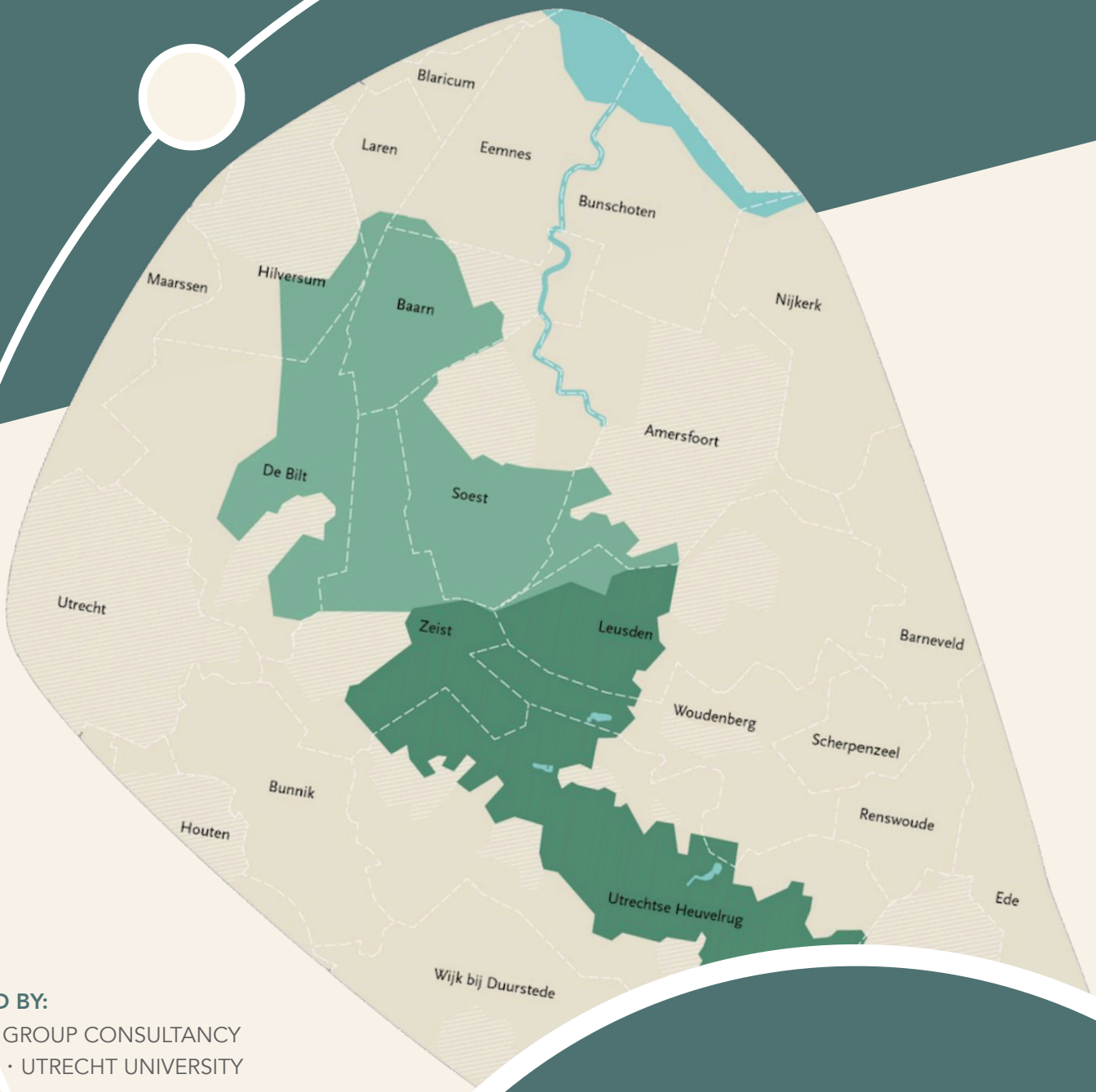
Blauwe Agenda
Utrechtse Heuvelrug



PREPARED BY:
STUDENT GROUP CONSULTANCY
PROJECT · UTRECHT UNIVERSITY

PREPARED FOR:
NPUH BLAUWE AGENDA
CONTACT PERSON: JEROEN HEEMSBERGEN

Nationaal Park Utrechtse Heuvelrug

Utrecht University

BLUE AGENDA

Decoupling the Rainwater System

Consultancy Report for NPUH

APRIL 2024

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Integrative Executive Summary

The disconnection from sewage systems in urban areas has a remarkable potential for groundwater infiltration at the Utrechtse Heuvelrug; up to a >2m increase in annual groundwater level at the Utrechtse Heuvelrug can be achieved if 100% disconnected sewer systems is achieved by all 14 municipalities at the study area (NPUH, 2021).

It is, however, indicated by the client that an in-depth analysis of the actualisation of such measures has been under-researched. Hence, this document seeks to contribute to the existing data with contributions of literature reviews and in-person interviews with spokespeople at each municipality in order to assess the current social, geographical and political environment surrounding disconnection of sewer systems.

The key goal is to identify the best practices to accelerate urban disconnection.

This document establishes municipal policy strategies in Subchapter 1, drivers and barriers for the implementation of measures in Subchapter 2, and geographical- and hydrological indicators relevant to assessing the urban infiltration potential in Subchapter 3. The findings of each subchapter are integrated into a collective analysis of each municipality in the integrative section.

Stemming from this analysis, three municipalities have been highlighted as having the highest potential for effective urban disconnection: **Soest, Hilversum,** and **Zeist**. The first key takeaway of this consultancy is:

- *Delegate additional resources to these three municipalities to overcome their political and social barriers in order to accelerate effective disconnection.*

The remaining municipalities are subsequently included in this analysis. Next, the following three municipalities have been established for further analysis: **Utrechtse Heuvelrug, Veenendaal,** and **Laren**. Each of these municipalities illustrates the individual variance in policy strategies, flourishment of drivers and barriers, and geographical conditions. We provide these analyses to spearhead our advice for the NPUH:

- *Cater to the needs and resource requirements of individual municipalities with a tailored approach in order to accelerate disconnection across all municipalities at the Utrechtse Heuvelrug.*

Integrative Advice

Introduction

SITUATION

Stichting Nationaal Park Utrechtse Heuvelrug (hereinafter NPUH) is the client for this consultancy project, which is an organisation active in the identically named area in the centre of the Netherlands, in the province of Utrecht. The park has a variety of landscapes, and its ridge was created during the last ice age. As nature has a high priority for the NPUH, their biggest goal is to improve biodiversity within the park, by creating ecological connections. Next to that, the NPUH acts as a communicator with the different actors in the area and coordinates collaborative action, as they are involved with the management of the park. Besides this, it lobbies for the park (to get financial means), shares knowledge and is always looking for ways to create projects to improve the park.

The NPUH collaborates with waterboards and water companies in their project the "Blauwe Agenda" (Blue Agenda). The Blue Agenda is a project to create a robust and future-proof water system on the Utrechtse Heuvelrug. The goal of the project is to increase the reach and thus the impact of the Blue Agenda, get new insights into how the Blue Agenda can be implemented and to facilitate that information reaches the right places and people (NPUH, 2022).

Within this project, the NPUH is responsible for facilitating participation procedures to involve the municipalities with the Blue Agenda, by organising information meetings. Furthermore, the NPUH creates awareness campaigns to let inhabitants, visitors and others become a part of the solution for the Blue Agenda. Additionally, the NPUH will share knowledge about the updates on the progress of the Blue Agenda and in a knowledge base on their website. Lastly, the NPUH does research to get insight into how water can be a guiding mechanism to design landscapes (NPUH, 2022).

COMPLICATION

Despite widespread availability of literature regarding the water system of the Utrechtse Heuvelrug, numerous municipalities of the Utrechtse Heuvelrug struggle with implementing urban measures for improving their groundwater recharge. Future climate scenarios put additional pressure on the member municipalities of the Utrechtse Heuvelrug to accelerate such urban measures. Climate models portray a future of more extreme weather events, prolonged droughts, increased global temperatures and reduced precipitation, which all affect the hydraulic system of the Utrechtse Heuvelrug.

Hence, the research on the effectiveness and necessity of urban water disconnection is extensive. The main information gap that currently exists is why municipalities have yet to employ effective strategies for the implementation of urban water disconnection despite the extensive pressures portrayed by future

climate scenarios. The NPUH seeks to increase its value proposition to the member municipalities, but drivers and barriers for implementation of effective disconnection policies have yet to be extensively identified for each municipality.

In light of the recently published climate scenarios by KNMI '23, it is stressed that more urgent and drastic measures are taken by member municipalities to maintain a good status for the hydraulic cycle of the Utrechtse Heuvelrug. To ensure that the extensive efforts of the NPUH to provide research and facilitate necessary interactions are fully utilised, this project group will study the progress, drivers, barriers and physical properties of each participating municipality regarding the decoupling of rainwater from the sewer system. Moreover, fruitful stakeholder interactions may be accelerated when a mutual understanding of barriers and drivers has been clarified.

QUESTION

The overarching question of this consultancy project will be: **"How can the decoupling of rainwater from the sewer system in municipalities throughout the Utrechtse Heuvelrug be accelerated through the Blue Agenda?"** For which three different sub questions are formulated to answer this overarching question.

Advice 1: Focus on Soest, Zeist & Hilversum

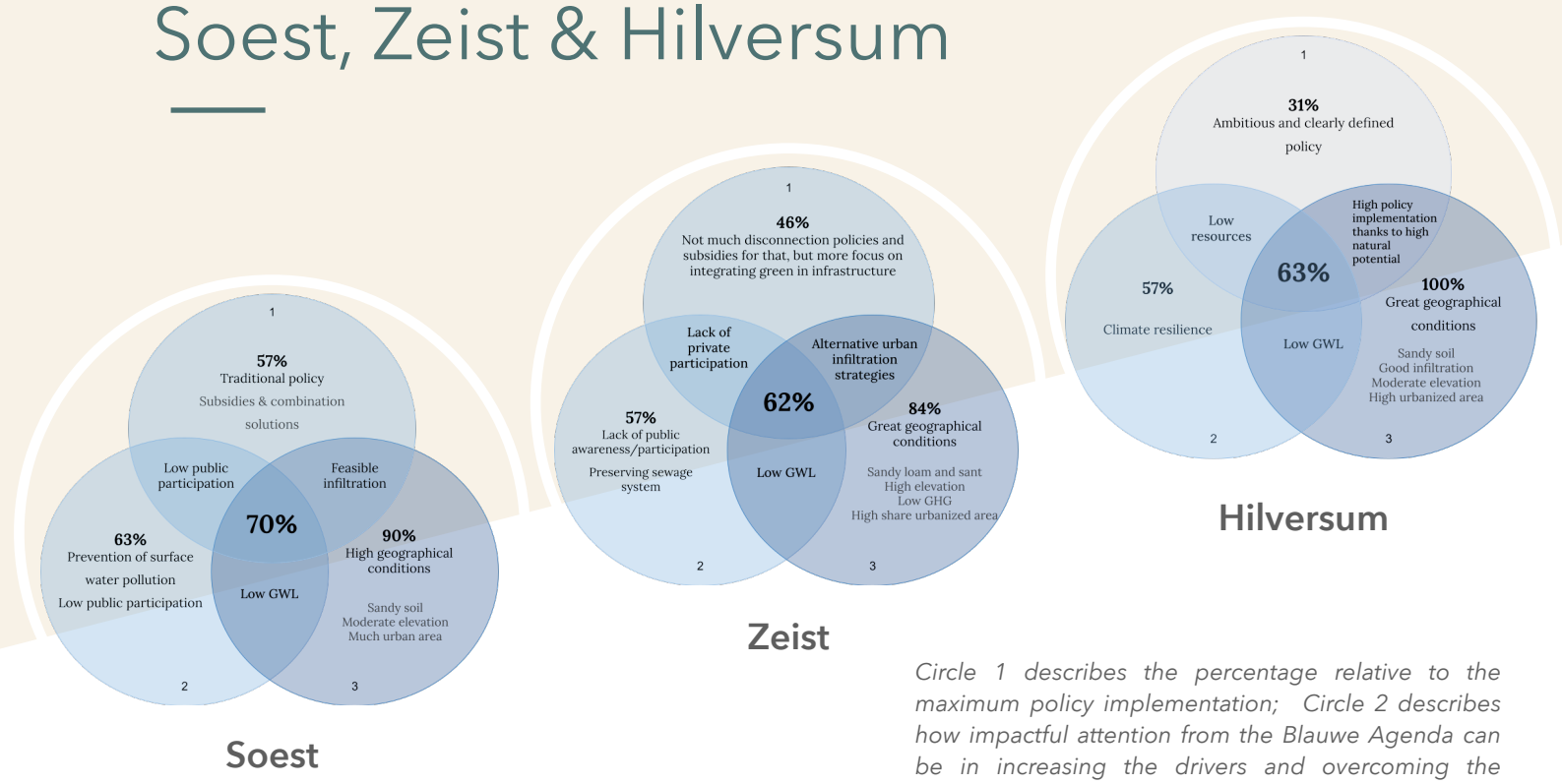


Figure 1. 'Overall potential' for Soest, Zeist and Hilversum

Circle 1 describes the percentage relative to the maximum policy implementation; Circle 2 describes how impactful attention from the Blauwe Agenda can be in increasing the drivers and overcoming the barriers; And circle 3 describes the effectiveness of disconnection practices, based on physical properties, such as groundwater level and soil type.

To accelerate disconnection across the studied area, focus most on Soest, Zeist, & Hilversum

By integrating findings from each subchapter, these municipalities were found to have the biggest '*overall potential*' to improve disconnection. Each subchapter explores the disconnection potential of every municipality, but each with a distinct focus; on current policy (circle 1), drivers and barriers (circle 2), and physical properties (circle 3), which all play a role in the progress of municipalities. Therefore, integrating the results of the research conducted across the three subchapters, it is clear that directing efforts towards Soest, Hilversum, and Zeist would yield the most substantial outcomes for advancing the goals of the Blue Agenda.

The percentages of each circle were determined from the results of each subchapter (see subchapters 1, 2, and 3), and the 'overall potential' was calculated by averaging them, allowing municipalities' potential to be compared. Below each subchapter potential, a brief breakdown of the found percentage is given. Figure 1 shows the municipalities with the highest overall potential, showing the integration between all sub-chapters.

It is important to note hat while Soest,
Zeist, and Hilversum have exceptional conditions
for the effective implementation of disconnection measures,
there are several municipalities that are worth paying attention to.
Baarn, Rhenen, Veenendaal, Leusden, Wijk bij Duurstede, and De Bilt have
moderate potential for effective disconnection measures too; there are, however, (combinations of) factors that reduce the municipal potential, such as inferior geographical and hydrological conditions, substantial barriers, and limited drivers. Supporting each of these municipalities individually by overcoming their own limiting factors can be valuable in order to accelerate urban disconnection; it is however advised to seek more optimal solutions first in Soest, Zeist, and Hilversum.

