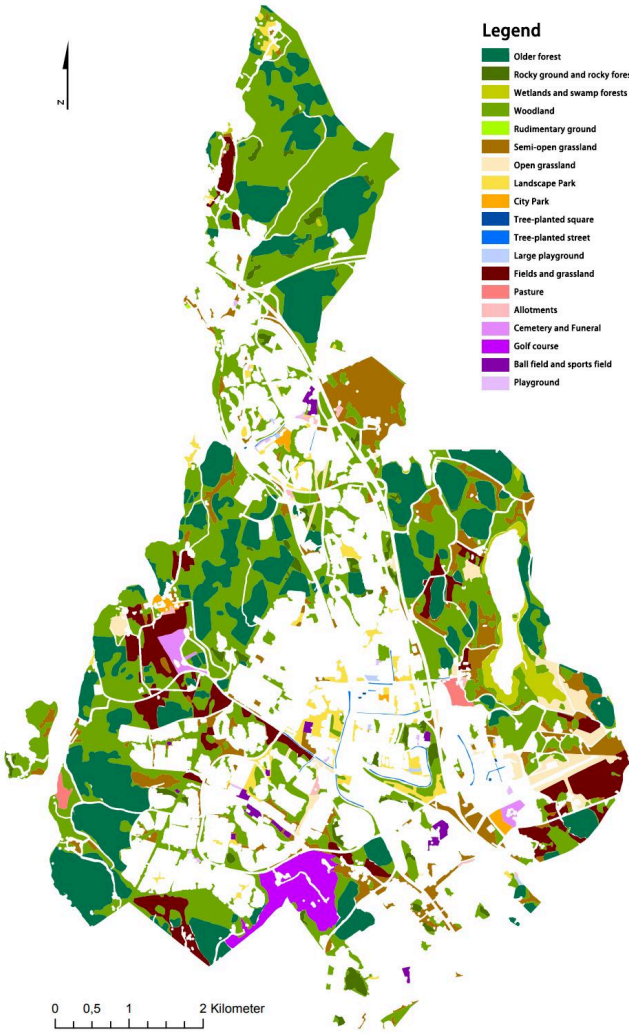


Fig. 11: Green Typology of Järfälla (Järfälla Municipality, 2018, 89)

This document serves as a comprehensive guide linking various sustainable and green-structure-related planning and legislative documents. It emphasises its importance, advocating the foundation role for follow-up detailed plans. However, it appears incomplete with several incomplete maps about green spaces, among which there are a lot of blanks (Fig. 11)(Järfälla Municipality, 2018, 40). The only document mentions the Grönstrukturplan is the Miljöplan 2023–2030 för Järfälla kommun med bolag, which was published in 2023 and said that Grönstrukturplan has been approved by the committee. Additionally, one of the goals is to encourage resident participation in development, supported by a survey.

4.3.3 Miljöplan (Environmental plan) 2023-2030

The environmental plan produced by Järfälla municipality is the newest official document and it pertains to the fulfilment of environmental goals. The environmental plan is focused on the years 2023-2030 (Järfälla Municipality, 2023a). The plan begins with a summary of the municipality's environmental policy(Järfälla Municipality, 2023a, 5), and then goes on to entertain specific environmental goals (ibid). These goals are identified, and clarified by measurable effective targets (ibid). These are then followed up through specific indicators that are presented in the plan (ibid). The goals produced by the municipality are the result of inspiration from both Agenda 2030, and the Swedish environmental goals (ibid). The six goals are: reduced climate impact and sustainable consumption and high environmental conscientiousness, fresh air, good built environment, poison-free society, rich animal and plant life, and sustainable consumption and high environmental conscientiousness (Järfälla Municipality, 2023a, 8). The goals most relevant to this project are "a good build environment" and "a rich plant and animal life". Therefore, these two goals will be studied more closely.

The goal "good built environment" focuses on a sustainable development of Järfälla, as well as considering sustainability when expanding in the municipality. The goal plans to increase the resilience of the built environment, as well as prioritising nature and culture (Järfälla Municipality, 2023a, 13). Buildings will be certified with a high standard, ensuring a future of responsible land and water usage (ibid). The first effective goal strives for the development of a system that helps the follow-up of planning, securing the sustainable development of the municipality (ibid). The second effective goal requires all newly built homes to be certified with at least a silver certificate, or similar, from miljöbyggnad (ibid). The third effective goal states that by 2026 60% of stormwater within Bällstaåns catchment area, and 40% of the stormwater within Mälarens catchment area will be cleaned (ibid). The fourth of the effective goals focuses on how Järfälla needs to be effectively planned to increase the resilience of the municipality in the wake of the challenges presented by climate change (ibid). The final effective goal focuses on noise reduction in urban areas (ibid).

The goal for the built environment has several indicators, listed in "bilaga 2" of the plan for the Environmental plan. These include 25 "measures" that are linked to indicators for each measure (Järfälla Municipality, 2023a, 29-31). Of these indicators, several are important to this project. The first being "a green structure plan with green area factor and ecosystem services contributes to the right priorities in Järfällas green areas" (Järfälla Municipality, 2023a, 29). For cleaning run-off stormwater, measures such as implementing green roofs and green walls have been suggested (ibid). Another measure included strengthening ecosystem services in the physical planning of the municipality (Järfälla Municipality, 2023a, 30).

The other goal relevant to this project is the goal that encompasses " rich plant and animal life." This goal aims to "preserve, utilise, and develop" biological diversity in a sustainable way, for the present and in the future (Järfälla Municipality, 2023a, 16). The effective goals include firstly that the area of protected nature will be at least 75 hectares by 2025 (ibid). Secondly, the eight prioritised "green landscape connections" will be protected and preserved to ensure that species habitats are prioritised (ibid). Lastly, Järfälla is striving for a 30% tree coverage in newly built areas, and at least 25% in the current areas in the municipality by 2030 (ibid). The municipality defines tree coverage by the area of land that is covered by foliage of tree crowns (Järfälla Municipality, 2023a, 38). The plan does not specify whether or not the trees have to be of a specific maturity, only that the land must be covered.

This goal also has assigned measures and indicators. For this goal, eight measures and their indicators were presented by the municipality (Järfälla Municipality, 2023a, 31). The measures most relevant pertain to increasing biodiversity and ecosystem services, as well as creating inventories of the existing green spaces (ibid). Although this section does not mention NBS or GBI, the municipality mentions that it does want to develop biodiversity and ecosystem services within the urban areas (ibid). The municipality states that they want to increase ecosystem services, and not how they are going to do that. More specific indicators and measures are needed to be able to assess how this will be achieved by 2030.

4.3.4 Strategier för hållbar utveckling i Jakobsberg (Strategy for Sustainable Urban Development in Jakobsberg) 2023

The Strategy for Sustainable Urban Development in Jakobsberg, primarily focuses on environmental, social and economic sustainability (Järfälla Municipality, 2023b, 1-2). Aiming to develop a more sustainable Jakobsberg from environmental, social and economic perspectives, the strategy assesses current status and proposes measures in three fields: Green Jakobsberg, Productive Jakobsberg and Equitable Jakobsberg (ibid). It covers existing green measures, linking to documents from global level, EU and national level and local level, such as Agenda 2023, EU Regional Development Fund, and Overview plan for Jakobsberg. It also includes successful endeavours and initiatives for equality. The plan concludes with some implementation introductions and outlines subsequent actions (Järfälla Municipality, 2023b, 31). Among them, the Green Jakobsberg is the most relevant section for this project.

In the first three sections, the municipality has acknowledged shortcomings in certain NBS and has compared many deficiencies with other existing municipal plans (Järfälla Municipality, 2023b, 3-19). For instance, there is a high building density and low green space per capita, with some areas having less than nine square metres of green space per person (Järfälla Municipality, 2023b, 16). Additionally, the tree canopy coverage in the central area ranges from 15-20%, falling below the targeted 25% outlined in the existing municipal Environmental Plan (ibid.). The distance to green spaces in central areas exceeds 300 metres, surpassing the guidelines set in the Green Structure Plan. Biodiversity in the central Jakobsberg has intense competition for land (ibid.). The dialogues with residents reveal a positive attitude towards existing parks and green spaces, with a desire for the central area to become greener and more attractive (ibid.). It is noted that increasing greenery should not just consider promoting biodiversity and a pleasant environment, but also involving safety considerations (ibid.). These first five sections highlight NBS issues in the central Jakobsberg, including insufficient vegetation density, long distances between green areas, difficulties in increasing green coverage, and safety concerns.

The section Green Jakobsberg, outlines the aim to establish a municipal area with more greenery, whether on the ground, rooftops, or facades (Järfälla Municipality, 2023b, 20-21). Three key measures to support biodiversity, climate adaptation, and climate resilience are presented (ibid.). Appendix 5 covers some of the NBS-related measures. Examples include the use of reservable planting boxes in municipal areas, the planting mini-forests near schools, increasing tree canopy coverage, establishing wildlife corridors, and incorporating digital technology into considerations, such as development of GIS to proposed bio-installations in Jakobsberg, and a further development of 3D city model of Jakobsberg reported weather, noise and others that contribute to a green Jakobsberg (ibid.). However, detailed information on these measures is scarce, making the policies rather conceptual and many descriptions lack conclusive details, perhaps due to ongoing deliberations. It is challenging to find specific descriptions or areas for further implementation in this plan on the municipal website. Many descriptions lack conclusive details, perhaps due to ongoing deliberations.

Lastly, the strategy document outlines the implementation and following-up actions (Järfälla Municipality, 2023b, 31). The budget for all measures is set at 83 million SEK, and collaboration with various resident groups will ensure citizen cooperation. There will be coordinators to monitor and follow up on the implementation (ibid). The strategy will also use online platforms such as SKR Network and Region Stockholm Network (ibid). Overall, the strategy translates previous goals into tangible actions, demonstrating progress in related projects and emphasising citizen involvement. However, potential risks lie in the description of project details, making it challenging to discern the extent of implementation, identify benefiting groups, and understand citizen participation, thus introducing an element of ambiguity to the measures.

4.4 Survey

A survey was conducted via the Facebook group “Vi är Järfälla", resulting in 66 responses from people living in Jakobsberg (the results were in Appendix 6). The majority of respondents were aged 35-44 years old, and they had lived in Jakobsberg spanning from just a few months to 59 years. 56.1% of the respondents live in single family homes, 28.8% live in condos, 10.6% live in rental apartments and the remainder live in townhouses. 48.5% of the respondents visit green areas weekly, 28.8% responded daily, 9.1% responded multiple times a day, 10.6% responded more rarely than once a month, 1.5% responded monthly, and 1.5% responded never. The most common reason for visiting green areas was to relax, followed by enjoying nature, and then exercise. Responding on the scale of 1-5, where 1 is the lowest amount of satisfaction and 5 is the highest amount of satisfaction, 40.9% of respondents claimed that the green areas close to them were of high quality, with 0% of the respondents responding 1 (the lowest quality). 95.5% of the respondents answered a 3 or higher regarding the quality of green areas near them. 69.3% of the respondents scored a 3 or higher in the scale when asked about if they were affected by the heat where they lived, 66.2% replied a 1 when asked about if they were affected by flooding.

When responding to what they thought would be a good addition to the green areas near them, the respondents suggested more parks. This was followed in popularity by flowers instead of lawns, more trees, and then green roofs. The respondents were also free to suggest their own ideas, where some responded that they were completely happy with the green areas around them, others wanted more art in nature around them, and more natural forests. 77.3% responded that they would like more nature based solutions near where they lived.

The respondents were asked to motivate why they thought Jakobsberg needed more NBS. A total of 45 responses were recorded. Some examples of these can be found in Appendix 6. It is evident from these responses that the respondents care a lot about their environment, and many want to see change in the green spaces near them. We also asked about what the respondents felt about the planning process. Using the 1-5 again, we asked whether or not the respondent felt included in the municipality's planning process. 60.9% responded with 1, the lowest level. Only 2 people felt fully involved in the planning process. We also asked whether people felt included in their housing association or rental housing association's planning processes. The results were more varied, with a higher number of people feeling included. The comparison can be found in figure 12 below. The respondents also answered whether or not they wanted to be more included in the planning process of green areas near them. The results are displayed in figure 13 below. The respondents were also not satisfied with the amount of information provided by Järfälla municipality regarding the planning of green areas. 84% responded a 3 or lower, showing the municipality could provide more information to the residents regarding their planning processes. When asked about their willingness to be involved in caring for additional NBS such as allotment gardens, 56.9% responded that they would not be willing to care for them.

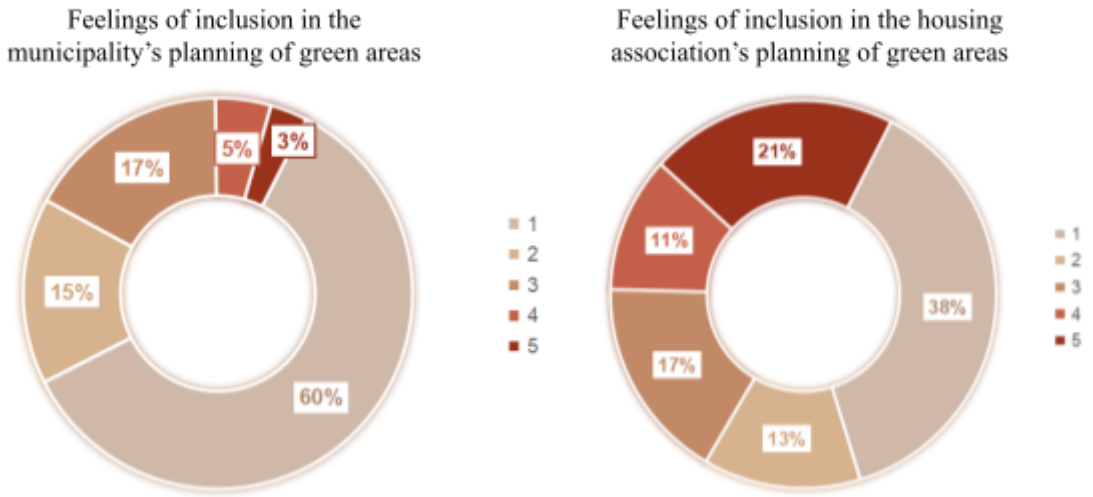


Fig. 12. Comparison of feelings of inclusion in the planning processes of green areas

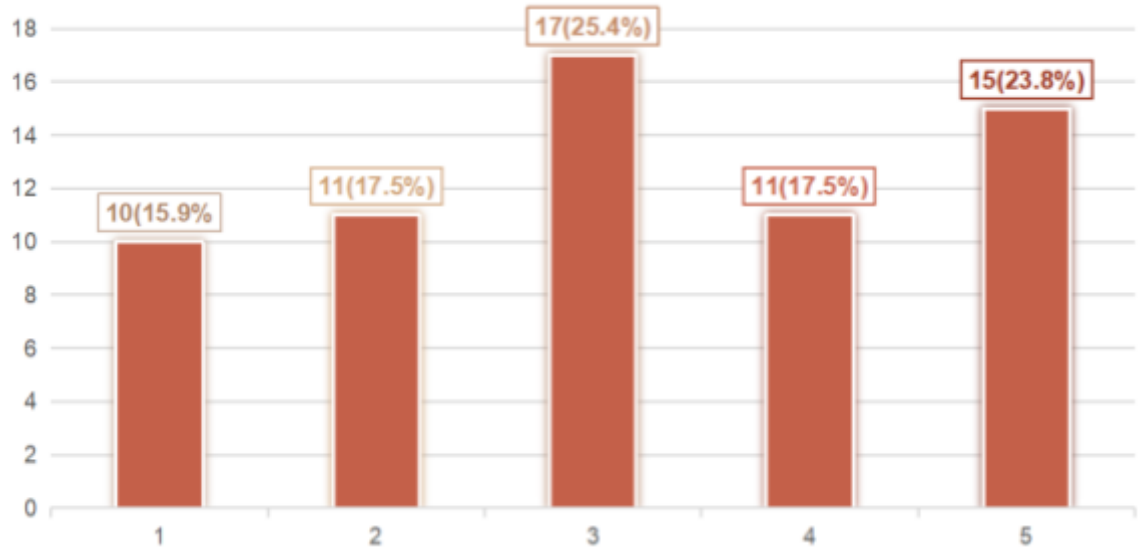


Fig. 13. More involvement in the planning process of green areas

5. Discussion

Rethinking Jakobsberg has led to an assessment of the types, amounts of, gaps in, and the perspectives of citizens in Jakobsberg regarding NBS. In illuminating the multifaceted nature of NBS, this discussion will endeavour to further delve into the interplay between science, planning, and the perspectives of individual citizens. Throughout this project, NBS has shown that combining ecological interventions with sustainability outcomes and climate change adaptation techniques helps to pave the way for a better understanding of how to address the contemporary environmental challenges of Jakobsberg.

5.1 Current status and future plans regarding Nature Based Solutions in Jakobsberg

As the first part of our research, we aimed to identify the pre-existing NBS in Jakobsberg. Through the site visit, the policy analysis, and the survey it can be determined that Jakobsberg boasts a variety of NBS, though there is room for improvement leading to suggestions that will be assessed in section 5.2. From the methods we were able to look at NBS through four different lenses: a curious lens from KTH students who are interested in NBS implementation, a municipal lens from the policy documents, a scientific lens through prior research, and a citizen-based lens, provided through the survey.

From these lenses, we were able to discern the current status of NBS in Jakobsberg. From the site visit, we saw that residential and central business districts showed a dominance of small clusters of trees, and multifunctional green spaces such as parks. Furthermore, in the visit we noted that there were many forested areas, often connected by walking networks. This was supported by some of the answers in the survey, where one respondent said “As I live today, I already have access to lots of green spaces, forest areas etc.” (see Appendix 7, response 16). Notwithstanding the prevalent greenery observed from both the site visit and the citizens, a discernable lack of NBS is evident in certain areas of the district signifying that these areas are potentially at risk of the adverse and heightened impacts of climate change. A notable finding was the scarcity of NBS in the vicinity of residential areas and the centre of Jakobsberg, especially in contrast to the greener spaces observed on the outskirts of the district. In the centre of Jakobsberg we observed that there were many open, impermeable parking spaces, roads, and outdoor areas. This was noted by a respondent in the survey who said, “We have too much concrete, asphalt, and glass in the area, especially in the new-builds” (see Appendix 7, response 3). These spaces are problematic as the excess of impermeable ground can lead to an increased risk of flooding (Swedish Environmental Protection Agency, 2022, 105), and the concrete and lack of vegetation can increase the UHI effect (Marando et al., 2022).

Furthermore, the quality of the pre-existing NBS in the city centre and surrounding residential areas is suboptimal, potentially undermining the efficacy of increasing biodiversity, and desired mitigating the challenges of flooding and UHIs. Through observations on the site visit, it was noted that some areas had a relative simplicity regarding NBS. An overall homogeneity of plant species was observed in these areas, with some examples of mature trees growing over manicured lawns. Additionally, it was also noted that in some of the newer built apartments closer to the city centre there were very few green spaces, yet the buildings were painted green. This is interesting as the municipality has a goal of 30% tree coverage in newly built areas (Järfälla Municipality, 2023a, 16), yet the areas that were observed in the site visit were surrounded by concrete with little vegetation. The

disconnect between some urban areas and nature shows that there is a potential to better the connectedness of green spaces within the district and help increase biodiversity (Dover, 2015, 13).

Although ecosystem fragmentation and other issues were observed in the site visit and mentioned in the survey, there have been acknowledgements and strategies proposed to tackle environmental problems. Throughout the four analysed planning documents there has been a development of NBS and how they can help to mitigate challenges faced by the municipality. The idea of "future-proofing" arose in the comprehensive plan 2014-2030 (Järfälla Municipality, 2014, 40). The idea was used as a way to help mitigate flooding and heat stress (ibid). This could be attained by adding green roofs and walls, as well as multifunctional areas that could work as flood mitigation (ibid). The Green Structure Plan also mentions the importance of nature in the urban space (Järfälla Municipality, 2018). It includes a mapping of valuable ecosystems (Järfälla Municipality, 2018, 18-39), and imagines a future with parks scattered across Jakobsberg and the municipality in order to facilitate the spreading of nature within the identified areas (Järfälla Municipality, 2018, 40-41).

The two newer plans assessed, the environmental plan (2023a) and the strategies for sustainable development in Jakobsberg (2023b), provide more nuanced insights into NBS. The environmental plan stresses the need to utilise NBS (Järfälla Municipality, 2023a). For example, it is mentioned that both the addition of green roofs and green walls in the municipality can help to clean run-off, helping them to achieve their 2026 goal of 60% of the stormwater that reaches bällstaån to be cleaned (Järfälla Municipality, 2023a 13). However, the policy document "strategies for sustainable development in Jakobsberg" (2023b) identifies areas in need of NBS (Järfälla Municipality, 2023a). For instance, the aforementioned goal of tree coverage mentioned in the comprehensive plans is discussed, and the current situation in Jakobsberg is shown to be insufficient (Järfälla Municipality, 2023b, 16). It also states that the municipality would like to establish an area with more greenery, focusing on NBS such as establishing wildlife corridors, reversible planting boxes in urban areas, and planting mini forests near schools (Järfälla Municipality, 2023b, 20-21).