Figures 2 and 3, presented on the next page, show the integrated results of each subchapter for the rest of the municipalities. For the municipalities with moderate potential, other measures next to rainwater disconnection are needed to achieve a future-proof water system. Subchapter 2 elaborates on the municipal barriers and subsequently establishes adequate responses to overcome these barriers. Subchapter 3 elaborates on additional measures and indicators for urban infiltration management. It is advised to investigate appropriate measures at the municipal level despite its moderate potential, making use of the suggested responses to barriers and intra-municipal water infiltration indicators.

Lastly, for the low potential municipality (Bunnik) we suggest focusing on other measures instead of rainwater disconnection. It is particularly stressed that water retention strategies are pursued, which is elaborated upon in subchapter 3.

The key takeaway from this advice is that all municipalities are capable of contributing to the collective water management of the Utrechtse Heuvelrug; however, to accelerate the process of effective urban disconnection, it is argued that the municipalities with the highest potential ought to receive the initial attention and extensive resources from the NPUH.

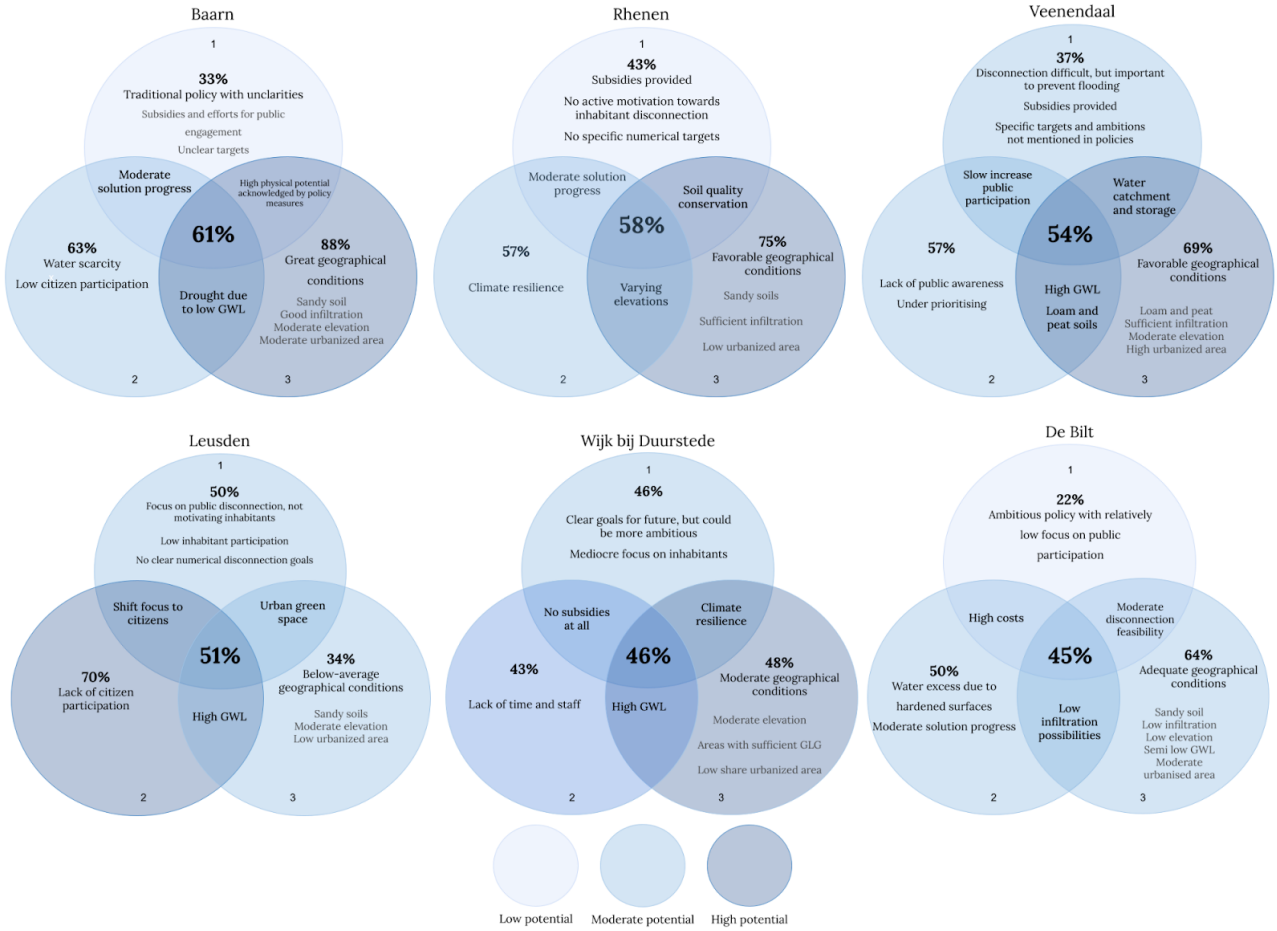


Figure 2. 'Overall potential' for Baarn, Rhenen, Veenendaal, Leusden, Wijk bij Duurstede and De Bilt

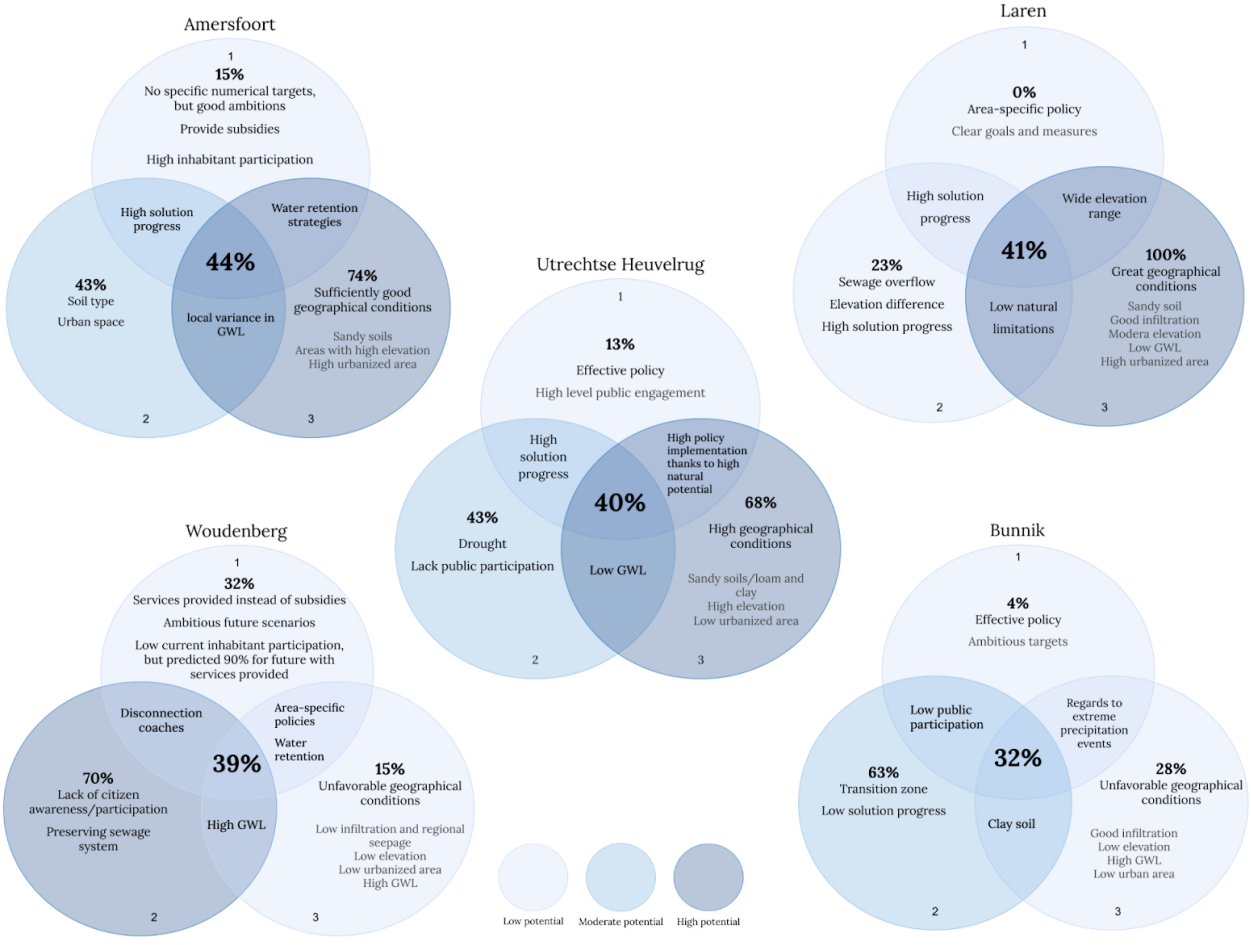


Figure 3. 'Overall potential' for Amersfoort, Woudenberg, Utrechtse Heuvelrug, Laren and Bunnik

Advice 2: Customising Unique Strategies

The NPUH should customise the Blue Agenda's strategies to the unique characteristics of each municipality to effectively accelerate disconnection

The policy recommendations in the Blauwe Agenda, currently, are too superficial to comply with municipalities' interests. Differences between municipalities were found to be too great for policy, drivers and barriers, and natural conditions. This hinders the implementation of the Blauwe Agenda, as these distinct physical properties, capabilities, and interests are not being reflected in the current policy recommendations. The municipal diversity will be demonstrated and explained by looking at the results of four characteristic municipalities.

Utrechtse Heuvelrug: Natural epitome & Veenendaal: Densely populated drain

First, we will discuss the defining characteristics of the municipality of the Utrechtse Heuvelrug, namely the high elevation, low percentage of the urban area, the effective infiltration policy implementation, and its sensitivity and exposure to impacts. This combination requires specific attention and the NPUH and the Blauwe Agenda could accelerate the disconnection process through careful consideration of these characteristics. First, the high elevation, and thus the associated and relatively low groundwater levels, along with high infiltration allow for great disconnection potential. In line with this is that the current disconnection policy of Utrechtse Heuvelrug is quite extensive and effective as this is not only the most feasible but also the most beneficial, given the exposure of the area to the effects of climate change. Low groundwater levels and areas of drought will hit the natural diversity of municipalities with similar characteristics the hardest and will therefore require urgent action. However, contradictory to this is the fact that Utrechtse Heuvelrug has only a small percentage of urban area (9%), contributing to little support base for disconnection policy as most rainwater is presently infiltrated by the soils. In this sense, there is little benefit to be gained in this municipality, even though the effects of poor infiltration policy in surrounding municipalities will hit Utrechtse Heuvelrug the hardest.

Opposite the Utrechtse Heuvelrug is Veenendaal, whose defining characteristics are its low elevation and densely populated area. Whereas Utrechtse Heuvelrug will suffer from the effects of droughts and low groundwater levels, Veenendaal needs to worry about flooding and high groundwater levels. As mentioned previously, infiltration in municipalities on the flanks of the national park is necessary to sufficiently replenish the groundwater levels on the hills, but this requires additional attention for these respective municipalities. Veenendaal is at a low elevation, but also densely populated, and therefore, is a major part urban area. This makes high groundwater levels problematic as associated importunities are prevalent as the area acts as a drainage point for the bigger region. This can include damage to buildings, especially historic ones, and increases the risk of flooding. Also, the major size of urban areas makes infiltration harder, therefore, increasing the potential for disconnection policy. Even though high groundwater levels can be problematic, disconnection is still very relevant for Veenendaal as this will prevent overload of the sewage system during peak precipitation events, as long as additional measures are taken. These measures should be aimed at facilitating water storage and discharge, requiring careful identification of solutions that make sense as a whole in the context of the area.

The contrasting characteristics of these two municipalities highlight the importance of specific policies and are shown in Table 1. From the NPUH, this requires separate considerations for each municipality with respect to the characteristics that make or break the current disconnection policies in the respective municipalities.

Utrechtse Heuvelrug	**Veenendaal**
High elevation: Between 9 and 69 m above NAP	*Low elevation:* Between 0 and 6 m above NAP
High feasibility and urgency for infiltration	*Feasibility for infiltration is low; however, urgency is high nonetheless*
Urbanized area: 9% → Low value potential from disconnection	*Urbanized area:* 40,8% → High value potential from disconnection
High environmental impact: → Biodiversity → Infiltration → Risk: drought stress	*High urban impact*: → Human health- and welfare → Risk: extreme precipitation
Area-specific requirements: Nature conservation Soil protection Infiltration management	**Area-specific requirements**: Sewage capacity Flood risk management

Table 1. Characteristics and requirements for Utrechtse Heuvelrug and Veenendaal

Laren: Jack of all Trades

The municipality of Laren is another great example to showcase the need for a specific approach. The defining characteristics of Laren are its relevant physical differences within the municipality, its history with general policy, and its socio-economic differences.

First, Laren holds a sizeable elevation range, generally speaking, the west of Laren is at a higher elevation of up to 20 metres and the east of Laren is at a lower elevation of as low as 4 metres. The differences in distance to groundwater levels are, thus, also considerate. Tying into this are (1) that the historic centre of Laren, and the majority of the population, is located in the lower parts of Laren, and (2) that people living in the lower parts of Laren are, generally, people with a lower socio-economic status. This has resulted in problems in the past as Laren had, prior to their current policy, set a general disconnection target of 70% for the whole of Laren. They facilitated resources to encourage inhabitants to start disconnecting and the majority of people who started disconnecting were in the historic centre, as this was densely populated. This was problematic due to disconnecting in this area being more expensive and less effective compared to potential-rich areas in higher parts of Laren. Additionally, the lower socio-economic status and them having high costs from disconnecting were undesirable. These higher costs arose from evaluating the consequences of this general approach led to Laren creating its own, unique area-specific approach which, in sub-chapter 1, is discussed in more detail.

Soest & Woudenberg: Polar Opposites

Another contrast that highlights the importance of municipality-specific advice is that of Soest and Woudenberg. First, the defining characteristics of Soest are its high natural potential, low public participation, and high percentage of urban areas. This combination makes a disconnection policy focused on stimulating inhabitants very attractive. Additionally, public participation is increasingly relevant due to holding a major share of urban areas. Soest's current disconnection policy is impeded by a low rate of public participation, but Blauwe Agenda's involvement with tailored measures and recommendations could greatly improve this. The sandy soil lends itself well for rainwater infiltration and it contributes to the urgency through increased exposure to climate change effects.

Contrarily, Woudenberg's defining characteristics are its low natural potential, high stimulation of inhabitants and low percentage of urban areas. Therefore, recommendations by the NPUH to increase public participation are less relevant as there is less decoupling potential due to the natural conditions and low share of urban areas. Furthermore, current policy is already aimed at stimulating inhabitants and further emphasis will result in diminishing returns. However, this combination does provide a worthwhile support base for municipality-wide projects that can supplement existing policy, addressing Woudenberg's respective challenges. The characteristics of both municipalities are shown in Table 2.