These policy documents show that there is an understanding of how NBS can be used as a multi-functional solution to combating challenges faced by the municipality. Over the four documents assessed, many aspects were covered including ways to combat heat stress and UHIs, flooding, and biodiversity loss. However, one observation made while reviewing all of the policy documents was the vagueness of the plans. It is noted that these plans are supposed to be vague, and more overarching rather than specific. Yet, more detail could help to realise these ideas. For instance, in the environmental plan, there are indicators and targets mentioned (Järfälla Municipality, 2023a). However, these goals are rather broad, and there is not necessarily a direct cause of action as to how to implement them. This illuminates a gap in our knowledge, as we would have liked to interview a municipality official in order to fully understand how these plans go from policy to implementation, yet we never heard back. Perhaps there are internal documents showing more detailed steps, or maybe there are not any and that would mean that perhaps that is an area where the municipality could improve their internal processes. Nevertheless, more understanding is required in order to understand the extent of policy implementation in reality, something that could be valuable to research in the future.

5.2 Potential for Nature Based Solutions in Jakobsberg

Following the previous section that identified the current state and pre-existing NBS in Jakobsberg, this section will propose recommendations for retrofitting NBS addressing three main challenges: UHI, floodings and biodiversity. Potential recommendations will be provided from three perspectives: our researcher's viewpoint on the implementation of NBS, the scientific lens of prior research, and the citizens' perspectives from the survey.

From these points of view, we explore the appropriate ways for implementing NBS in Jakobsberg to tackle the trio of existing challenges. As for the UHI effect, it has been observed that citizens in Jakobsberg are confronted with heat threats. This is corroborated by survey results in which 69.3% of respondents rated their experience of heat in their living areas as three or above out of five. The site visit observations also underscore the need for implementing more NBS, especially considering the adverse heat impacts of extensive impermeable surfaces (Makido et al., 2019).

NBS provides various measures to combat the UHI effect (Swedish Environmental Protection Agency, 2022, 97). The increase of trees and vegetation can reduce urban temperatures by transpiration and shading effects (ibid.). Currently in Jakobsberg, there is still a need for more green coverage, as it hovers around 15% in many areas, far less than Järfälla municipality's aspirational goal of 30% (Järfälla Municipality, 2023b, 16). The ideas from survey respondents echoes this need, as one said "more parks/flowers/trees should be planted between homes and where there is space, the environment is worse" (see Appendix 7, response 6). Mitigating UHI by NBS is not just about planting deciduous trees for increased canopy cover; it can also be smaller-scale interventions like green roofs and green walls, even in spatially constrained urban settings (Jansson et al., 2006; Swedish Environmental Protection Agency, 2022, 98; Xing et al., 2017). In dense urban centres like Jakobsberg Centrum, where it is challenging to increase the number of trees, heat mitigation can be achieved through the adoption of flexible green roofs and enhancing the reflectivity of the ground surfaces (Makido et al., 2019; Ruiz, 2019).

Regarding flood management, observations during the site visits shows the prevalence of impervious surfaces such as parking areas, roads and outdoor spaces, and also exposes the poor quality of natural ecological structures in the city centre, which are not conducive to efficient rainwater runoff. However, an intriguing result from the survey suggests that flooding is not perceived as a predominant issue in Jakobsberg, with 66.2% of respondents rating their experience of flood impact as 1 out of 5. A plausible explanation for this could be Jakobsberg is higher than relative parts of Järfälla, and there is no major river in this area. These contribute to a lower probability of floodings in this area.

Nonetheless, proper flood prevention remains in need, as rainwater from Jakobsberg can potentially impact other areas. Hence, flood control measures for this area should be integrated with broader strategies encompassing other nearby areas of Järfälla. Retrofitting NBS can play a vital role in flood management and reducing surface runoff (Mabrouk et al., 2023). Such measures include the combination of Low-Impact Development (LID) tools such as rain gardens, green roofs, permeable asphalt and vegetation/rainwater troughs (ibid.). They can create buffers against heavy rainfall issues (ibid.).

Moreover, considering the biodiversity, site visits have observed the monotonous issue in ecological structures. This observation points to a need for implementation of NBS to

alleviate ecosystem fragmentation. The local citizens also reflect a strong inclination towards more dynamic and ecologically diverse landscapes. One respondent vividly expressed a desire for “Flowers in all colours of the rainbow as pollinators and which create sensual experiences and joy in more places” (see Appendix 7, response 8). Concurrently, there have been some measures for biodiversity, as the municipality has planned to introduce planting boxes and establish wildlife corridors in Jakobsberg (Järfälla Municipality, 2023b, 20-21). These reflect their commitment to ecological enhancement.

Further extending these efforts, NBS can be strategically employed to transform urban settings into dynamic natural corridors (Dover 2015, 13). This involves the integration of urban habitats, interconnected through planning. Such habitats can be green roofs, meadows, gardens and vegetable planting boxes (Horn et al., 2023, 16). These diverse spaces of nature serve to attract different insects and birds, thereby enriching biodiversity. Also, an important component of this strategy is the promotion of biodiversity awareness and active engagement. Educational endeavours, including the distribution of informative materials and some seeds, as well as ecological activities can foster a deeper public connection with the environment (ibid.). In summary, these comprehensive approaches collectively hold the potential to cultivate a more biodiverse Jakobsberg.

5.3 Public Opinion and its Importance to Planning in Jakobsberg

In this section, we will explore public opinion and participation in the application of NBS in Jakobsberg. The public in Jakobsberg wishes to receive more information about the planning of nearby green spaces from the local municipality and to be more involved. According to the results of the survey, respondents felt that they were not involved in the municipal planning process, with 60.9% of them rating their involvement as one out of five. They were also not satisfied with the amount of information provided by Järfälla municipality regarding the planning of green areas, which 84% responded a three or lower out of five.

This replies to the question of whether a discrepancy exists between the needs of citizens and the focus of policy. The policy review above spanning from the comprehensive plan of 2014 through to the Strategy for Sustainable Urban Development in Jakobsberg of 2023 reveals a progressive inclusion of resident feedback by Järfälla municipality, particularly in stages of planning (Järfälla Municipality, 2014; Järfälla Municipality, 2018; Järfälla Municipality, 2023a; Järfälla Municipality, 2023b). Similar to the survey, the municipality has conducted multiple surveys on residents' needs and have collected similar feedback, such as the demand for different types of NBS, and future NBS projects (personal communication with Järfälla municipality, 8 December 2023). Despite this, beyond initial surveys about preliminary inclinations, long-term residential requirements have not been thoroughly integrated into policy initiatives. Although some policy documents explicitly advocated for residents' involvement (Järfälla Municipality, 2018). Therefore, there is still a certain gap between citizens' needs and policies, including insufficient awareness about policy information among residents, superficial levels of participation, and the lack of access information on long-term maintenance and management (Willems et al., 2020; O’Sullivan et al., 2020).

Despite these identified gaps, it must be acknowledged that public expectations are not always aligned with practical realities, largely due to the logistical challenges faced by the municipality in organisation (personal communication with Järfälla municipality, 8 December 2023). Furthermore, there are inherent constraints in the implementation and management processes, such as limited resources including funding and NBS management personnel, as well as the prolonged growth cycles of plants which impede the visibility of outcomes (ibid.).

These factors contribute to a series of dilemmas faced by the government in retrofitting NBS (ibid). What's more, from the presentation of the municipality, there appeared to be a disparity between the public desire for increased participatory rights in environmental decision-making and their actual willingness to take care of NBS. Results from the survey can support this observation, indicating that while a significant respondents (66.7%) hoped for more information and involvement in NBS-related activities (rating their expectation higher than three out of five), a smaller part shows a willingness to actively engage in maintaining these solutions. Especially, 56.9% of respondents indicated that they do not want to take care of additional NBS such as allotment gardens. Again, there could be an interview with municipal authorities, which would serve to elucidate the operational mechanisms of this system.

There are also efforts under exploration above to bridge the gaps and incorporate citizen participation throughout the various phases of NBS for more sustainable implementation. Feasible measures include increased spread of information, which can be facilitated through various promotional means (Horn et al., 2023, 16). Further, the dissemination of knowledge about ecosystems and NBS requires enhanced public educational efforts, such as the distribution of informational leaflets and seed packets on pollinating insects in Milan (ibid). Similarly, during the implementation phase, encouraging resident participation in local transformations, like distributing seed packets for residents to plant on their green balconies (ibid), and organising community competitions to select the best community garden transformations are effective approaches. The most critical aspect in the maintenance and management phase is sustaining long-term participation (Willems et al., 2020). Policy support for residents' involvement in various activities can help in this maintenance (ibid).

6. Conclusion and Recommendations

In conclusion, NBS are being used as a multi-functional solution to climate change in Jakobsberg, yet there is room to improve especially considering the opinions of the public. Throughout this project, we have seen an immense care for the nature that exists in Jakobsberg in both the municipality's plans and from the public's responses. Yet, there are several components in which we, as an objective outsider's perspective, think the municipality could improve from the results we have gathered in this project. These are:

Table 2. Recommendations

Steps	**UHI**	**Flooding**	**Biodiversity**
Decision making	Use measurable indicators with set dates in the environmental planning documents; Send out more information to the citizens about NBS and green space planning;		
Public participation	Initiate community gardening schemes; Involve citizens more, and create public education initiatives; Invite citizens in the long-term maintenance.		
Implementation examples	Decrease the amount of asphalt and impermeable surfaces; Increase tree and vegetation coverage; Flexibly use vegetation in urban centres.	Corporation within the whole Järfälla; Low-Impact Development(LID) tools, such as rain gardens, green roofs, permeable asphalt and vegetation/rainwater troughs.	Exchange lawns for wildflowers; Green roofs and pollinator roofs and gardens should be implemented to a greater extent; Educational endeavours among citizens.

The project results highlight Järfälla municipality's strong commitment to nature and the environment. Citizens have been shown to value their surroundings, and care enough to suggest changes that they would like to see around them. With this enthusiasm, Jakobsberg is poised for a promising future, where nature and humans flourish amongst an urban environment that is resilient against the challenges of climate change.