Soest	**Woudenberg**
Geographical and hydrological feasibility: • High natural potential • High urbanized area	*Geographical and hydrological feasibility:* • Low natural potential • Low urbanized area
Identified drivers and barriers: • Large area of public-owned property • Low public participation	*Identified drivers and barriers:* • High public participation • Small area of public-owned property
Contrasting the socioeconomic and geographical challenges of Soest and Woudenberg → Municipal challenges addressed through a universal lens are <u>ineffective</u> considering the contrasting nature of these challenges.	

Table 2. Characteristics and requirements for Soest and Woudenberg

To conclude, the NPUH should increase the customisation of the Blauwe Agenda because superficiality is hindering its implementation. Each municipality plays its own role in the disconnection and requires different policy recommendations and targets. By providing various sets of measures for different situations and conditions or by tailoring advice for each municipality, advice will be more applicable and disconnection will increase.

CHAPTER 1

Current Policies in the Municipalities

On the extent to which municipalities' rainwater disconnection policies are established in the local policy

BY:
Bente van Westerop
Donna Kooij
Elyse Lüschen
Thomas van Zuijdam

1.1 Introduction

1.1.1 Situation

The Blue Agenda highlights the importance of disconnecting rainwater from the sewage system. Municipalities in the Utrechtse Heuvelrug play an important role in this, as it is their responsibility to implement and effectively manage these policies. Currently, ambitions towards rainwater disconnection differ in each municipality, resulting in diverse actions within the region. Some municipalities have made significant developments for this purpose, by for example providing subsidies, having clear goals for the future, and focusing on inhabitant motivation and participation. Conversely, there are municipalities that have made minimal progress or lack specific goals regarding rainwater disconnection.

1.1.2 Complication

The Blue Agenda highlights the importance of disconnecting rainwater from the sewage system. Municipalities in the Utrechtse Heuvelrug play an important role in this, as it is their responsibility to implement and effectively manage these policies. Currently, ambitions towards rainwater disconnection differ in each municipality, resulting in diverse actions within the region. Some municipalities have made significant developments for this purpose, by for example providing subsidies, having clear goals for the future, and focusing on inhabitant motivation and participation. Conversely, there are municipalities that have made minimal progress or lack specific goals regarding rainwater disconnection.

1.1.3 Question

Overall, there are still many uncertainties on what the specific goals are for each municipality and how these goals differ for the involved sectors. To provide more information on this matter, we have come up with the following research question: **“To what extent are municipalities’ rainwater disconnection policies established in the local policy?”** To further fill in the research question, the ambitions and measures of the policy will be studied and assessed for specificity.

1.2 Advice

Below we have laid out our main points of advice on the best way forward for the rainwater disconnection policy of the municipalities in the area of the Utrechtse Heuvelrug. In our results and evidence section, we will elaborate further on the extent of the disconnection policies of the respective municipalities. However, first, we will explain the following advice we have based on our findings.

1. **Municipalities would do well to shift the focus from making subsidies available to providing a service instead**
2. **Defining ambitions and goals more clearly in addition to deciding on specific measures and implementation early on would prove fruitful**
3. **Anticipating the rapidly changing climate scenarios and their corresponding peak precipitation events will prevent having to play catch-up in the future**
4. **More specifically, it could prove greatly beneficial for municipalities to study the area-specific approach employed in Laren**

We will now further explain our advice and how this came to be.

1.2.1 From Subsidies to Service

Municipalities would do well to shift the focus from making subsidies available to providing a service instead.

The vast majority of municipalities have subsidies available for either the disconnection of rainwater pipes, the purchase of rainwater barrels, or the instalment of green roofs. Whilst these are all great measures to reduce the strain on the sewage system and to facilitate rainwater infiltration, we have found that these subsidies often remain largely underutilised.

For municipalities like De Bilt, Hilversum, Wijk bij Duurstede, and Zeist, it is important to first facilitate resources to engage the public while all other municipalities benefit from relocating them.

From our interviews with the municipalities of Laren, Veenendaal, and Soest it became apparent that simply the availability of subsidies is often not sufficient to encourage people to go about the steps. Reasons for this are that people may be

unaware of the subsidy, and the benefits of disconnecting. Furthermore, sometimes households simply are uninterested in the subsidy as the money offered is not worth the hassle.

Therefore, our advice is to no longer offer subsidies as a standalone measure. Examples of how subsidies can be supplemented effectively are by employing so-called “afkoppelcoaches” that can go door-to-door to notify people of the availability of the subsidy, the benefits of undertaking the steps, and help them get started. This measure has proven effective in municipalities like Veenendaal and Laren, increasing the participation rate of disconnection greatly. However, a limitation of this measure became quickly apparent too as it is very labour-intensive and will, therefore, not be best suited for densely populated municipalities.

Another alternative measure to subsidies is to perform the service itself, as opposed to facilitating households to do it themselves. From our findings we can conclude that municipalities have found that households are often more open to a service offered, for example, someone who comes by to disconnect the rainwater pipe. This way, households will not be dissuaded by the effort it takes to apply for a subsidy and to then perform the work themselves which will result in a higher rate of disconnected households. A foreseeable limitation to this alternative is that it will be more costly. This can be counteracted in part if the middleman in the equation can be negated. If the municipality can directly employ people for these kinds of small adjustments to buildings, costs can be reduced.

1.2.2 Defining Ambitions and Goals

Defining ambitions and goals more clearly in addition to deciding on specific measures and implementation early on would prove fruitful.

During review of policy documents from municipalities it is often apparent that goals and ambitions in addition to their respective measures and implementation are not clearly defined or properly supported.

An example of this was highlighted in our interview with the municipality of Laren. In this interview it was mentioned that before the current plans, Laren had set the goal of 70% disconnection of all paved area, aside from this general target, aspects of this were not defined. What happened was that households in the lower areas of Laren, in the centre, ran into high costs of disconnection alongside the area being low in potential for disconnection. This, in part, gave rise to a new approach. with specific goals, supported by research with fitting measures.

For the municipaltiies of Baarn, Hilversum, Leusden, Rhenen, Soest, Veenendaal,

Utrechtse Heuvelrug, and Zeist, this is not the case yet and from policy documents, it is often unclear what the target is and the goal is not always supported evidently. A comprehensive strategy that is more specific will greatly help in achieving a robust water system in the municipalities of the Utrechtse Heuvelrug. In the long run, it is both more effective and efficient to start strong by setting a realistically feasible and situationally fitting target for disconnection. An all-encompassing target of 70% disconnection will only prove to further implicate future developments.

1.2.3 Climate Scenarios

Anticipating the rapidly changing climate scenarios and their corresponding peak precipitation events will prevent having to play catch-up in the future.

Disconnection policy is often based on handling peak precipitation events and defining how much damage can be expected in such an event in relation to a time scale. This is specific to each municipality but what is universal, and maybe inevitable, is that climate change is moving at such a rapid pace that these climate scenarios are quickly outdated. Therefore, we see benefits to be gained by setting more ambitious goals and anticipating this rapid pace. In this way, projects don't have to embark on a game of catch with the ever-changing climate. The reason why we see benefits here is that the cycle of policy is slower than climate change at the moment. Plans that are designed in 2018, approved in 2020, and implemented by 2025 are quick, but still not efficient enough. Therefore, setting goals to stay ahead of the curve will result in measures that can handle scenarios that were not realistic when first designed. The municipalties of Baarn, Bunnik, Laren, Woudenberg, and Zeist are ambitious in their predictions and these are generally better performing municipalities in their disconnection policy.

1.2.4 Area-specific Approach

More specifically, it could prove greatly beneficial for municipalities to study the area-specific approach employed in Laren.

As we have discussed in the integrative advice, Laren has had an unsuccessful experience with general targets regarding their disconnection policy. In addition to peak precipitation events in 2014, 2016, and 2019, a revised approach was needed. "Laren Regenklaar'' started execution in 2020 and will be finished by 2025, conveying a comprehensive and coherent strategy focused on long-term improvements.

Furthermore, the approach within “Laren Regenklaar” is unique in its careful identification of potential-rich areas, the design of fitting measures, and the allocation and acquisition of resources.

In the early stages of the project, Laren was very specific in determining areas with high potential for disconnection, looking at each individual property and ranking these. For potential rich areas, disconnection coaches were used to look at fitting solutions together with the property owners to ensure a high participation rate.

Additionally, general meetings were organised and information was relayed consistently. However, this approach requires a lot of resources and labour force, for Laren, they acquired this by increasing the sewage charges, resulting in a sizeable budget, but also, spending their money wisely in areas that have a high potential and foregoing spending money on other measures such as subsidies.

For other municipalities it can be beneficial to learn from the unique and area-specific approach of Laren. Laren boasts a public participation rate of 85% and has achieved major successes with their comprehensive strategy, emphasising the lessons to be learned.

1.3 Results and Evidence

Once all essential data was collected from literature research and interviews, this information was put in the following spreadsheet:

Spreadsheet Evidence Chapter 1

This results section will offer a comprehensive overview of the progress made by each municipality concerning the disconnection of rainwater, while also assessing areas where further improvement may be needed.

1.3.1 Amersfoort

The municipality demonstrates a strong awareness of the pressing issues outlined in the Blue Agenda, despite not explicitly referencing it in their policies. Instead, they have developed their own policies that align with the principles of the Blue Agenda. While specific numerical targets are lacking, they offer subsidies, information, coaching, and financial assistance to residents interested in disconnecting their sewer pipes. A considerable portion of the municipality has already undergone disconnection, reflecting the willingness of residents to participate. Their approach primarily targets areas where the most significant impact is observed.

1.3.2 Baarn

Municipality Baarn is active in creating opportunities for inhabitants to disconnect and motivating them to do so. They have “afkoppelcoaches” which inform the inhabitants (Gemeente Baarn, 2023), and also subsidies for green roofs, rainwater barrels and the disconnection of rainwater pipes is provided (Groendak subsidie 2024, 2024), but the degree of participation by inhabitants is not mentioned. The municipality works together with other municipalities and organisations, however, what their goals are for the future and how this will be performed is unclear (Bevaart et al, 2012). There are no specific ambitions mentioned in their policies, and also not what they expect for future rainfall values.

1.3.3 De Bilt

Municipality the Bilt is in regards to the decoupling of rainwater from the sewage system on the right track. In their policies, the percentage of future disconnection is unclear, but how the disconnection will be performed is explained elaborately, with specific costs attributed to this (Water- en Rioleringsplan 2022-2026, 2022). Furthermore, it is mentioned that “meekoppelen” will always be performed, and they have ambitious future plans, as they are counting on future precipitation of 70mm/hour during heavy rainfall. While the municipality actively motivates inhabitants to disconnect, their policies did not mention anything on the actual inhabitant participation. Also, only subsidies for inhabitants to disconnect their rainwater pipes is provided, and not for the installation of green roofs and rainwater barrels (Duurzaamheid, n.d.).

1.3.4 Bunnik

The Bunnik municipality has a high focus on motivating inhabitants to disconnect and also provides all three subsidies for them (Sedumdak Bunnik?, n.d.) (Van den Bovenkamp, 2022), as a way to motivate them. Next to subsidies, “afkoppelcoaches” are also a way in which the municipality is trying to increase the inhabitant participation, which is currently on a moderate level. Furthermore, future scenarios are ambitious, as they are striving towards no nuisance with rainfall of 70mm/hour, and with vital services still functioning with rainfall of 90mm/hour, and the disconnection of rainwater from the sewage system is mandatory at all new project sites (Vugs & Hofstede-Elzinga, 2023). The municipality is also active in other projects, showing a willingness to learn from other municipalities and organisations.

1.3.5 Hilversum

The municipality of Hilversum boasts an ambitious policy with clearly defined goals and measures. Although they only offer 1 form of subsidies, effective efforts are being made to stimulate inhabitants to disconnect. We weren't able to secure an interview and therefore are not able to determine the degree of public participation but it is clear that emphasis is put on this goal. Also, Hilverusm is ambitious in its predictions for peak precipitation events, sitting at 70mm/hour. Furthermore, combination solutions in disconnection are standard practice and municipality-wide projects are structurally defined and executed

1.3.6 Laren

The municipality of Laren has a unique approach following extreme precipitation events. After increasing sewage charges for a couple of years, the project “Laren Regenklaar” was funded and would span from 2020-2025. Under “Laren Regenklaar” there are multiple municipality-wide projects that are unique in that it is area-specific to a high degree, even considering individual houses. For each area or situation, there is a specific solution formulated that is carried out over a long term, the range of types of disconnection is wide. Laren also always looks for opportunities to “meekoppelen”. Additionally, Laren boasts a high public participation rate through this approach and the employment of disconnection coaches in addition to cooperative and transparent collaboration with inhabitants. At the time, the target of 45mm/hour precipitation events was held as a measure but the target for later than 2025 has been increased to 70mm/hour. Also, the target for disconnection is specifically set at 57% of all paved area, making distinctions between areas where disconnection is fruitful and useful and areas where disconnection is expensive and futile.

1.3.7 Leusden

In addition to their collaboration with other municipalities and organisations, the Leusden municipality mainly focuses on public decoupling, without motivating inhabitants (Rip & Tammers, 2019). The municipality is eager to help inhabitants by for example providing “afkoppelcoaches” and some subsidies, however, the initiative to disconnect should come from the inhabitants themselves, as this initiative does not come from the municipality itself. Currently, 33% of the inhabitants want to disconnect, showing room for improvement in this area. Future heavy peak rainfall is expected to be 50 mm/year, indicating that the municipality might need to be more ambitious in regards to their future scenarios and their goals, as well as developing more specific percentages instead of general ambitions for their goals.

1.3.8 Rhenen

The municipality of Rhenen lacks explicit mention of the Blue Agenda in their policies or documents. While they offer subsidies for green roofs, disconnection of rainwater and rainwater barrels, they aren't actively encouraging residents to participate. Additionally, there are no specific goals or targets regarding rainwater disconnection outlined in their policies. All in all, there are general ambitions set in their policy, however there is still great potential in explicitly incorporating the Blue Agenda into

their plans, actively promoting and educating residents about rainwater disconnection, and setting measurable targets for their environmental efforts.

1.3.9 Soest

The municipality of Soest has a traditional approach regarding their disconnection policy. Subsidies are available for green roofs, disconnection, and rainwater barrels for inhabitants and disconnecting is encouraged through the employment of disconnection coaches. Also, "meekoppelen" is a standard practice in Soest. Soest is currently taking 40mm/hour precipitation peaks as a measure for future precipitation but more ambitious targets will be considered for the "Omgevingsvisie". Soest wishes to disconnect 20,000m2 per year of public space, for the private space there is no target and public participation is low. Therefore, the municipality is considering ways to increase participation by inhabitants. To disconnect the public space, there are no municipality-wide projects specifically dedicated to this cause but the target of 20.000m2/year is met through "meekoppelen". The location of Soest makes disconnection of rainwater feasible resulting in policy staying consistent, only shifting slightly in keeping water visible on ground level as opposed to putting it underground.