7. References

Aboelata, A. and Sodoudi, S. (2019). Evaluating Urban Vegetation Scenarios to Mitigate Urban Heat Island and Reduce Buildings' Energy in Dense Built-up Areas in Cairo. *Building and Environment*, 166, p.106407. doi:https://doi.org/10.1016/j.buildenv.2019.106407.

Ängelholm Municipality (2021). *Dagvatten Och Klimatanpassning - Rain Gardens Eller Regnbäddar*. [online] www.engelholm.se. Available at: https://www.engelholm.se/fordjupning/sa-arbetar-vi-med/klimatanpassning/atgards--och-beredskapsarbete.html [Accessed 14 Jan. 2024].

Anguelovski, I., Connolly, J.J.T., Cole, H., Garcia-Lamarca, M., Triguero-Mas, M., Baró, F., Martin, N., Conesa, D., Shokry, G., del Pulgar, C.P., Ramos, L.A., Matheney, A., Gallez, E., Oscilowicz, E., Máñez, J.L., Sarzo, B., Beltrán, M.A. and Minaya, J.M. (2022). Green Gentrification in European and North American Cities. *Nature Communications*, 13(1). doi:https://doi.org/10.1038/s41467-022-31572-1.

Arlati, A., Rödl, A., Kanjaria-Christian, S. and Knieling, J. (2021). Stakeholder Participation in the Planning and Design of Nature-Based Solutions. Insights from CLEVER Cities Project in Hamburg. *Sustainability*, 13(5), p.2572. doi:https://doi.org/10.3390/su13052572.

Bai, X., Dawson, R.J., Ürge-Vorsatz, D., Delgado, G.C., Salisu Barau, A., Dhakal, S., Dodman, D., Leonardsen, L., Masson-Delmotte, V., Roberts, D.C. and Schultz, S. (2018). Six Research Priorities for Cities and Climate Change. *Nature*, [online] 555(7694), pp.23–25. doi:https://doi.org/10.1038/d41586-018-02409-z.

Barrios, E., Valencia, V., Jonsson, M., Brauman, A., Hairiah, K., Mortimer, P.E. and Okubo, S. (2017). Contribution of Trees to the Conservation of Biodiversity and Ecosystem Services in Agricultural Landscapes. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 14(1), pp.1–16. doi:https://doi.org/10.1080/21513732.2017.1399167.

Barth, B.J., FitzGibbon, S.I. and Wilson, R.S. (2015). New Urban Developments That Retain More Remnant Trees Have Greater Bird Diversity. *Landscape and Urban Planning*, 136, pp.122–123. doi:https://doi.org/10.1016/j.landurbplan.2014.11.003.

Baycan-Levent, T. and Nijkamp, P. (2009). Planning and Management of Urban Green Spaces in Europe: Comparative Analysis. *Journal of Urban Planning and Development*, 135(1), pp.1–12. doi:https://doi.org/10.1061/(asce)0733-9488(2009)135:1(1).

Browne, J., Coffey, B., Cook, K., Meiklejohn, S. and Palermo, C. (2018). A Guide to Policy Analysis as a Research Method. *Health Promotion International*, [online] 34(5), pp.1032–1044. doi:https://doi.org/10.1093/heapro/day052.

Dover, J.W. (2015). *Green Infrastructure.* 1st ed. [online] London: Taylor and Francis, p.13. Available at: https://doi-org.focus.lib.kth.se/10.4324/9780203121993 [Accessed 14 Jan. 2024].

Ekologigruppen (2018). *Handlingsplan För Ökad Biologisk Mångfald I Järfälla Kommun*. [online] *Biologisk Mångfald*, pp.1–37. Available at: https://www.jarfalla.se/byggaboochmiljo/klimatochmiljo/biologiskmangfald.4.3bfae18d1750260040ac428.html [Accessed 14 Jan. 2024].

European Commission (n.d.). *Consequences of Climate Change*. [online] The European Commission. Available at: https://climate.ec.europa.eu/climate-change/consequences-climate-change_en [Accessed 14 Jan. 2024].

General Services Administration (2011). *The Benefits and Challenges of Green Roofs on Public and Commercial Buildings a Report of the United States General Services Administration*. [online] Available at: https://www.gsa.gov/system/files/The_Benefits_and_Challenges_of_Green_Roofs_on_Public_and_Commercial_Buildings.pdf [Accessed 14 Jan. 2024].

Google Maps (2024). *Map of Jakobsberg*. *2024 Google*. Available at: https://www.google.com/maps [Accessed 14 Jan. 2024].

Handler, F. (2023). *Food Preparedness and Protection of Agricultural Land among Municipalities: a Case Study in Haninge and Heby Municipalities*. [MSc Thesis] pp.1–41. Available at: https://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-334198 [Accessed 14 Jan. 2024].

Hayes, A.T., Jandaghian, Z., Lacasse, M.A., Gaur, A., Lu, H., Laouadi, A., Ge, H. and Wang, L. (2022). Nature-Based Solutions (NBSs) to Mitigate Urban Heat Island (UHI) Effects in Canadian Cities. *Buildings*, 12(7), p.925. doi:https://doi.org/10.3390/buildings12070925.

Horn, O., Lorentz, L.A. and Guénard, M. (2023). *CLEVER Regional Solutions Catalogue: Showcasing Good Practice NbS Interventions and Enablers from China, Europe and Latin America*. [online] *The CLEVER Cities*, pp.1–56. Available at: https://clevercities.eu/ [Accessed 14 Jan. 2024].

IUCN (2020). *IUCN Global Standard for Nature-based Solutions: a user-friendly Framework for the verification, Design and Scaling up of NbS: First Edition*. [online] Gland, Switzerland: IUCN, p.14. doi:https://doi.org/10.2305/iucn.ch.2020.08.en.

Jansson, C., Jansson, P.-E. . and Gustafsson, D. (2006). Near Surface Climate in an Urban Vegetated Park and Its Surroundings. *Theoretical and Applied Climatology*, 89(3-4), pp.185–193. doi:https://doi.org/10.1007/s00704-006-0259-z.

Järfälla Municipality (2014). *Växa Med kvalitet, Översiktsplan Järfälla - Nu Till 2030*. [online] *Järfälla Municipality*, pp.1–120. Available at: https://www.jarfalla.se/byggaboochmiljo/stadsutvecklingochdetaljplaner/oversiktsplanerochstrategiskadokument/oversiktsplan2050.4.20dd2ca2187db9c22d5f7b6.html [Accessed 14 Jan. 2024].

Järfälla Municipality (2015). *Utvecklingsprogram För Jakobsbergs Centrala Delar*. [online] *Järfälla Kommun*, pp.1–61. Available at: https://www.jarfalla.se/byggaboochmiljo/stadsutvecklingochdetaljplaner/detaljplanerochprogram/utvecklingsprogramforjakobsbergscentraladelar.4.6d168bc8154d2fa5d1fc41ea.html [Accessed 14 Jan. 2024].

Järfälla Municipality (2018). *Grönstrukturplan*. [online] *Tekniska Nämndens Sammanträde 2018-06-20*, pp.1–100. Available at: https://www.jarfalla.se/kommunochpolitik/politikochnamnder/namnder/tekniskanamnden/tekniskanamndenshandlingar2018/tekniskanamnden20180620.4.5a6039a61631ad1488e358a5.html [Accessed 14 Jan. 2024].

Järfälla Municipality (2022). *Klimatanpassningsplan - Miljöbarometern - Järfälla Kommun*. [online] *Järfälla Kommun*, pp.1–44. Available at: https://jarfalla.miljobarometern.se/klimatanpassningsplan/ [Accessed 14 Jan. 2024].

Järfälla Municipality (2023a). *Miljöplan 2023–2030 För Järfälla Kommun Med Bolag*. [online] *www.jarfalla.se*, pp.1–42. Available at: https://www.jarfalla.se/byggaboochmiljo/klimatochmiljo/miljoochklimatarbete.4.6734bb8137ee0f195980002288.html [Accessed 14 Jan. 2024].

Järfälla Municipality (2023b). *Strategy for Sustainable Urban Development in Jakobsberg*. [online] *www.jarfalla.se*, pp.1–33. Available at: https://www.jarfalla.se/byggaboochmiljo/stadsutvecklingochdetaljplaner/hallbarurbanutveckling.4.5e2d810118697502d118e7ef.html [Accessed 14 Jan. 2024].

Joint Research Centre (2022). *Cities Are Often 10-15 °C Hotter than Their Rural Surroundings*. [online] joint-research-centre.ec.europa.eu. Available at: https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/cities-are-often-10-15-degc-hotter-their-rural-surroundings-2022-07-25_en [Accessed 14 Jan. 2024].

Kiss, B., Sekulova, F., Hörschelmann, K., Salk, C.F., Takahashi, W. and Wamsler, C. (2022). Citizen Participation in the Governance of Nature‐based Solutions. *Environmental Policy and Governance*, 32(3), pp.247–272. doi:https://doi.org/10.1002/eet.1987.

Knight, T., Price, S., Bowler, D., Hookway, A., King, S., Konno, K. and Richter, R.L. (2021). How Effective Is 'Greening' of Urban Areas in Reducing Human Exposure to Ground-level Ozone concentrations, UV Exposure and the 'Urban Heat Island Effect'? an Updated Systematic Review. *Environmental Evidence*, [online] 10(1), pp.1–38. doi:https://doi.org/10.1186/s13750-021-00226-y.

Lawrenz, F., Keiser, N. and Lavoie, B. (2003). Evaluative Site Visits: a Methodological Review. *The American Journal of Evaluation*, 24(3), pp.341–352. doi:https://doi.org/10.1016/j.ameval.2003.08.003.

Li, G., Fang, C., Li, Y., Wang, Z., Sun, S., He, S., Qi, W., Bao, C., Ma, H., Fan, Y., Feng, Y. and Liu, X. (2022). Global Impacts of Future Urban Expansion on Terrestrial Vertebrate Diversity. *Nature Communications*, [online] 13(1), p.1628. doi:https://doi.org/10.1038/s41467-022-29324-2.

Mabrouk, M., Han, H., Fan, C., Abdrabo, K.I., Shen, G., Saber, M., Kantoush, S.A. and Sumi, T. (2023). Assessing the Effectiveness of Nature-based Solutions-strengthened Urban Planning Mechanisms in Forming Flood-resilient Cities. *Journal of Environmental Management*, 344, pp.118260–118260. doi:https://doi.org/10.1016/j.jenvman.2023.118260.

Makido, Y., Hellman, D. and Shandas, V. (2019). Nature-Based Designs to Mitigate Urban Heat: the Efficacy of Green Infrastructure Treatments in Portland, Oregon. *Atmosphere*, 10(5), p.282. doi:https://doi.org/10.3390/atmos10050282.