1.3.10 Utrechtse Heuvelrug

The Utrechtse Heuvelrug municipality is an integral part of the core municipalities committed to the Blue Agenda, actively engaging with its objectives. They provide subsidies for initiatives like green roofs, rainwater barrels, and rainwater pipe disconnection, aiming to maximise water retention. Their approach involves informing and incentivising residents, supported by "afkoppelcoaches" who assist with rainwater pipe disconnections. For new constructions or renovations, there are requirements to disconnect or infiltrate rainwater, minimising discharge into the existing sewerage system. While the municipality lacks specific disconnecting targets, they prioritise areas facing significant challenges such as overwhelmed sewerage systems or high maintenance costs. Through the Blue Agenda, they also explore larger projects like the potential rainwater disconnection at campsite 'Het Grote Bos'.

1.3.11 Veenendaal

For Veenendaal disconnection of rainwater is also a relevant and urgent problem. The location of Veenendaal makes it more difficult as it is located at a low point, functioning as a drain of the water system. Therefore, disconnection is more difficult but also more important to prevent flooding. There is an emphasised focus on public participation. The municipality offers subsidies for rainwater barrels, disconnection of rainwater pipes and underground infiltration. Additionally, the municipality employs a disconnection coach and makes efforts to increase public participation through campaigning, although public participation is still low. Furthermore, Veenendaal executes municipality-wide projects to improve the robustness of the water system through Lapine systems or wadis among others. Also, “meekoppelen” is a standard practice. Current targets and ambitions are unknown and will be published later by the municipality.

1.3.12 Wijk bij Duurstede

The municipality of Wijk bij Duurstede is ambiguous in its disconnection policy but well on track. The municipality does not offer subsidies for climate-resistant living at the moment. However, the municipality does execute municipality-wide projects such as wadis and water storage cellars. The goal is for 2 project sites to be handled each year. Furthermore, the municipality aims to disconnect 30% of all paved area. Until 2050, 100% of sewers will be disconnected if opportunities for “meekoppelen” arise, after 2050 this will be reduced to 30%. Also, disconnection coaches are not common practice but have been employed at times. Wijk bij Duurstede strives to prevent damage to structures with peak precipitation events of up to 60mm/hour. There is no information on current public participation but the expectation is 58%.

1.3.13 Woudenberg

Woudenberg is doing well in regards to the disconnection of rainwater. Instead of subsidies, they provide services and pay for the installation of green roofs and disconnecting rainwater pipes, but not for rainwater barrels. Furthermore, their policies show collaboration with other municipalities, ambitious future scenarios and a great focus on inhabitants (Leusink & ter Horst, 2019). Currently, inhabitant participation is low, but it could increase substantially in the future, since the policy of Woudenberg mentions 90% willingness to disconnect from inhabitants when the municipality offers services and pays for it. Also, by introducing “afkoppelcoaches” the

participation of inhabitants may increase, and also more clear goals for the future will be beneficial for the municipality.

1.3.14 Zeist

Currently, the municipality of Zeist provides subsidies solely for rainwater barrels. A key challenge in rainwater disconnection efforts in Zeist is the relatively good condition of existing rainwater pipes, obviating the need for replacement. Their focus now shifts towards integrating green elements into infrastructure projects, like road reconstructions, to enhance local rainwater infiltration. Realistically, they aim to infiltrate approximately 70% of annual precipitation, with the remainder flowing into the sewer system. Their aspiration to disconnect 30% of specific neighbourhoods within five years, equating to 5% of roof surfaces, faces hurdles due to private ownership. Compelling residents to act is complex, as coercion is not an option. Zeist acknowledges the need for greater engagement with residents, suggesting initiatives such as subsidies and coaching to facilitate private disconnection efforts. In summary, while Zeist actively participates in the Blue Agenda, there is untapped potential, particularly in incentivising and providing subsidies to residents.

The collected data was once more organised into a new table, presenting an overview of each municipality's potential for enhancing their existing policies and ambitions. This table serves as a useful tool for the NPUH, offering an overview of municipalities to prioritise for the Blue agenda.
The table is presented in table 3 on the following page.

Municipality	Subsidies	"Meekop - pelen"	Goals	Sewage charges	Projects	Future scenarios	Stimulating inhabitants	Participation by inhabitants	Potential score	**Ranking score**
Amers-foort	9	9	12	6	12	6	10	9	9.9%	**15 %**
Baarn	9	9	4	4	12	3	15	X	22.3%	**33 %**
Bunnik	9	9	12	4	12	9	15	X	2.6%	**4 %**
De Bilt	3	9	8	6	12	9	15	X	14.9%	**22 %**
Hilversum	3	9	12	6	8	9	10	X	20.9%	**31 %**
Laren	9	9	12	6	12	9	15	9	0 %	**0 %**
Leusden	6	9	4	6	12	6	5	6	33,3 %	**50 %**
Rhenen	9	9	8	6	12	3	5	6	28.4%	**43 %**
Soest	9	9	8	4	4	3	10	3	38.3%	**57 %**
Utrechtse Heuvelrug	9	9	8	6	12	9	15	6	8.6%	**13 %**
Veenen-daal	9	9	8	6	8	3	15	3	24.7%	**37 %**
Wijk bij Duurstede	3	9	8	6	8	6	10	X	30.6%	**46 %**
Wouden-berg	6	9	4	6	12	9	15	3	21.0%	**32 %**
Zeist	6	9	8	4	4	9	10	6	30.9%	**46 %**

Low Potential 0-20%	**Medium Potential** 20-40%	**High Potential** 40+%

Table 3. Overview of municipalities' potential

While analysing the percentages of overall achievements made by municipalities reveals that municipalities Leusden, Rhenen, Soest, Wijk bij Duurstede and Zeist, all with a calculated ranking of over 40%, stand out as having the highest potential for enhancing rainwater disconnection. Primarily, these municipalities lack focus on stimulating residents to disconnect, e.g. due to the lack of subsidies or having passive forms of motivation tactics rather than actively stimulating residents.

On the other hand, municipalities Amersfoort, Bunnik, Laren and Utrechtse Heuvelrug, all with a calculated ranking of 15% or less, require less attention from the NPUH, as they are already prioritising the significance of rainwater disconnection and have established appropriate policies and ambitions to address this issue.

1.4 Methodology

1.4.1 Research Framework

For our research, we proposed to conduct a reconstruction of the policy theory of the municipalities, as found in the proposal. However, the justification and relevance of this framework were grounded in a basis of principles and norms of the municipalities. Preliminary to our research, we had hypothesised that the stakes and interests of different sectors would be a prevalent point of consideration for municipalities that would, in part, dictate the direction of groundwater, and in turn, disconnection policy.

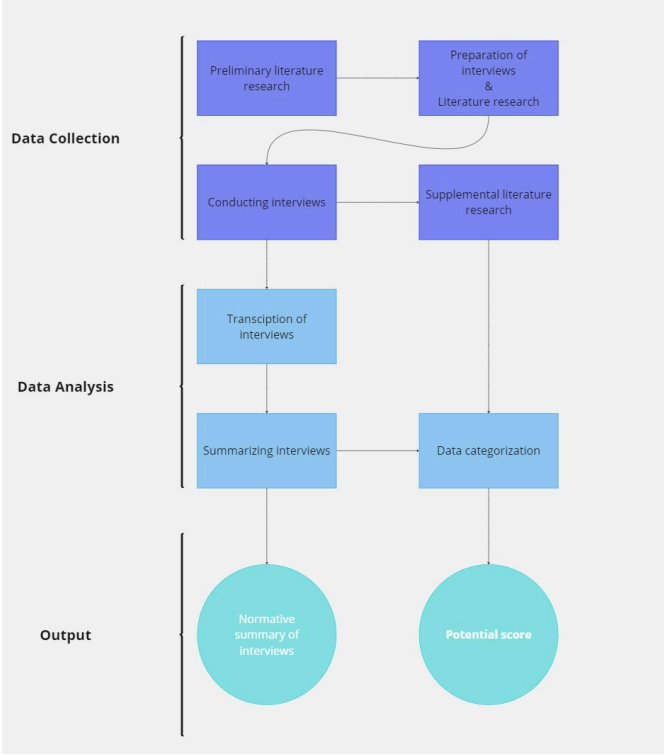


Figure 4. Research framework

Nevertheless, during our interviews, we soon came to find that disconnection policy is less controversial than anticipated and is often a standard or even traditional practice. Weaknesses in disconnection policy did not originate from considerations between stakeholders and sectors, and therefore, we have decided to not follow through with the proposed framework as it would not be relevant enough to our subquestion.

As we opted out of the reconstruction of policy theories, we processed our data differently. We found that the data from the interviews was hard to quantify or categorise to make comparisons. Additionally, we felt that coding the interviews would not give a correct representation as the answers to "What is the policy?" are too extensive for coding. Therefore, we started by normatively summarising all interviews and policy documents to answer all interview questions we prepared as completely as possible. After discussion of the content, we constructed 12 categories that would allow us to compare policy to a certain extent. It is important to note that policies were especially divergent and unique in their own right so our data categorising can not pertain to the full extent of municipalities' policy. That is also the reason why we made normative

summaries of the policy to the best of the knowledge gained from the interviews and policy documents. In this way, more depth and detail could be put towards explaining every policy.

Next, we categorized the data into 9 headers, namely; *Subsidies, Meekoppelen, Goals, Sewage charges, Projects, Future scenarios, Stimulating inhabitants, and Participation by inhabitants*. We scored the municipalities on these categories and attached a weight to each factor. **"Stimulating inhabitants"** is determined to be the most defining category and was attached a weight of 5. We found that focusing efforts on increasing public participation is vital to successful policy. Then, **"Projects"** and **"Goals"** were found to be important as clearly defined and execution of clear goals is integral, resulting in a weight of 4. Then, **"Subsidies"** are important as they portray the facilitation of resources by the municipality but as we have found are not the best standalone measures, therefore, a score of 3. **"Meekoppelen"** and **"Future scenarios"** were also given a score of 3 as they are relevant but not pivotal measures.

Finally, **"Participation by inhabitants"** was also given a score of 3 considering its ambiguity which is also why this category would be left out if information was unknown as opposed to the other categories that would receive the lowest score.

Lastly, **"Sewage charges"** was given the lowest score of 2 as increasing this does signify an increase in budget for fruitful solutions, it is also an inconclusive indicator. These scores were then converted into percentages which were then used to subtract from a 100%, resulting in our **"Potential score"**. Therefore, a high score for the categories results in a low potential score, and vice versa. As we found a relatively narrow range of scores, we curved the data to reflect the percentage of maximum potential. Our lowest possible score was 27, a third, which is why we divided our potential score by two-thirds so the data would be more universal with the scores from subgroups 2 and 3 which is why we used this **"Ranking score"** for the integrative advice.

Thus, we then categorized the data and gave municipalities a score, as explained below, for how well they performed in each category. These categories were then weighed as the prevalence of some measures is more important towards the goal of disconnection. These weights have been attached in line with our understanding of the matter and their importance. Next, a score would be calculated from 0 - 100, 100 being the best score, and we then converted these by doing 100 - score to get a score representing the **potential** for improvement. Therefore, municipalities that score high have a low **potential** score.

1.4.2 Data Collection

To reconstruct the policy theory, we will depend on a literature review and interviews with the municipality. The study of publicly available databases and policy documents by the municipality will be our preliminary concern, this will allow us to form initial hypotheses of the relations in the policy theories of the individual municipalities. To find relevant information for our research question, there are some search terms which might be helpful for us to use: disconnection rainwater, water policies, rainwater sewage system, etc. Combined with these search terms, the name of the specific municipality should be added, as this allows us to investigate each municipality separately.

The semi-structured interview will be helpful for this sub-questions, which is imperative to fill in the knowledge gaps to reconstruct the policy theory, while also allowing it to deviate slightly according to the responses of the interviewee.

1.4.3 Data Analysis

The data analysis will comprise of compiling the data from both our interviews and literature review into sub-questions, categorising our subsection research question, namely:

1. *What is the extent of active rainwater disconnection policy?*
2. *What are the municipalities' ambitions and measures?*
   - *Are these specific?*
3. *How is focus distributed between private and public stakeholders?*
   - *Are there differences found between inhabitants and business owners?*

This will allow us to easily produce a comprehensive understanding of the found data. Further data analysis will be done according to the proposed research framework. Information and statements will be compiled into a goal tree, containing ultimate goals, intermediate goals, and means. Afterwards, we will form goal-means relations, cause-effect relations, and normative relations. The final step is to compile these into one cohesive, reconstructed, policy theory.

1.4.4 Feasibility

For the proposed method we expect a high feasibility. A lot of data from the municipalities is publicly available and from our preliminary literature review we have already gathered a basic understanding of the municipalities' policies. Processing the data according to the proposed framework is also feasible given the time.

The only foreseeable obstacle is the response rate from municipalities. We will contact them as soon as possible but it is possible that some municipalities are not available for an interview. Should this happen, we will make sure to do a thorough literature review to get as much information as possible, still. Also, we will then focus our efforts on the municipalities that we are able to get into contact with.

CHAPTER 2

Drivers & Barriers

On the drivers and barriers at the domestic and public level that can be identified by municipalities for disconnecting rainwater from the sewer system – and how these barriers can be overcome via the Blue Agenda

BY:
Andrei del Villar
Sarah Visscher
Lora Bonthuis
Cato Oosterink

2.1 Introduction

2.1.1 Situation

The NPUH strives to increase participation of the Blue Agenda among the regional municipalities in and around the Utrechtse Heuvelrug area in order to accelerate the disconnection process. However, to achieve full participation, increasing knowledge and awareness among each municipality and their inhabitants is needed. In order to effectively reach municipalities and accomplish actual change, it is important to gain insight into the specific aspects that drive and hinder the municipal governments and their inhabitants from successfully implementing disconnection on a large-scale. Drivers for disconnection of the rainwater-sewer system are motivators which encourage inhabitants or municipalities to participate in the Blue Agenda, and can include; low groundwater levels, summer droughts, and a sustainable and future proof sewage system. Barriers, conversely, are factors which hinder municipal/ inhabitant participation and can include varying factors such as; physical and geographical aspects, budget, and motivation (Smeets, & Weterings, 1999). Therefore, this chapter aims to understand the various drivers and barriers of each municipality, as well as interactions between them in order to provide suitable assistance and advice to the NPUH.

2.1.2 Complication

In striving for their sustainability aims, the NPUH encounters certain complications that impede their advancement. Among these is the involvement of multiple municipalities in the Blue Agenda which presents some challenges. Each municipality faces different drivers and barriers, a varying degree of progress in implementing disconnection measures, and different attitudes and motivation to cooperate. Moreover, geographical factors such as elevation and soil type vary amongst the municipalities, leading to variations in drivers and barriers. Therefore it is difficult to have one single approach to tackle all municipalities, and the participation and cooperation of each municipality must be analysed individually. Additionally, as it was revealed in the interviews, many municipalities were not aware of the Blue Agenda, highlighting the need of NPUH to engage with municipalities to accelerate the Blue Agenda.

2.1.3 Question

This report aims to provide the NPUH with specific steps necessary for each of the municipalities to successfully implement disconnection via the Blue Agenda. There will be an insight gained into the needs and weaknesses of the varying municipalities, as well as some possible shortcomings of or changes needed in the Blue Agenda. To gain this knowledge, the following question was formulated:

"What drivers and barriers at the domestic and public level can be identified by municipalities for disconnecting rainwater from the sewer system, and how can these barriers be overcome via the Blue Agenda?"

To answer this question, there will be a focus on various aspects; the drivers and barriers for the municipalities will be assessed for both public and domestic disconnection. The focus in this assessment is on the municipal government, but information on the behaviour and participation of inhabitants will be gained from municipalities as well. To assess the drivers, we strive to understand how severe the impact of a non-disconnected rainwater-sewer system will be in the future for each of the municipalities, as well as the effectiveness of subsidies and public awareness campaigns for domestic disconnection. To assess the barriers, we aim to gain insight into the municipalities' monitoring processes. Drivers and barriers will be assessed using the DPSIR Framework (Smeets, & Weterings, 1999), which is outlined more in depth in the *Methodology* section. Lastly, we aim to understand the municipal government's perspective on the help provided by the NPUH and stakeholders through the Blue Agenda as well as their openness to participate in and collaborate on the Blue Agenda.

2.2 Advice

Advice 1: Focus on the implementation and acceleration of rainwater disconnection on the following municipalities: Woudenberg, Bunnik, Soest, Veenendaal and Zeist

The potential for rainwater disconnection implementation in these municipalities is higher than 50%

Table 4 shows an overview of the potential for rainwater disconnection implementation across all municipalities. Notably, five out of the eight interviewed municipalities show a potential exceeding 50%. Because of this, directing the efforts of the Blauwe Agenda towards these municipalities promises the most significant impact on disconnection. Woudenberg holds the highest potential, reaching 70%. With the exception of Bunnik, all municipalities demonstrate a moderate to moderately high potential across drivers, barriers, and responses. Bunnik, while showing fewer drivers, faces significant challenges in overcoming its barriers. Further details regarding the potential of each municipality are available in the results section for each municipality.

Woudenberg, Veenendaal and Zeist have a moderate to moderately high willingness to collaborate with the Blauwe Agenda

Among the five municipalities, these three expressed their desire for direct collaboration with the Blauwe Agenda, making them the easiest to help. While Bunnik and Soest showed less willingness to collaborate, providing advice and support tailored to their specific needs can still facilitate the overcoming of barriers and increase their disconnection efforts.

Advice 2: Differentiate the Blauwe Agenda to focus on municipality specific drivers and barriers

Drivers and barriers occur varyingly

Figure 5 and 6 how the occurrence of all the drivers and barriers of the interviewed municipalities, showcasing the diversity among drivers and barriers. 8 different drivers (Fig 5) and 10 different barriers could be identified (Fig 6). Notably, these factors include opposing elements, such as water scarcity and water excess, both serving as drivers. Each municipality presents a unique combination of drivers and barriers, as

detailed in Tables D.1 and D.2 in the appendix, highlighting the need for a tailored approach to facilitate successful disconnection among municipalities.

The same barriers and drivers occur for different reasons

Even though the municipalities all have a different set of drivers and barriers, there are similarities to be found. However, having similar drivers or barriers does not necessarily mean that the same solution will be effective. For example, for most municipalities, excess water is a driver. The underlying reason for this is very different. In the municipalities at the foot of the Utrechtse Heuvelrug, a high groundwater level is the cause for water overflow in case of heavy rain. Contrastingly, for the municipalities at the flanks, the densely urbanised city centres are a bigger problem for water overflow.

This will increase the willingness to collaborate with the Blauwe Agenda

Currently, there are multiple municipalities that are not very willing to collaborate (Table 4) among which are Soest, Bunnik and Amersfoort. The municipality of Soest, doesn't think the Blauwe Agenda can help overcome their barriers. If the Blauwe Agenda would offer knowledge specifically for Soest's challenges, their acceptance of help would likely increase, thereby enhancing disconnection efforts. For the case of Bunnik, the interviews revealed that their reluctance to accept help was because they felt lectured by the Utrechtse Heuvelrug and the Blauwe Agenda on how they should be dealing with the rainwater. If the Blauwe Agenda could show them how they specifically could improve without interfering too much with them, it is likely they would be more open to accepting help. In Amersfoort, the main reason for the low willingness is because they are already quite far in the project and don't need more help. However, they still face some physical problems which are unique to Amersfoort, for which they are more likely to accept tailored advice.

Advice 3: The most effective solutions the Blauwe Agenda should focus on are relieving effort and knowledge exchange, for domestic and public disconnection, respectively

These solutions target the most occurring and most difficult to overcome barriers

Figure 6 shows that the most occurring domestic barrier is the low citizen participation (mostly due to low awareness and motivation). All municipalities apart from Amersfoort mentioned they were or have been struggling with citizen participation.

Most municipalities also mentioned that this was the barrier they had the most struggle with overcoming. The specific reasons can be found in the specific municipality descriptions. The relieving effort solution can overcome this barrier by removing the need for awareness and motivation to disconnect. Because when the municipality executes the disconnection for citizens, motivation or awareness is not needed. This solution also tackles the domestic disconnection barrier of lack of money, as citizens don't need to invest money in it.

The most occurring public barriers are the physical barriers of high groundwater levels, urban spacing and soil type. Specific knowledge is needed for the individual cases of each municipality. Even though each municipality's case is different, there are a lot of similar aspects shared between the municipalities. For instance, there are quite some municipalities that have to deal with sloping areas or municipalities with a groundwater level close to the ground level. When one municipality has found a solution for one of the physical problems, it is useful to share this information with the other municipalities to overcome these barriers.

These solutions have been proved effective in the municipalities where they were implemented

The relieving effort solution has been proved effective in Laren. How they implemented this can be found in the specific information on Laren in the results section. Together with the disconnection coaches this will result in almost full disconnection at the end of this year. They have found it to be much more effective than subsidies, as now the people are actively reminded that they are asked to do this. Besides this, some municipalities actioned the relieving effort as disconnecting the front of domestic properties when they were disconnecting in the public domain in front of the property. This was for instance done in Amersfoort, where a disconnection of 80% has been reached already.

The knowledge exchange has been implemented in several municipalities, like Woudenberg, Soest and Amersfoort. The exchange of knowledge is giving them information on how to overcome their specific barriers and they mentioned it has been very useful.

2.3 Results and Evidence

2.3.1 Potential

For all interviewed municipalities we have calculated an 'overall potential' score (Table 4). These scores are based on how many drivers and barriers were identified (see Table 5 in section 2.4.3). The higher the potential, the more opportunities exist for the Blue Agenda to help the municipality.

Municipality	Drivers	Barriers	Responses	Overall potential	Willingness to collaborate with Blauwe Agenda
Utrechtse Heuvelrug				43 %	High
Soest				63 %	Low
Laren				23 %	Moderately high
Bunnik				63 %	Low
Amersfoort				43 %	Low
Woudenberg				70 %	Moderately high
Veenendaal				57 %	Moderate
Zeist				57 %	Moderately high

Table 4. Potential for rainwater disconnection implementation and willingness to collaborate with the Blauwe Agenda, for the interviewed municipalities.

2.3.2 Interview findings and DPSIR Frameworks

This section will discuss the findings of the interviews with the municipalities based on the DPSIR Framework. The drivers (in green), barriers (in red) and responses (in blue) components are all unique to each municipality and are insights gathered from the respective experts of each municipality. The pressure component of the framework remains the same for all municipalities, as changing weather patterns due to climate change is a constant pressure affecting all areas on and surrounding the Utrechtse Heuvelrug. The state and impact components will depend on the geographical characteristics of the specific municipality.

Overview of drivers, barriers and responses

The occurrence of all drivers, barriers and responses can be found in Figures 5, 6 and 7, respectively. The most prominent drivers are resilience to climate change and protection against extreme weather, both excess water and water scarcity. The most prominent barriers are lack of citizen participation, due to lack of awareness, motivation and money, and physical barriers, like high groundwater levels, soil type and urban space. In terms of responses, all municipalities apply the combined disconnection solution. For overcoming the domestic barriers, most municipalities are working with a disconnection coach or are (partially) relieving efforts for citizens by doing the disconnection for them.

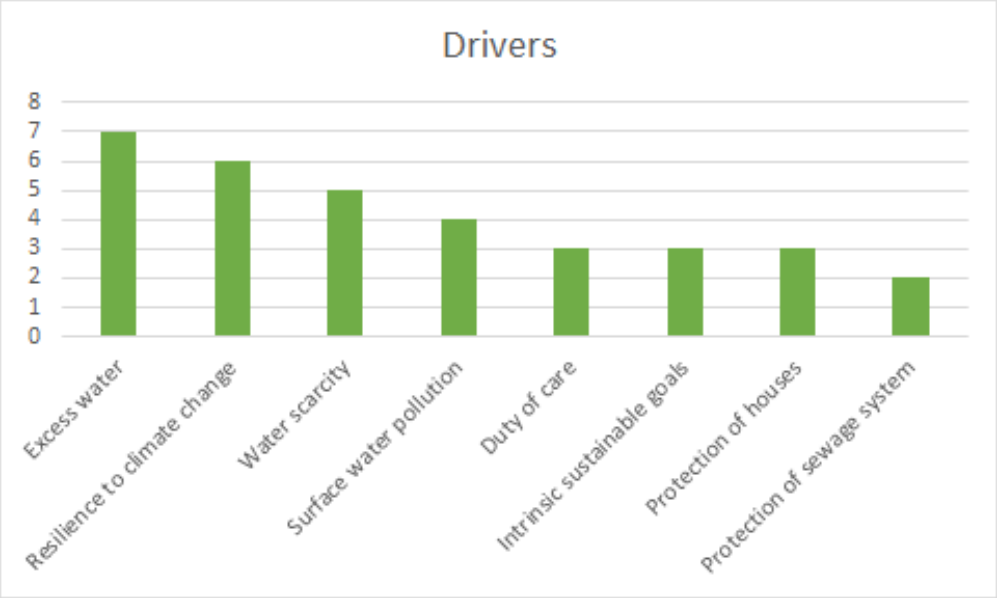


Figure 5. Occurrence of drivers within the interviewed municipalities.

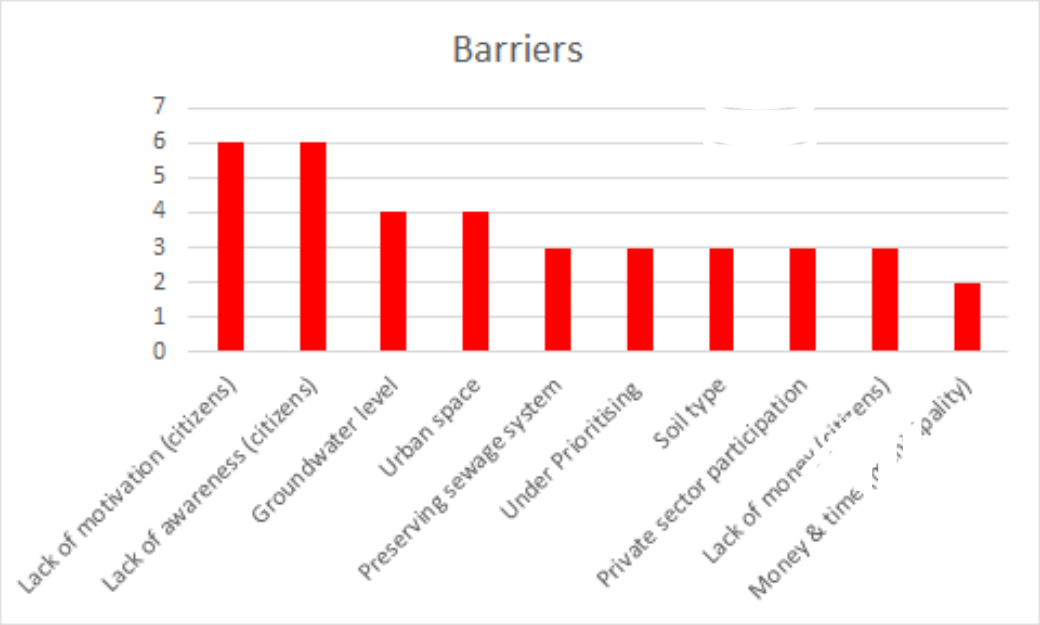


Figure 6. Occurrence of barriers within the interviewed municipalities.

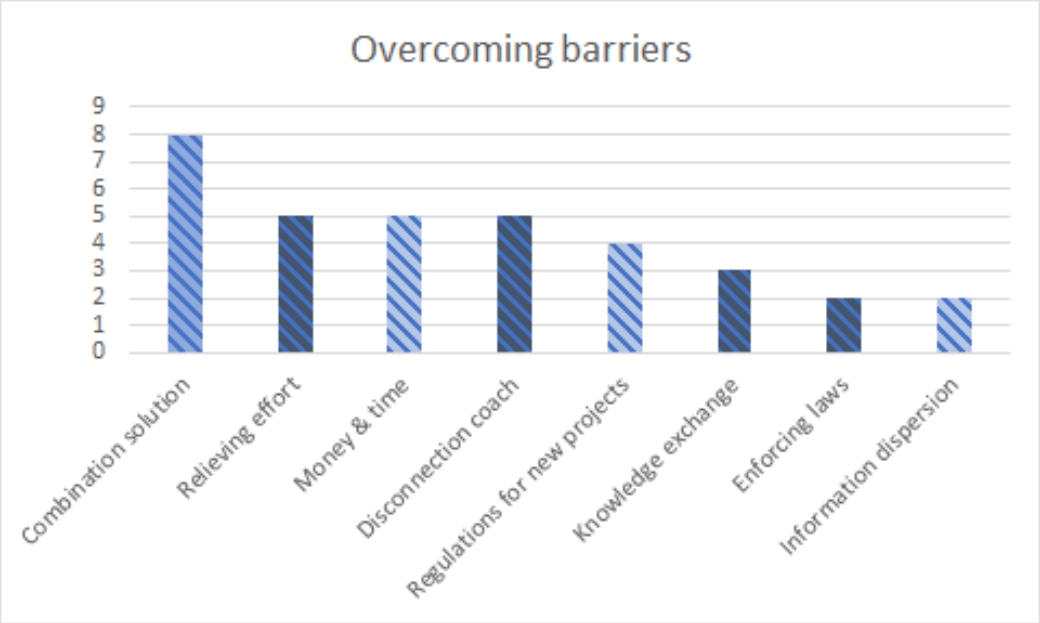


Figure 7. The occurrence of the implementation of solutions within the interviewed municipalities. Light blue solutions for public barriers, dark blue for domestic barriers.

Utrechtse Heuvelrug

The municipality of Utrechtse Heuvelrug is situated at the top of the hill ridge, resulting in high elevation and low groundwater levels. The low groundwater level combined with water scarcity has led to desiccation and seasonal droughts. The municipality's intrinsic goals revolve around climate resilience and preservation & recovery of natural systems and biodiversity, particularly with a focus on weather and climate predictions. Lastly, runoff leads to excess water in the current sewage system, resulting in high maintenance costs.