Marando, F., Heris, M.P., Zulian, G., Udías, A., Mentaschi, L., Chrysoulakis, N., Parastatidis, D. and Maes, J. (2022). Urban Heat Island Mitigation by Green Infrastructure in European Functional Urban Areas. *Sustainable Cities and Society*, 77, p.103564. doi:https://doi.org/10.1016/j.scs.2021.103564.

Milliken, S. (2018). Ecosystem Services in Urban Environments. *Elsevier eBooks*, pp.17–27. doi:https://doi.org/10.1016/b978-0-12-812150-4.00002-1.

Nasar, J.L. and Jones, K.M. (1997). Landscapes of Fear and Stress. *Environment and Behavior*, 29(3), pp.291–323. doi:https://doi.org/10.1177/001391659702900301.

O'Sullivan, F., Mell, I. and Clement, S. (2020). Novel Solutions or Rebranded Approaches: Evaluating the Use of Nature-Based Solutions (NBS) in Europe. *Frontiers in Sustainable Cities*, 2, pp.1–13. doi:https://doi.org/10.3389/frsc.2020.572527.

Patton, C.V., Sawicki, D.S. and Clark, J. (2016). *Basic Methods of Policy Analysis and Planning*. London ; New York: Routledge.

Patton, M.Q. (2015). Evaluation in the Field. *American Journal of Evaluation*, 36(4), pp.444–460. doi:https://doi.org/10.1177/1098214015600785.

Prokić, M., Savić, S. and Pavić, D. (2019). Pluvial Flooding in Urban Areas across the European Continent. *Geographica Pannonica*, 23(4), pp.216–232. doi:https://doi.org/10.5937/gp23-23508.

Puskás, N., Abunnasr, Y. and Naalbandian, S. (2021). Assessing Deeper Levels of Participation in nature-based Solutions in Urban Landscapes - a Literature Review of

real-world Cases. *Landscape and Urban Planning*, 210, p.104065. doi:https://doi.org/10.1016/j.landurbplan.2021.104065.

Ruiz, J.S. (2019). *LEAFSKIN® Green Shady Structure*. [online] Oppla. Available at: https://oppla.eu/casestudy/19393 [Accessed 15 Dec. 2023].

Sarabi, S.E., Han, Q., Romme, A.G.L., Vries, B. de and Wendling, L. (2019). Key Enablers of and Barriers to the Uptake and Implementation of Nature-Based Solutions in Urban Settings: a Review. *Resources*, 8(3), p.121. doi:https://doi.org/10.3390/resources8030121.

Statisticon (2023). *Befolkningsprognos*. [online] Järfälla I Siffror. Available at: https://www.jarfalla.se/kommunochpolitik/insynochrattssakerhet/jarfallaisiffror.4.640dac6b1300db73e7c800010856.html [Accessed 9 Jan. 2024].

Statistics Sweden (2022). *Population per Region by Age and sex. Year 2010 - 2022*. [online] Statistikdatabasen. Available at: https://www.scb.se/en/ [Accessed 9 Jan. 2024].

Stockholm County Council (2018). *Regional Development Plan for the Stockholm Region*. [online] www.regionstockholm.se. Available at: https://www.regionstockholm.se/om-regionstockholm/Information-in-English1/Regional-development/ [Accessed 14 Jan. 2024].

Swedish Environmental Protection Agency (2022). *Nature-based Solutions-A Tool for Climate Adaptation and Other Societal Challenges*. [online] *www.naturvardsverket.se*, Bromma, Sweden: Naturvårdsverket, pp.7–182. Available at: https://www.naturvardsverket.se/publikationer/7000/978-91-620-7074-8/ [Accessed 15 Dec. 2023].

Therese Fallast, M., Pansinger, S., Krebs, G., Moser, M. and Zobl, A. (2021). Systematically Retrofitting City Streets: Meeting the Demands of Climate Change through Multifunctional Climate-responsive Street Gardens. *Urbani Izziv*, 32(1), pp.111–122. doi:https://doi.org/10.5379/urbani-izziv-en-2021-32-01-004.

Willems, J.J., Molenveld, A., Voorberg, W. and Brinkman, G. (2020). Diverging Ambitions and Instruments for Citizen Participation across Different Stages in Green Infrastructure Projects. *Urban Planning*, 5(1), p.22. doi:https://doi.org/10.17645/up.v5i1.2613.

Wong, N.H. and Yu, C. (2005). Study of Green Areas and Urban Heat Island in a Tropical City. *Habitat International*, 29(3), pp.547–558. doi:https://doi.org/10.1016/j.habitatint.2004.04.008.

Xing, Y., Jones, P. and Donnison, I. (2017). Characterisation of Nature-Based Solutions for the Built Environment. *Sustainability*, 9(1), p.149. doi:https://doi.org/10.3390/su9010149.

8. Appendix

Appendix 1, Documents analysed and their relevant contents in the scope of this report. By author

Document	Dates relevant	Problem Identification	Proposed NBS from the municipality	Establish Evaluation Criteria
Översiktsplan	2023-2030	The municipality of Järfälla identifies tackling climate change as a key focus amidst growth. They assert that Järfälla has a crucial role in the future growth of Stockholm and Sweden. The environmental issues highlighted include the reduction of greenhouse gases, effective energy production, and the adaptation of urban areas to the effects of climate change. Closeness to green areas and creating a built environment prioritising the interplay of green areas, humans, and nature are also recognized as important aspects.	**"Water and green areas of high quality"**: Emphasis on the health of environments and parks, with specific guidelines for biodiversity, ecosystem services, and the preservation of green areas and nature reserves. **"The meeting between urban and nature"**: Focus on making nature accessible to people, with guidelines for parks, connectedness to nature, and the use of newly built areas to bring people closer to nature. **"Future-proof and robust technical infrastructure"**: Precursor to NBS, with guidelines for using technical NBS to adapt to a changing climate. Suggestions include compensating impermeable areas with green roofs, using greenery and water to mitigate floods and heat stress, strategic placement of buildings to minimise flood risks, and introducing	The document mentions the concept of the "green areal factor," which is a measurable goal for progress. The municipality aims to achieve a factor of 0.5 in newly built areas, calculated by the amount of ecologically active ground divided by the area of the plot. This provides a quantifiable criterion to evaluate and map the progress in incorporating greenery into the municipality. However, specific details about the current progress or monitoring mechanisms are not explicitly mentioned in the provided content.

			multifunctional areas for flood mitigation.	
Grönstruktur-plan	Published in 2018, not finished yet	The **Grönstrukturplan** identifies the primary challenge for Järfälla as addressing dynamic environmental changes and urbanisation. The municipality emphasises the importance of its robust green structure, acknowledging its role in residents' recreation, health, and ecosystem services, particularly in climate regulation. Seven specific challenges related to the planning, development, and management of Järfälla's natural land are outlined, along with corresponding objectives.	Proposed several Nature-Based Solutions (NBS) through guidelines and planning principles: Future scenarios illustrating valuable tree species areas, green structure distribution, ecological landscape connections, and flood-prone zones. Guidelines for green patterning encompassing planning, design, and management principles. Emphasis on regional city centre planning with a grid city structure and parks. Mention of ecological connections for bees and butterflies, distribution of amphibian habitats, and land providing ecosystem services in the current state analysis.	The document outlines mechanisms for evaluation and follow-up, including: ● Green model analysis ● Biodiversity assessment ● Citizen participation evaluation ● Rainwater assessment However, the document notes that it appears incomplete, with several maps and commitments for future implementation lacking clarity. Despite being released in 2018, there is no information on subsequent revisions or updates on official government platforms. The Miljöplan 2023–2030 mentions the approval of the Grönstrukturplan, but gaps between resident input and planning outcomes indicate a need for more meaningful resident engagement. Additionally, incomplete maps about green spaces and the lack of clear commitments

				for future implementation are highlighted in the document.
Environmental plan	2023-2030	In the Environmental Plan 2023-2030, the municipality identifies two key goals relevant to the project: **"Good Built Environment":** Focuses on sustainable development, resilience, and nature and culture prioritisation. It aims to certify buildings with high standards, implement stormwater cleaning measures, and effectively plan for climate change challenges. **"Rich Plant and Animal Life":** Aims to preserve, utilise, and develop biological diversity sustainably. It includes goals for protected nature areas, prioritised landscape connections, and	**"Good Built Environment":** Measures include the development of a green structure plan, implementation of green roofs and walls for stormwater cleaning, and strengthening ecosystem services in the physical planning of the municipality. However, the document lacks specific details on how NBS will be utilised, such as the quantity and location of green roofs or the specific plants used. **"Rich Plant and Animal Life"**:Measures include increasing biodiversity and ecosystem services, protecting "super trees," and creating inventories of existing green spaces. While the document expresses a desire to develop biodiversity and ecosystem services in urban areas, specific NBS strategies are not detailed.	**"Good Built Environment":** The goal has specific indicators, such as the presence of a green structure plan with a green-areal-factor. However, some indicators lack concrete details, leading to potential challenges in assessing progress. **"Rich Plant and Animal Life":** The goal includes indicators related to the area of protected nature, preservation of landscape connections, and tree coverage. However, specific details on how the municipality plans to achieve increased ecosystem services are not provided. The document outlines the municipality's environmental goals, which are inspired by Agenda 2030 and Swedish environmental goals. The goals are measurable, with specific indicators, but some lack the level of detail necessary for clear assessment. The municipality

		increased tree coverage in both newly built and existing areas.		expresses a commitment to sustainable development and environmental conscientiousness.
Strategy for Sustainable Urban Development in Jakobsberg	2023	The Strategy for Sustainable Urban Development in Jakobsberg primarily focuses on environmental, social, and economic sustainability. Grounded in green, productive, and equitable principles, the strategy assesses the current status and proposes measures in three fields: Green Jakobsberg, Productive Jakobsberg, and Equitable Jakobsberg.	In the Green Jakobsberg section, the aim is to establish a municipal area with more greenery, whether on the ground, rooftops, or facades. Three key measures in the areas of biodiversity, climate adaptation, and climate resilience are presented. Some of the NBS-related measures include: Use of reservable planting boxes in municipal areas; Planting mini-forests near schools Increasing tree canopy coverage Establishing different wildlife corridors; Incorporating digital technology into considerations.	The strategy document outlines implementation and follow-up actions, including a budget of 83 million SEK and collaboration with resident groups. Coordinators will monitor and follow up on the implementation using online platforms. However, there are challenges in finding detailed information on these measures on the municipal website, and many descriptions lack conclusive details, possibly due to ongoing deliberations. Potential risks lie in the description of project details, making it challenging to discern the extent of implementation, identify benefiting groups, and understand citizen participation, introducing an element of ambiguity to the measures.