Identified barriers in Utrechtse Heuvelrug are mainly centred around the domestic sector, as citizens perceive rainwater disconnection practices as technical, costly, or unnecessary. Additionally, citizens identify rainwater disconnection as a risk for flooding due to recent conditions of high precipitation. Other identified barriers include low participation of the private sector and technical difficulties in urban spaces.

The municipality of Utrechtse Heuvelrug has implemented multiple practices to overcome barriers to rainwater disconnection. Disconnection coaches, local citizen initiatives, and information is available for domestic disconnection stimulation. Active approach of businesses and research in private disconnection by the municipality solves private barriers. Other identified solutions include increased knowledge and budget through collaborating with HDSR and regulations for new projects.

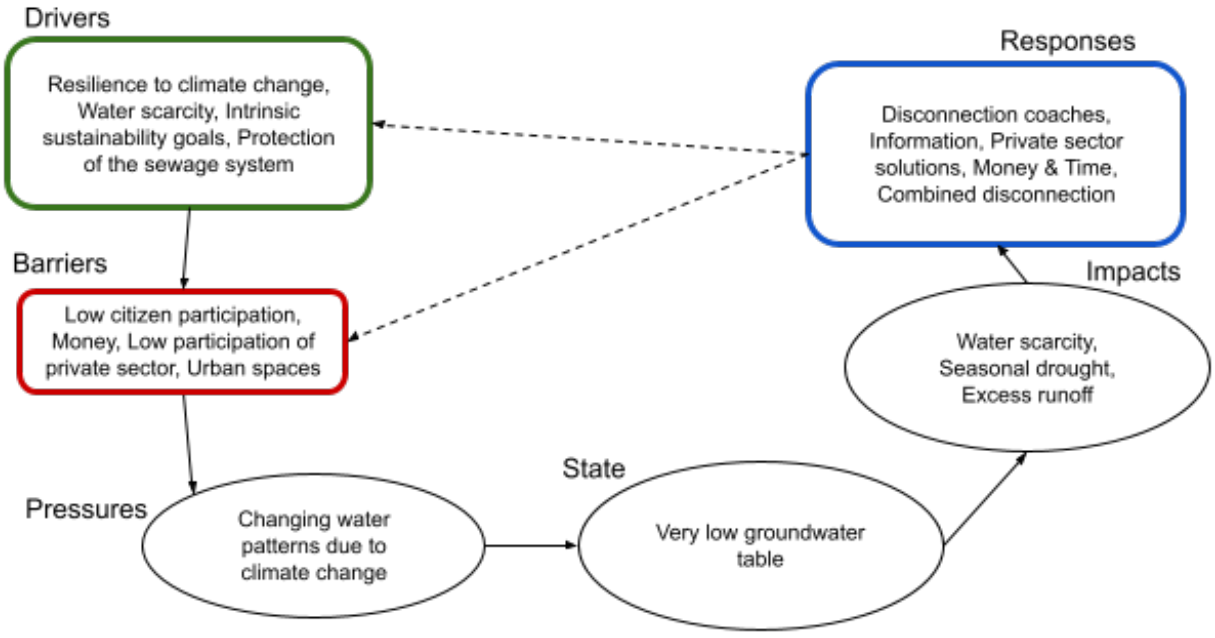


Figure 8. DPSIR model of the municipality Utrechtse Heuvelrug based on the interview

Soest

The municipality of Soest is located on a hill, therefore the elevation varies along the area, resulting in a local difference in groundwater level. In the lowly elevated area, where the groundwater level is higher, the interests of the Blue Agenda and Natuurmonumenten conflict with those of the neighbourhood's inhabitants. Natuurmonumenten wants a high groundwater level to restore peat landscapes, while the citizens want lower groundwater levels to prevent wet basements. Soest aims to increase climate resilience through rainwater disconnection. Their goal is to withstand 40 mm precipitation per hour in order to prevent damage and the pollution of surface water and groundwater, the latter being especially important because of drinking water.

Low citizen participation has been identified as the main barrier in Soest. The subsidies implemented for domestic disconnection, which cover 30% of expenses, have not been effective as citizens appear to not be willing to invest money, time, or effort into disconnection. Additionally, disconnection is more difficult due to limited urban space, too little workforce, and variety in elevation.

To overcome barriers, disconnection coaches have been implemented, which increased domestic disconnection from ~0% to 70%. Public disconnection is mainly done through combined reconnection with other construction work. Lastly, Soest has indicated to consider the enforcement of domestic disconnection through laws in the future, if needed.

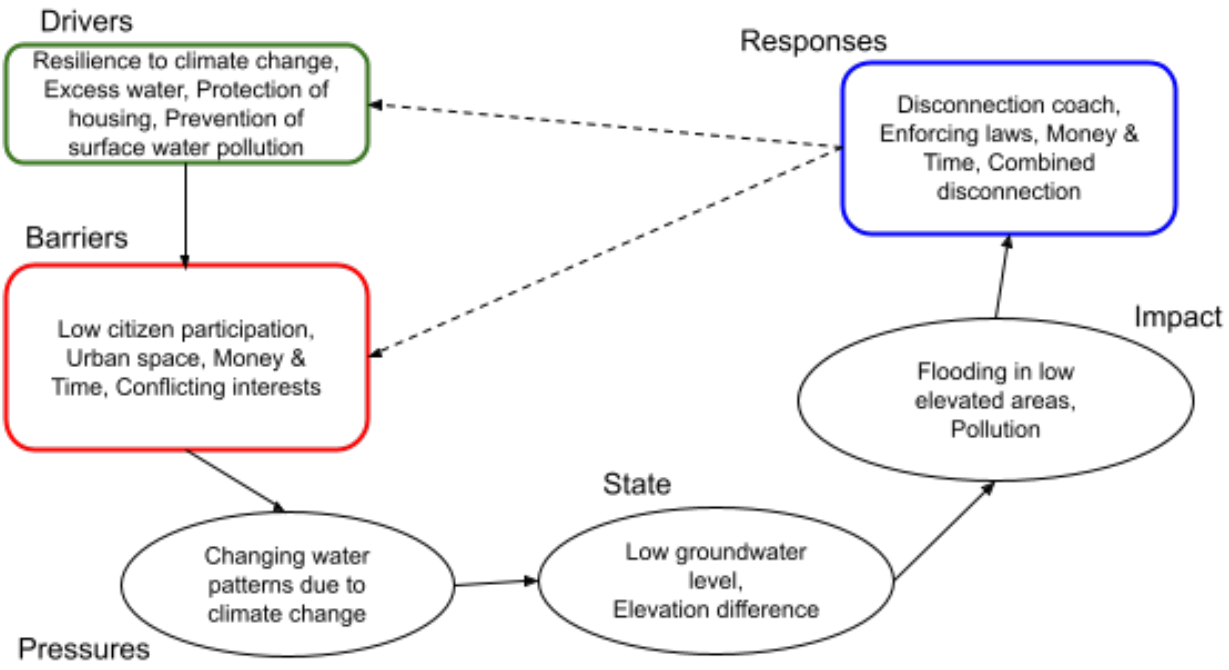


Figure 9. DPSIR model of the municipality Soest based on the interview

Laren

The municipality of Laren is partially located on a hill, with the city centre located at a lower elevation, resulting in the groundwater level being close to the surface. Past problems of sewage overflow causing flooding, damage to monumental buildings, and high damage costs are hoped to be mitigated through rainwater disconnection.

Disconnection is most difficult in the lowly elevated historic centre, due to high groundwater levels and little urban space for infiltration of precipitation, as the area is densely populated with little garden or green spaces. Therefore, Laren indicates storage bins and gravel pits to be more suitable solutions. For rainwater disconnection, the municipality focuses on the hillside area, where infiltration of precipitation is possible and therefore disconnection is easier, cheaper, and with less risk.

Laren has overcome problems with citizen participation through the implementation of disconnection coaches, in addition to information provision at events and via flyers. Additionally, the money from increased sewage charges is used to implement domestic disconnection without any effort or direct costs for citizens. As a result, domestic disconnection is at 90%. Lastly, combined disconnection is implemented in the public space and the municipality is willing to use enforcement for domestic disconnection if necessary.

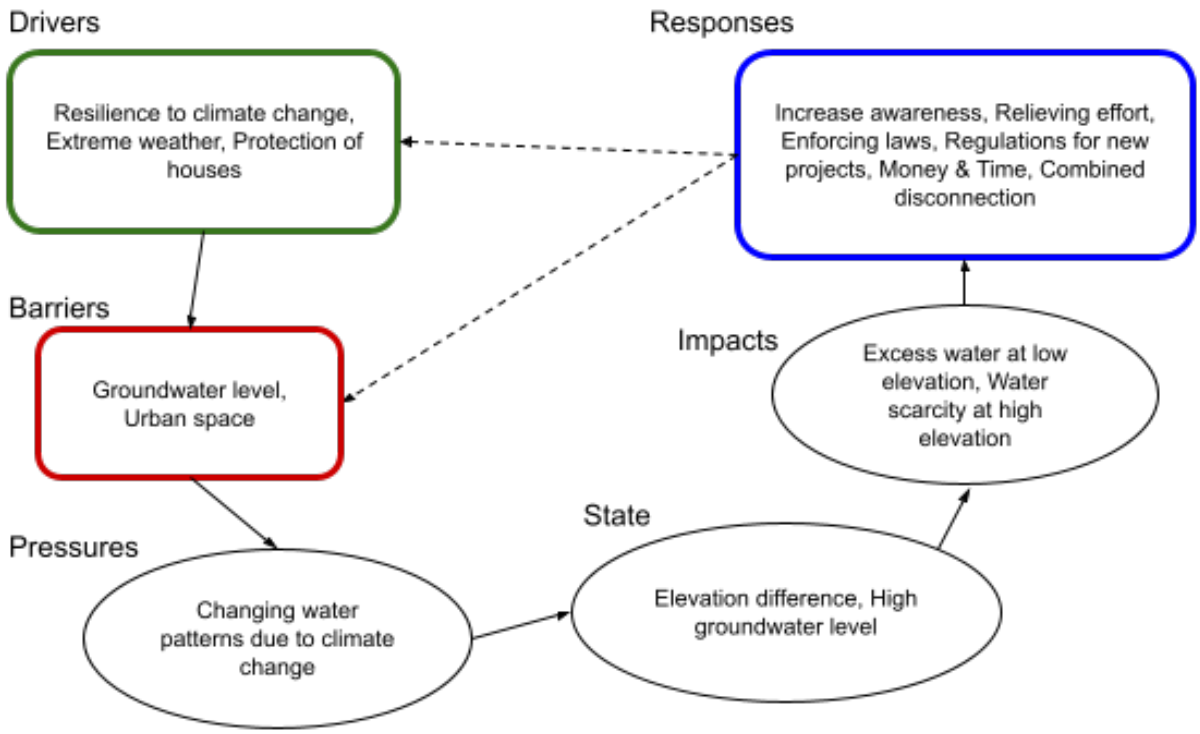


Figure 10. DPSIR model of the municipality Laren based on the interview

Bunnik

The municipality of Bunnik is located in a transition zone between the higher elevated Utrechtse Heuvelrug and the lowly elevated flanks, creating problems regarding both water scarcity and water excess. However, the municipality's main motivation to implement rainwater disconnection is the wasteful and unsustainable nature of the combined sewage system, as clean precipitated water is processed in wastewater treatment plants. Lastly, duty of care regarding rainwater and groundwater is identified as a driver of rainwater disconnection.

Low participation in the domestic and public sectors are identified as barriers in Bunnik. Low citizen participation results from low awareness and unwillingness to invest money or time into disconnection. Under prioritisation of the public sector is a result of low motivation to actively approach citizens or organisations and the challenge of replacing the extensive current system. A physical barrier is the risk of flooding due to Bunnik's elevation and clay soil, which limit rainwater infiltration. Bunnik has not taken much action to implement rainwater disconnection due to its barriers, therefore the main focus is on combined disconnection.

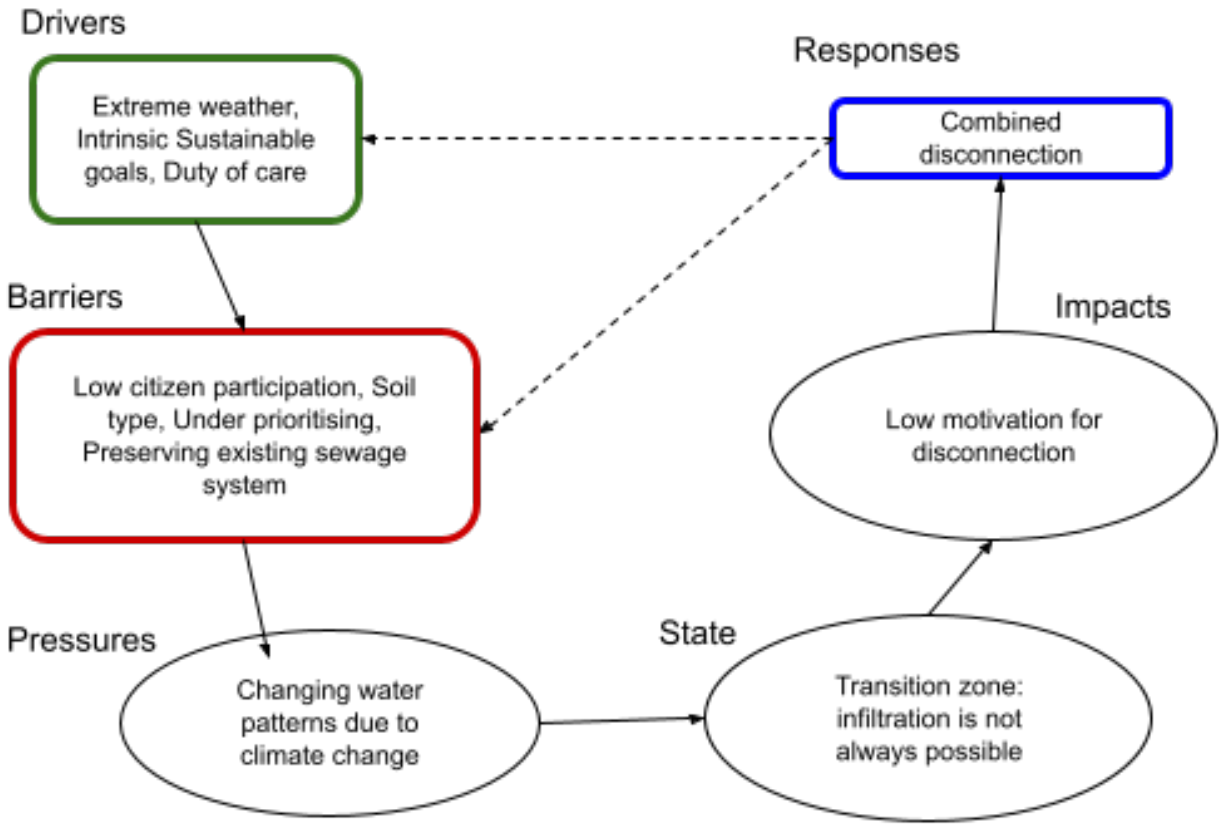


Figure 11. DPSIR model of the municipality Bunnik based on the interview

Amersfoort

Amersfoort is a large municipality north of the Utrechtse Heuvelrug which aims to be climate resilient to extreme weather events regarding both water scarcity and excess. Furthermore, Amersfoort has two drinking water supply establishments, therefore prioritising the prevention of surface water pollution.

The historic city centre has limited underground space for two separated sewage systems , which is identified as a barrier for disconnection. Other barriers are low permeability due to soil type and varying infiltration capability due to groundwater levels.

To encourage domestic disconnection, Amersfoort employs rainwater coaches and includes domestic front gardens in public disconnections. In the public sector, regulations for new projects and combined solutions are implemented. Lastly, the municipality collaborates with other organisations in the 'covenant of future-proof housing construction'. Amersfoort has successfully implemented efforts towards 80% of rainwater disconnection.

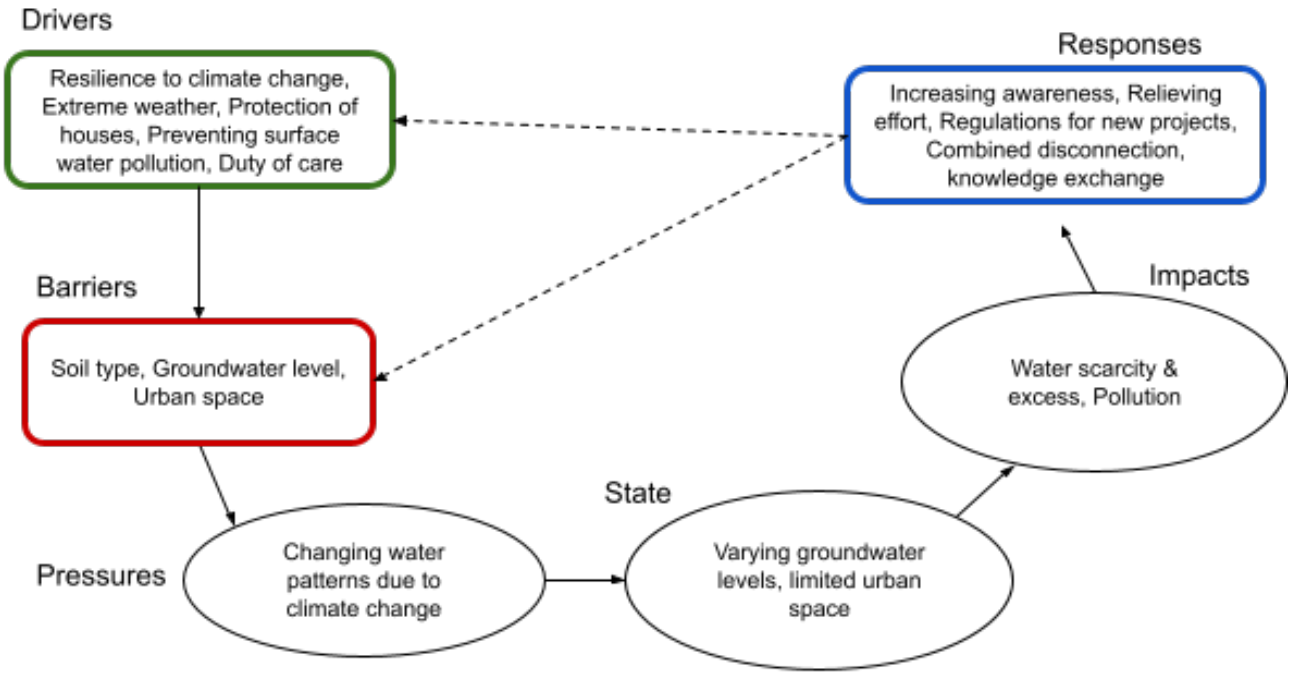


Figure 12. DPSIR model of the municipality Amersfoort based on the interview

Woudenberg

Woudenberg is located on the slopes of de Utrechtse Heuvelrug, adjacent to the municipality of Scherpenzeel, with whom they collaborate closely on rainwater disconnection policy. The municipality focuses on future climate resilience to excess water, as current problems regarding high groundwater levels, seepage, and intense summer rain storms are predicted to increase in frequency. In addition to direct problems of flooding, Woudenberg aims to prevent surface water pollution as a result of mixing sewage and surface water.

However, rainwater infiltration is not desirable in the entire municipality, as high groundwater levels present the risk of groundwater contamination due to decreased absorption by the soil. Therefore, water storage management such as wadis and ditches are more favourable. An additional barrier is low awareness and motivation among citizens, of whom some have expressed not to be willing to cooperate with municipal plans.

Progress in overcoming barriers is made through relieving the effort of citizens, who were not interested in subsidies but more willing to collaborate if rainwater disconnection was done by the municipality. However, the municipality fears for increased groundwater levels if rainwater disconnection and infiltration is implemented on a regional scale, and suggests the Blue Agenda to coordinate this properly.

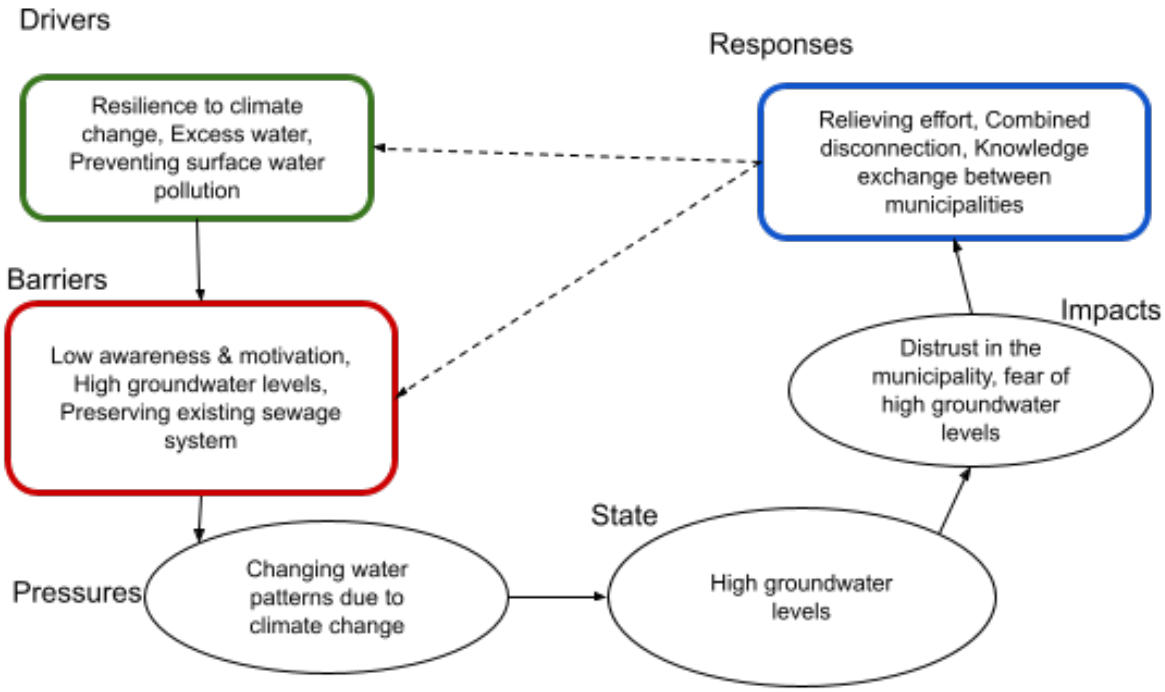


Figure 13. DPSIR model of the municipality Woudenberg based on the interview

Veenendaal

Veenendaal is situated in a depression, therefore the municipality experiences conflicting drivers and barriers to those of the Blue Agenda. The municipality identifies to be intrinsically sustainable and progressive, which is reflected by its aim to be circular in 2050. In addition, Veenendaal intends to be resilient to precipitation up to 70mm. Even though summer drought and heat stress do occur, water excess is a more significant problem, caused by the municipality's low elevation. The desire to ensure the sewage system is future-proof and reliable originates from the relatively large risk of flooding, especially compared to the Utrechtse Heuvelrug area.

Most barriers identified for Veenendaal relate to the low elevation. Combined, high groundwater levels, seepage, flooding, and clay soil complicate rainwater disconnection and make citizens distrustful of disconnection practices. Disconnection subsidies remain fairly unused by citizens as the risk of possible consequences from rainwater disconnection are perceived as higher than the monetary incentive. However, Veenendaal admits it could act more on disconnection by setting targets. Currently, underground disconnection is not prioritised due to monetary reasons and collaboration on the Blue Agenda is not prioritised as it does not align with the municipality's specific drivers and barriers due to elevation.

The municipality of Veenendaal has experienced that, to overcome barriers, relieving citizens effort is more effective than implementing subsidies. Additionally, there is a rainwater advisor available for all domestic disconnection and 'blue' and 'green' regulations for new projects. Lastly, rainwater disconnection is implemented in combination with other construction work.

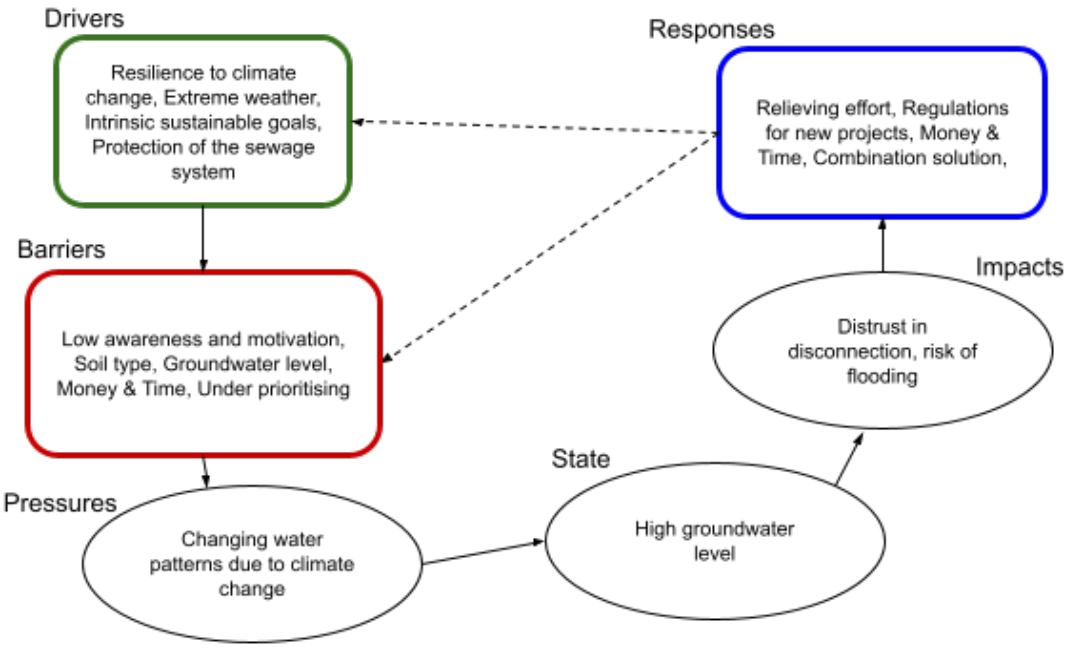


Figure 14. DPSIR model of the municipality Veenendaal based on the interview

Zeist

The municipality of Zeist is located on a transition zone between the Utrechtse Heuvelrug and the flanks, therefore it experiences both low and high groundwater levels. Due to recent weather patterns, Zeist's main driver for disconnection is excess water, to prevent both flooding and surface water pollution.

The main barrier identified for Zeist is the preservation of the current sewage system, which is expected to remain in good condition for a long time. Therefore, the municipality considers the replacement of the current system as a non-priority at this time, as the monetary, timely and material costs outweigh the benefits at the present. Additionally, participation in both the domestic and private sectors are identified as barriers.

Zeist has made progress in overcoming barriers by relieving citizens' effort in disconnection, which the municipality believes to be more effective than subsidies. Rather than putting effort and money into subsidies, domestic rainwater pipes are disconnected for free. Additionally, Zeist implements disconnection combined with construction and regulations for new projects.

Zeist indicates that the Blue Agenda could assist through monetary means, however, the municipality acknowledges that the money needed to cover sewage replacement exceeds the NPUH's budget.

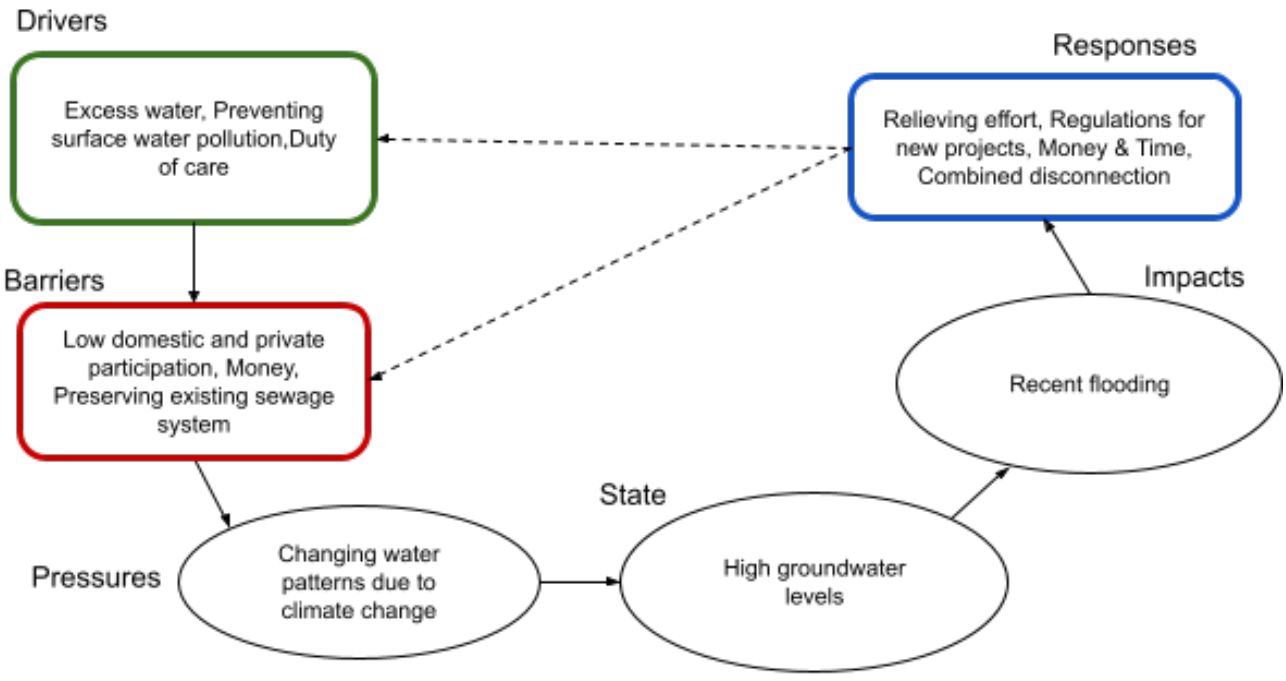


Figure 15. DPSIR model of the municipality Zeist based on the interview

Collaboration with Blue Agenda

The interviews with municipalities did not only focus on drivers and barriers, they also aimed at gaining insight into the improvement of the collaboration between the municipalities and the Blue Agenda. The municipalities' responses were varying, and not all of the municipalities seemed to be very willing or open to collaborate with the Blue Agenda on municipal rainwater disconnection. On the other hand, positive responses that have been identified are; sharing information, collaboration, money, coordination on groundwater levels, and workforce.