Appendix 2. Guidelines presented by the municipality in the Översiktsplan (Järfälla Municipality, 2014, 34-40)

Section	Guidelines
"Water and green areas of high quality" (Järfälla 2014, 34)	➢ To preserve and increase the worth of nature reserves within the current borders ➢ Work with neighbouring municipalities to care for Görvälnkilen and Järvakilen ➢ Key biotopes and the priority ecological landscape connection's duties should be ensured ➢ Bällstaån and Veddestabäcken should be developed as greenblue recreational areas ➢ Multifunctional areas should be preserved and developed to contribute to more ecosystem services ➢ Each resident should have at least 300m walking distance to a park, and 500m to a city park ➢ Current green areas in parks should be protected ➢ Urban parks should be moulded to promote a sense of calm as well as a space for recreation ➢ Areas for children to play should be placed in areas with good air quality ➢ The children's possibilities to play in nature should be supported
"Meetings between the urban and nature" (Järfälla 2014, 35)	➢ Buildings in closeness to parks and nature should be planned consciously ➢ Urban walking and biking tracks should be well connected with the paths to nature reserves and recreational spaces ➢ New builds should be used to make nature more accessible ➢ Possibilities to grow own food should be placed in the built up areas
"Future-proof and robust technical infrastructure" *Out of 10 guidelines, these are relevant to our project. The others can be found on page 40 of the Översiktsplan.* (Järfälla 2014, 40)	➢ There will be good access and availability to recycling facilities. ➢ The percentage of impermeable ground will be minimised. Green roofs and walls will be prioritised. ➢ Storm water should be cleaned as close to the source as possible. ➢ There should be a large element of greenery, water, and permeable ground in the city environment to produce a good storm water management and to reduce the effect of heat waves. ➢ Technical systems and buildings should be placed in a way that minimises the risk for flooding. ➢ Multifunctional areas should be used to limit the consequences of flooding. For example, parks and nature reserves can be created to produce overflow areas. ➢ Adaptation to climate change will be done.

Appendix 3. Seven targets of Green Structure in Järfälla (Järfälla Municipality, 2018, 14)

Targets	**Ecosystem services**
Provide **experience-rich and easily accessible** parks, natural areas, open spaces and greenways.	Productive - oxygen; regulatory - air, water; cultural - experience, memory.
Take into account, preserve and develop selected **species' habitats and connections.**	Supporting all ecosystem services
Järfälla residents should be offered **participation** in the development of their own neighbourhood	Cultural - preserving memories, creating new values
Allow the green structure to be **sufficiently extensive** to receive large amounts of precipitation and high water flows, regulate the temperature and provide good recreational values.	Regulatory - retardation, equalisation, purification, temperature reduction
Preserve, protect and visualise the **historic landscape** and add new landscape values.	Cultural - memories, creating new values
Create **water treatment facilities** in parks, nature and green urban spaces that interact with the site and provide **experiential values**.	Regulatory - cleaning stormwater; productive - drinking water; cultural - experiences and well-being.
Design **attractive**, **safe** public spaces with a wide range of experiences and activities.	Cultural - experiences, memories

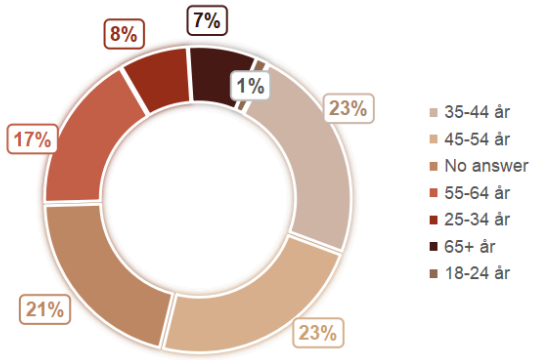
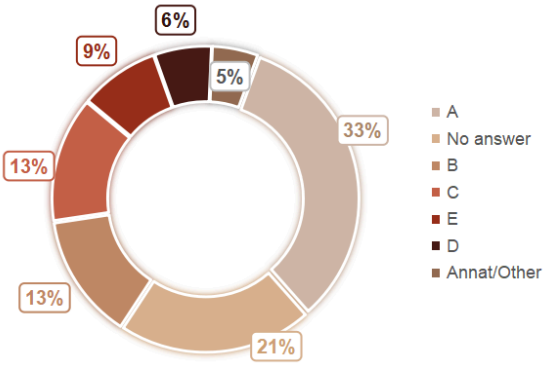
Appendix 4: Relevant NBS Guidelines of planning, design and management (Järfälla Municipality, 2018, 44-50)

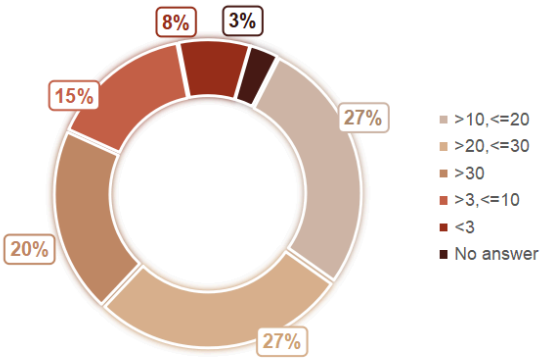
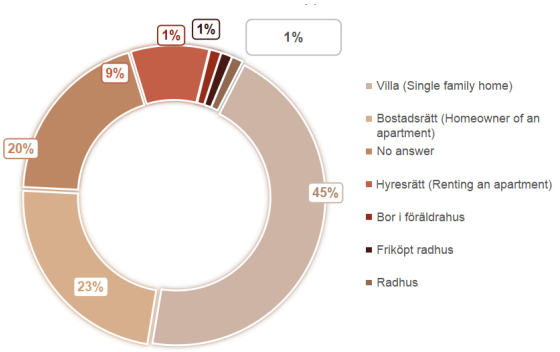
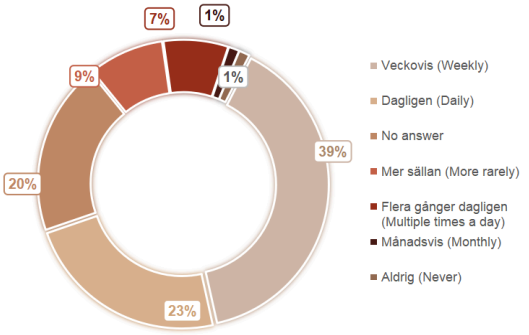
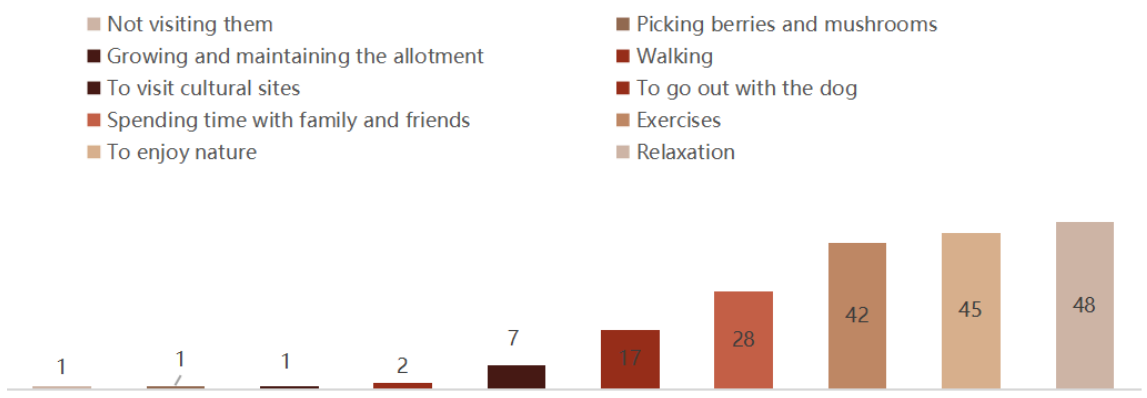
Processes	Relevant Guidelines
Planning	➢ Prioritise the conservation and development of two main green corridors, Görvälnkilen and Järvakilen, with a focus on reinforcing Görvälnkilen's weaker segments in Stäket. ➢ Protect and develop the valuable oak areas in Jakobsberg North, Kallhäll, and Stäket, recognized for their significance at European and regional levels. ➢ Ensure adequate space for tree growth in detailed planning, with specified distances from buildings depending on tree size. ➢ Implement a tree-planting scheme in parking lots, with one tree per ten parking spaces, grouping them into clusters. ➢ Encourage planting tree species from latitudes similar to Sweden in parks, beneficial for local wildlife. ➢ Integrate green infrastructure considerations into park siting, cultural landscape, and natural area conservation. ➢ Ensure each urban district has at least one well-designed park section or a flourishing pocket park. ➢ Utilise streets for rainwater management, leveraging their ecological potential for retention and purification.
Design	➢ Design parks and conserve areas with attention to green infrastructure, ecological connections, and historical and species diversity. ➢ Base spatial planning on integrity areas, defining personal, social, public, and expressive encounter ranges. ➢ Topography is utilised and reinforced to provide varied movement experiences of physical exertion for both children and adults. ➢ Park benches are placed every 250 metres. ➢ Installations are only permitted if they comply with the reserve's regulations and do not contravene the Cultural Environment Act. Applications for licences are made to the relevant authority.
Management	➢ The forest and park management plan is being developed based on the Biodiversity Action Plan. ➢ Management that favours species linked to pasture - such as mowing, grazing and arable land use - should be strengthened. ➢ Parks, natural areas and greenways that belong to the ecological landscape connections selected by the municipality must be managed so that the function of the connections is maintained and strengthened. ➢ Great importance is attached to the choice of plants to ensure that pollinators have access to nectar from early spring to late autumn. ➢ Seasonal changes are highlighted by choosing plants with different flowering time, leaf colour and fruiting. Great emphasis is placed on the selection of plants to ensure that pollinators have access to nectar from early spring to late autumn. ➢ Plants with strong fruiting are chosen for parks and natural areas, but not for streets and squares.

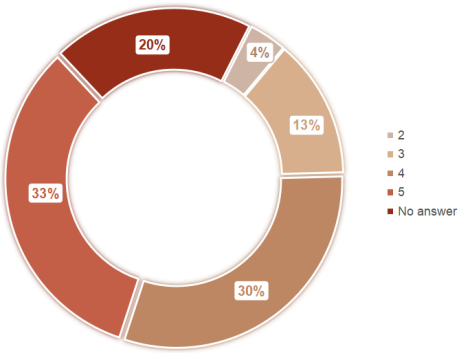
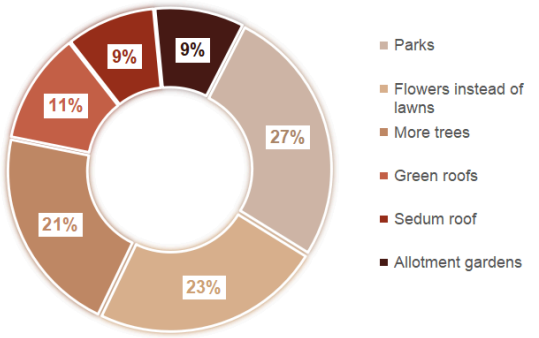
Appendix 5: A few of proposed NBS-related measures for Gröna Jakobsberg

Fields	**Measures**
Biodiversity	➢ Create a greener Jakobsberg by increasing urban cultivation in the municipal area; ➢ Expand the work with and create four mini-forests; ➢ Increase the degree of crown coverage in built-up parts of Jakobsberg; ➢ Increase the conditions for biological diversity; ➢ Deadwood lane in Jakobsberg; ➢ Extra beehive behind Jakobsberg Centrum; ➢ Development of GIS as an analysis tool to promote work with biodiversity; ➢ Jakobsberg,as the testers for digital twins, develop 3D city models.
Climate adaptation and climate neutrality	➢ Utilise roof surfaces in the municipal district of Jakobsberg to contribute to a faster climate transitioning; ➢ Promote increased energy efficiency and strengthen work with PED ➢ Action studies and cost-benefit analysis for flood measures in central Jakobs Mountain; ➢ Promote a circular urban development in Jakobsberg; ➢ Promote a sustainable renovation of properties.
Climate-smart mobility	➢ Simplify and make accessible routes to Jakobsberg's green areas; ➢ Establish mobility hubs in Jakobsberg.

Appendix 6. Questions and results from the surveys

Questions	**Results**
Samtycke/Consent Innan du fortsätter, vänligen ge ditt samtycke till att vi kan använda de svar du tillhandahåller. Vi försäkrar dig om att din information och dina svar kommer att behandlas konfidentiellt och endast användas inom ramen för dessa två projekt. Vi kommer inte att dela din information med obehöriga parter. Before you proceed, please provide your consent for us to use the information you provide. We assure you that your information and responses will be treated confidentially and used solely for the purposes of these two projects. We will not share your information with any unauthorised parties.	100% Ja, jag samtycker (Yes, I consent)
Hur gammal är du? How old are you?	
Vart bor du? Where do you live? 	

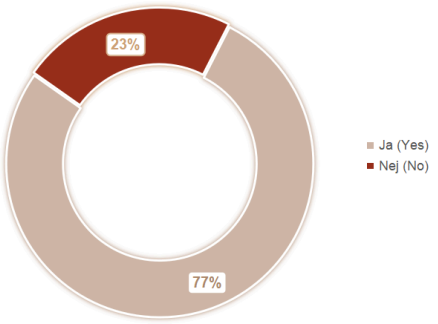
Hur länge har du bott i Jakobsberg? How long have you lived in Jakobsberg?	
Vad är din nuvarande bostad status? What is your current residential status?	
Hur ofta besöker du grönområden såsom parker, skog, eller trädgårdar nära dig? How often do you visit green areas such as parks, forests, or gardens near you?	
Varför besöker du dessa grönområden? Why do you visit these green areas? (Välj alla som gäller/Select all that apply)	
	

På en skala av 1-5 (där 1 är lägst och 5 är högst), hur skulle du värdesätta kvaliteten av de grönområdena nära dig? On a scale 1-5 (Where 1 is the lowest and the 5 the highest), how would you rate the quality of the urban green spaces close to you?	
Om naturbaserade lösningar skulle implementeras nära dig, vad hade du föredragit (välj alla som gäller): If nature based solutions would be implemented near you, what would prefer (choose all that apply):	

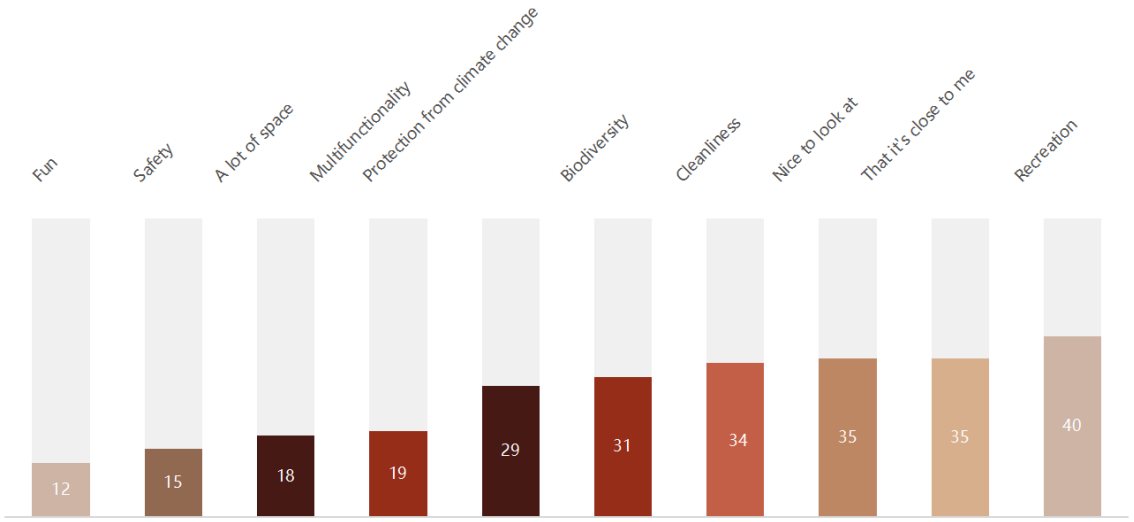
Om du valde "other", vilka naturbaserade lösningar hade du vilja ha?

If you chose "other," which nature based solutions would you want?

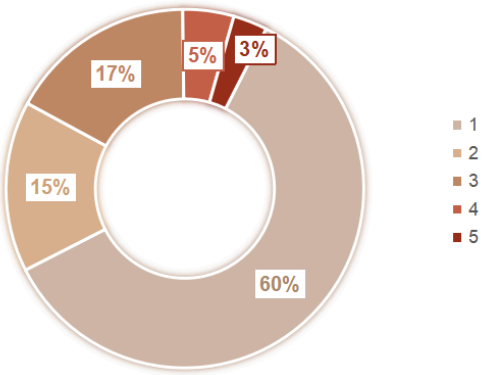
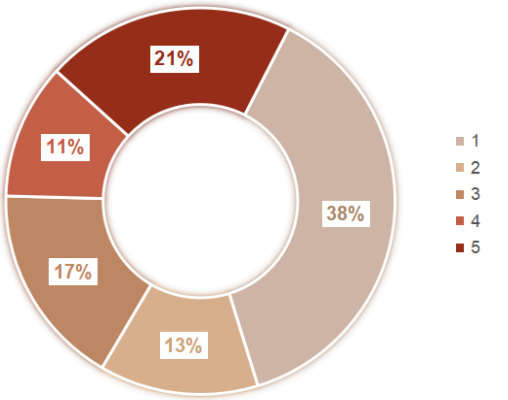
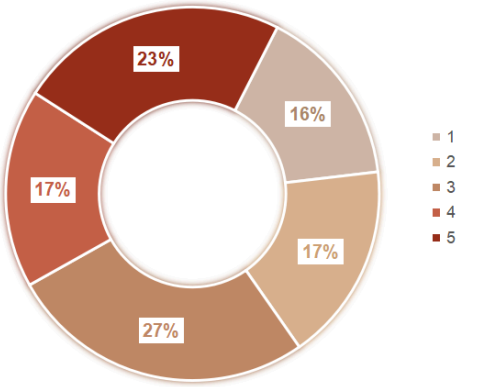
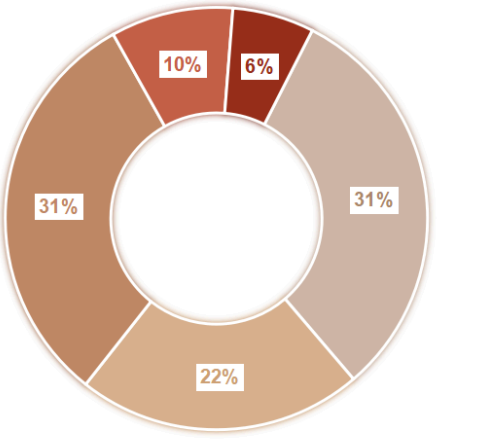
Mer djur.
mer konst ute i naturen, vi har såna fina gröna yter att msn ksn ha både konst med blommor å träd till dkulpturer.
Gräsområden och gamla fotbollsplaner skulle man kunna plantera om så att det finns intressanta växter och små träd att klättra på. Folk går inte i skogen. Men barnen som bor på området skulle säkert nyttja de. Till ex skapa kringelkrogig cykelbana mellan buskar.
Om man slutar ta bort för onödiga byggen, behover man inte göra konstgjorda åtgärder.
Genomtänkta planteringar i rondeller, se t.ex nuvarande tråkiga stenlagd rondell utanför polishuset eller tomma rostiga lådor utanför Grilliant/Kvarnvägen/Dansgaraget.
Hade varit fint om Bällstaån skulle kunna omvandlas till ett grönblått stråk med parker, vattenhantering, odling och mer rekreation. Som skulle kunna binda ihop Jakobsberg, Viksjö och Veddesta/Barkarby.
Inga.
Bygga försiktigt. Lämna kvar natur .
Se ovan, mera grönt runt centrum och ökad närhet till Kvarnbacken utan att passera otrygga tunnlar.
Naturlig skog, äng.
Bergemsparken är ok

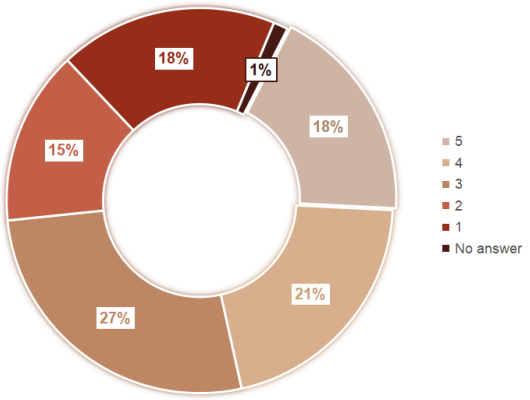
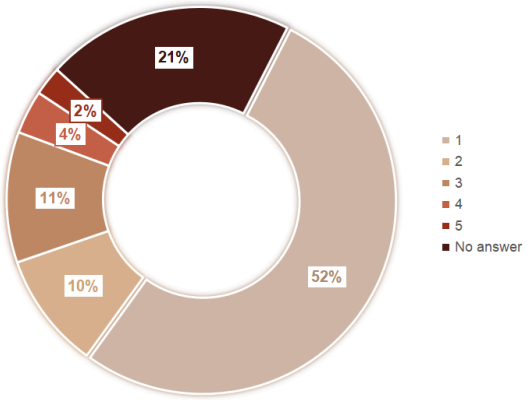
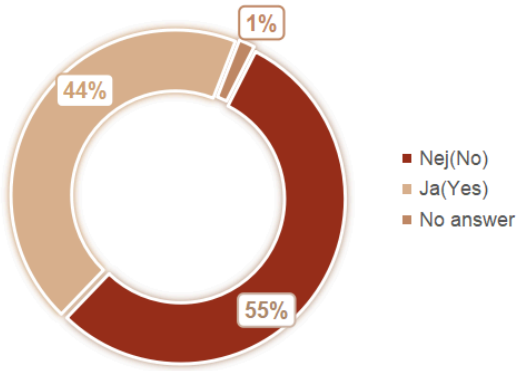
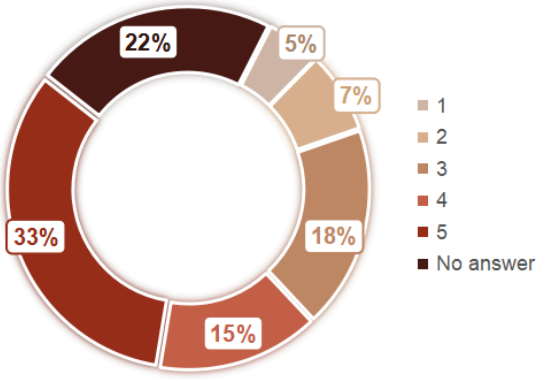
Skulle du vilja att det implementeras flera naturbaserade lösningar nära dig? Till exempel takträdgårdar, flera kolonilotter, flera träd? Would you like there to be more implementation of nature based solutions close to you? For example, rooftop gardens, allotment gardens, or more trees?	
Var snäll och motivera ditt svar. Det kan vara allt från att du tycker att det hade känts mindre tryggt med flera träd, eller om du verkligen vill att det ska finnas flera möjligheter för dig att odla eget. Please motivate your answer. You can answer anything- for instance, perhaps you would feel more unsafe if there were more trees planted, or maybe you really want a chance to grow your own food!	These results are in Appendix 7.

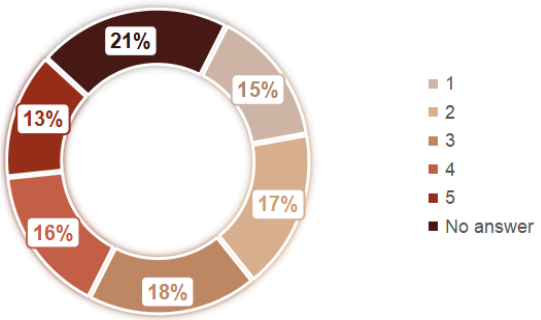
Vad är viktigt enligt dig när det kommer till gröna områden? What is important to you regarding green spaces? (Välj alla som gäller/Select all that apply)



Om du valde "annat", berätta gärna om varför. If you picked "other" please tell us why.	Se mitt svar vid Övrigt. Så lite tillrättalagda miljöer som möjligt. I Sverige råder ingen brist på skog/träd, däremot så behövs mer öppna marker för blommor och andra växter för att tillföra en balanserad flora. Naturen är viktigare 100 procent än kliniska parker

Jag känner mig inkluderad i kommunens planeringsprocess där det gäller utvecklingen av bl.a grön infrastruktur. I feel included in the municipality's planning process regarding the development of, for example, green infrastructure.	
Jag känner mig inkluderad i min förenings- eller hyresvärdens planer för grönområden nära där jag bor. I feel included in my housing associations or rental associations plans for the green areas close to where I live.	
Jag skulle vilja vara mer involverad i planeringsprocessen gällande grönområden nära mig. I would like to be more involved in the planning process regarding green areas near me.	
Jag är nöjd med mängden information vi får om gröna områden och planeringen av gröna områden i Järfälla kommun. I am satisfied with the amount of information we get about green areas and the planning of them in Järfälla municipality.	

Jag är påverkad av värmen under somrarna där jag bor. I am impacted by the heat during the summers where I live.	
Jag är påverkad av översvämningar där jag bor. I am impacted by flooding where I live.	
Jag skulle vara villig att vårda annan övrig grön infrastruktur såsom kolonilotter om det fanns nära mig. I would be willing to take care of other green infrastructure like allotment gardens if they existed near me.	
Jag skulle vilja ha flera multifunktionella* grönområden nära mig. I would like to have more multifunctional* green spaces near me. *Med multifunktionalitet menas att det gröna området kunde användas till flera olika användningsområden. Till exempel att odla mat, grilla, leka, utföra motion, öka biodiversitet osv. *By multifunctionality we mean a green area that could be used for multiple	

purposes. For example, to grow food, bbq, play, exercise, increase biodiversity etc.	
Jag är nöjd med det gröna i mitt område och vill inte se ändringar. I am satisfied with the greenery in my area, and don't want any changes.	

The following questions are the corporation with the other group in green roofs.

Skulle du vara mer intresserad av att bo i en bostad med tillgång till takträdgårdar om du kunde påverka din hyra genom att hjälpa till med skötseln av trädgården?

Would you be more interested to living in a residence with access to rooftop gardens if you could affect your rent by helping out with the maintenance of the garden?

- ○ Yes
- ○ No

Skulle du vara villig att betala mer varje månad för att ha en takträdgård eller ett grönt tak på ditt hus? Would you be willing to pay more every month to have access to a green roof in your building?

- ○ Ja (Yes)
- ○ Nej (no)

Vilka fördelar förknippar du med takträdgårdar och gröna tak? What benefits do you associate with rooftop gardens and green roofs? (Välj alla som gäller/Select all that apply)

- [ ] Förbättrad luftkvalité (Improved air quality)
- [ ] Energieffektivitet (Energy efficiency)
- [ ] Förbättrad utseende (Enhanced aesthetics)
- [ ] Ökat fastighetsvärde (Increased property value)
- [ ] Matproduktion (Food production)
- [ ] Rekreation (Recreation)
- [ ] Ökad biodiversitet (Increased biodiversity)
- [ ] Other...

Om du vet att det finns takträdgårdar i ditt område, har du någonsin besök eller använt en? If you are aware of rooftop gardens or green roofs, have you ever visited or utilized one?

- ○ Ja (Yes)
- ○ Nej (No)
- ○ N/A

Om du vet att det finns takträdgårdar i ditt område, har du någonsin besök eller använt en? If you are aware of rooftop gardens or green roofs, have you ever visited or utilized one?

- ○ Ja (Yes)
- ○ Nej (No)
- ○ N/A

Vet du i fall det finns takträdgårdar eller s.k. gröna tak i ditt område? Are you aware of the existence of rooftop gardens or green roofs in your area?

- ○ Ja (Yes)
- ○ Nej (No)
- ○ Kanske (Maybe)

Om du valde "annat" berätta gärna om varför.

If you picked "other" please tell us why.

Long-answer text

Vad är viktigt enligt dig när det kommer till gröna områden?

What is important to you regarding green spaces?

- ☐ Renhet (Cleanliness)
- ☐ Mycket plats (A lot of space)
- ☐ Biodiversitet (Biodiversity)
- ☐ Multifunktionalitet (Multifunctionality)
- ☐ Skydda mot klimatförändringar (Protection from climate change)
- ☐ Rekreation (Recreation)
- ☐ Fint att titta på (Nice to look at)
- ☐ Rolig (Fun)
- ☐ Säkerhet (Safety)
- ☐ Att det är nära mig (That it's close to me)
- ☐ Other...

Appendix 7. Public responses on why Jakobsberg needs more NBS, direct translation from author

Respondent	Response
1	**Good as it is.**
2	Järfälla seems to have far more green areas than they can take care of. For many years I have fought for Järäflla municipality to maintain trees that block street lights.
3	We have **too much concrete**, asphalt, and glass in the area, especially in the new-builds.
4	I get **happiness** from flowers.
5	It feels nicer to be able to **rent a space to garden**, cosy.
6	Moved here a lot for natural areas that exist. The trend now is to take down trees everywhere, private individuals as well as in public. Knowledge of the ecosystem has become frighteningly poor. More parks/flowers/trees should be planted between homes and where there is space. The trees at E18 were taken down at Tånglöt, Shurgard - they need to be restored for less noise and air purification, now it feels like the motorway is outside the house compared to before, the noise from the road is very disturbing. **The environment is worse.**
7	There are few **green areas** that don't feel like **an emergency solution** from the council. **We need more real green areas.**
8	Flowers in all the colours of the rainbow as pollinators and which create sensual experiences and joy in more places. Preferably around roundabouts, junctions and exits.
9	**The sunflower farms in Järfälla are fantastic**, but a little more interesting plantings would be needed when the municipality e.g. is spending millions on the fence along Mälarvägen down to Görväln and the design of the fence now "steals" a large part of the natural experience of walking along Mälarvägen. **Jakobsberg centre is a disaster** - there have been small point efforts, but an overall approach is needed to make the centre's surroundings pleasant to visit and stay with more benches, "rooms", plantings, works of art such as conversation-pieces.
10	**It increases safety in areas** where it leads to more adults outside. People in areas become somewhat familiar with each other.
11	I would think it would be fun to be able to plant your own food/if there was generally better accessibility to grow your own food when you don't have your own garden. It was fun to see the interest that would potentially be aroused in people who had not previously thought about it.
12	Far too few parks/green areas/trees are built when new residential areas are

	built. It will be unpleasant to stay there when there are only lots of buildings without green areas between the houses.
13	It's always nice to have green, **if it's taken care of**! We don't want any more problems with rats or pests near homes or shops.
14	There are plenty of allotment gardens in the area.
15	Turn football pitches into fun gardens!
16	As I live today, I already have access to lots of green spaces, forest areas, etc.