For sharing information, the Utrechtse Heuvelrug indicates that they already use the communication plan from the Blue Agenda, and focuses this on the spreading of information. However, Veenendaal and Laren indicate that sharing municipality-based knowledge on natural and financial aspects would lead to a beneficial collaboration. Soest indicates that the Blue Agenda should focus their information sharing efforts on approaching the existing collaborations between municipalities, not to try and create new collaborations.

A collaboration focussed on establishing connections is also seen as important by some Municipalities. Laren points out that the Blue Agenda can be used as a link between municipalities and organisation, whereas Zeist expresses that it can be used to connect all municipalities together. Amersfoort believes that collaboration on communication and campaigns, especially associated with the NPUH, could be more effective. Coordination on regional groundwater levels was indicated as a very important collaboration factor by municipalities Zeist and Woudenberg, who are on the flanks of the Utrechtse Heuvelrug. They reiterate the importance of a well thought out disconnection protocol, as rapid large-scale rainwater disconnection could lead to problems due to water excess.

Lastly, Laren and Amersfoort state that monetary help via the Blue Agenda could benefit the rainwater disconnection in their municipalities. Both municipalities do not specify quantified budgets needed to accelerate disconnection but argue that money is always useful and subsidy implementation is usually effective. However, municipalities have reservations on collaboration on the Blue Agenda. The most prominent doubts occur because of the difference in physical aspects, such as elevation, groundwater level and soil type, between the municipalities, especially compared to the Utrechtse Heuvelrug. The municipalities of Woudenberg, Bunnik, and Veenendaal express the concern that the Blue Agenda was created with mainly the Heuvelrug area in mind, therefore, it does not account for possible long-term negative effects of water excess on the flanks due to rapid large-scale rainwater

disconnection. Additionally, as the Blue Agenda does not appropriately align with the municipalities' perspective of rainwater disconnection, they feel that one unified strategy will not be effective for the entire region.

The municipalities of Soest and Amersfoort indicate that there already are multiple platforms and collaborations on knowledge sharing and partnership. Amersfoort expressed surprise that the Blue Agenda is not already involved in those collaborations, whereas Soest stated that the Blue Agenda should approach those collaborations instead of creating new communication efforts.

2.4 Methodology

To gain a clear understanding of how municipalities around the Utrechtse Heuvelrug deal with the disconnection of rainwater, it is important to choose the right method that gathers the most detailed and rich data. Two methods were used in this subchapter, namely interviews and a literature review. Conducting interviews is a suitable option to obtain quantitative data relevant to our research question (Barrett & Twycross, 2018), and the literature review will complement the information obtained from the interviews, and can replace it in case an interview was not conducted.

2.4.1 Research Framework

The selected framework for addressing this sub-question is an adapted version of the DPSIR Framework, a conceptual model widely utilised in environmental management and policy analysis to understand the interactions between human activities and the environment (Smeets & Weterings, 1999). DPSIR outlines the relationships among Driving forces, Pressures, States, Impacts, and Responses, illustrating how these elements interconnect. To adapt this framework to our project, barriers will be added as an additional component of the framework, and the responses will only address the drivers and barriers components, as these components are the main focus of the research question. The adapted framework is depicted in Figure 16.

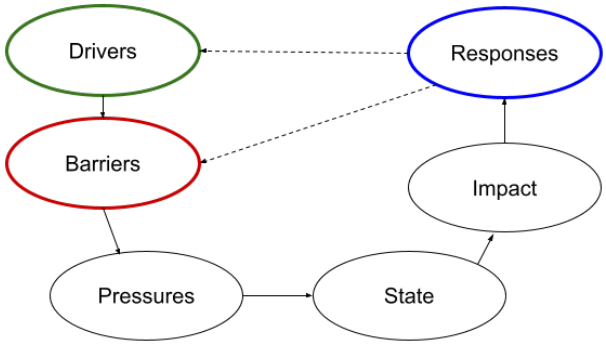


Figure 16. DPSIR Framework (adapted from: Smeets & Weterings, 1999)

This framework has many advantages and is relevant for this sub-question for various reasons. Firstly, it considers the driving forces and barriers of a specific activity (in this case disconnection), and shows its relationship with the other components of the model, including potential responses and solutions. The framework will help identify the driving forces behind the current rainwater management practice, as well as the barriers this may present, which is an essential part of our investigation. Additionally, this framework accommodates the integration of both qualitative and

quantitative data, making it suitable for incorporating insights from interviews with municipalities as well as findings from the literature review.

The application of the framework needs a structured methodology. Firstly, *drivers* and *barriers* will be identified through the interviews conducted with the municipalities. These discussions will provide valuable insights into the underlying factors influencing current rainwater management practices within the Utrechtse Heuvelrug. Subsequently, the *pressures* on the municipal sewage system, the *state* of disconnection together with physical and hydrological aspects in the municipality, and the *impact* of the combined drivers and barriers on the municipal water system will be shortly analysed. Finally, using the insights collected from both the interviews and literature review, *responses* and solutions will be formulated to address each component of the DPSIR framework, but with particular emphasis on the drivers and barriers, as these are the most relevant to answer the sub-question.

2.4.2 Data Collection

The interviews with municipalities were conducted in a semi-structured manner, which will make sure that core elements are explicitly being asked, while still being flexible in questions. Since municipalities are expected to experience different drivers and barriers and some to be more involved in the disconnection process already than others, semi-structured interviews will allow the questions to tailor to their answers, and thus get the best output from them.

In addition to interviews, a literature research was conducted, which focused particularly on municipality sites and documents for information to get more in-depth knowledge that complements those interviews. In the case that a certain municipality was not interviewed, the literature review will provide the data for the results. Since the amount and type of information available will vary by municipality, a mixture of interview and literature review findings will form a comprehensive view of the current state, drivers and barriers of the municipal policies.

In order to gain understanding on the drivers and barriers that generate the (in)ability of municipalities to implement the Blue Agenda, one on one contact is preferred. However, this data collection, in the form of semi-structured interviews, can lead to discrepancies in the data due to a difference in knowledge or willingness to cooperate between the municipalities. Due to the short time span of this research, multiple municipalities were not able to set up an interview for us with the right person, leading some questions unanswered. Additionally, some interviews differed in focus topic, as some interviews were done with the municipality's sewage experts, whereas other interviewees were disconnection coaches.

2.4.3 Data Analysis

To facilitate the data analysis, the interviews were transcribed, initially either by Microsoft Teams or Microsoft Word and then checked manually with the help of the recording. The transcribed interviews were coded into four different categories: drivers, barriers, overcoming barriers and collaboration with the Blauwe Agenda. Within these categories, themes were defined that came forward during the interviews. The coding was done in 4 different tables (one per category) for each municipality. A template of these tables is shown in Appendix I.C.

Following the coding per municipality, we applied the DPSIR model on each municipality. When the information from the interviews was not sufficient or no interview was conducted, the information from the literature review was used to apply the DPSIR model.

Finally, for each municipality, the potential for disconnection implementation was determined. For the categories drivers, barriers and responses, the separate potential was determined. The average of these values led to the overall potential. The potential was separated into 5 groups as shown in Table 5. When there was too little information, a 100% potential was assigned, as still much could be won by gathering this information. A high potential will be assigned if they have a lot of drivers and barriers, but not a lot of responses.

High potential: 100-80%	**Moderately high potential: 80-60%**	**Neutral potential: 60-40%**	**Moderately low potential: 40-20%**	**Low potential: 20-0%**	**Too little information: 100%**

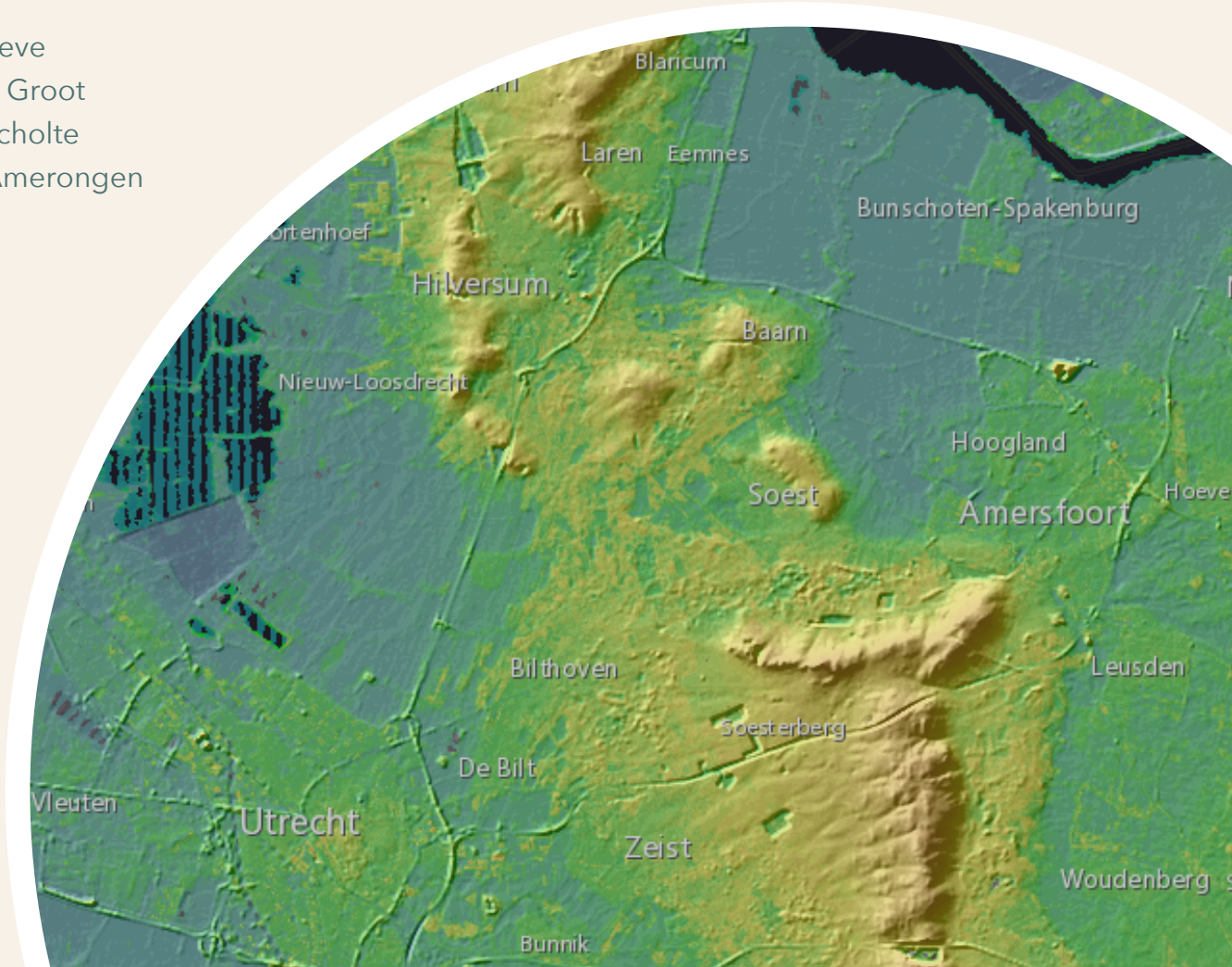
Table 5. Group separation of the potential, with according colours and percentages.

CHAPTER 3

Future Scenarios & Infiltration Modelling

On the adequacy of the ambitions of the Blue Agenda; based on whether the ambitions are (1) future proof and (2) tailored to municipalities

BY:
Koen Stroeve
Jasper de Groot
Matthijs Scholte
Ties van Amerongen



3.1 Introduction

3.1.1 Situation

Decoupling of rainwater is necessary for the NPUH municipalities according to the Blauwe Agenda, because of the overload the sewer-systems in the area are experiencing. On top of that, the groundwater supply of the Utrechtse Heuvelrug finds trouble due to the increasingly urbanised area. Rainwater is not able to infiltrate directly into the ground, causing troubles in times of drought because there is no fresh groundwater supply. This problem will worsen due to climate change in the upcoming years, as more extreme hazards will occur (Gill, 2006). Extreme hazards in this particular scenario will be expressed as extreme wet periods and extreme dry periods.

Furthermore, nature in the national park has been suffering from these climatic changes with dry summers causing plants and trees to die, due to low groundwater levels. The decoupling of rainwater would allow groundwater level to increase and recover its natural balance.

The Blauwe Agenda of the NPUH presents advice for all municipalities of the NPUH. This advice includes actions to take to ensure the decoupling of rainwater in the best way possible. This advice builds further on the climate scenarios of the KNMI'14 report.

3.1.2 Complication

The Blue Agenda acknowledges that the current framing of disconnection opportunities is under-explored. It establishes the potential increase in groundwater level from moderate- and excellent disconnection policy execution. However, it is left unexplored how hydrological and geomorphological indicators affect the true potential of each disconnection scenario. Eco-hydrological factors may influence municipalities across the area in different ways and this is currently not taken into account in the Blauwe Agenda. Furthermore, the KNMI has since released an updated report on future climate scenarios: the KNMI'23 report. It is unclear how the adaptations made in this report affect the ambitions for disconnection by the NPUH.

3.1.3 Question

Following the complications presented in the previous paragraph, the question: "Is the Blauwe Agenda tailored for every municipality"? In short, after a literature review the answer to that question was no. This led to the formation of the research question **"Are the ambitions of the Blauwe Agenda adequate?"** To answer this question, '*adequate*' is divided into two definitions:

I. **Future proof:** Are the ambitions on disconnection stated in the Blue Agenda sufficiently future-proof?

II. **Tailored to municipalities:** How can the ambitions on disconnection stated by the NPUH be tailored to municipalities?

Subchapter three asks the question, what eco-hydrological differences occur across the park and what a more tailored advice would look like based on this. It therefore aims to provide the NPUH with a clear visualisation of indicators and their potential for decoupling rainwater across the municipalities of the park. The indicators chosen to provide the final advice are soil type, seepage or infiltration, elevation, average highest groundwater level (GHG), average lowest groundwater level (GLG) & urbanised area. An explanation of how these indicators are linked with decoupling is presented in subchapter 2.1.1 Indicators. Additional indicators and subsequent measures to increase urban groundwater infiltration are addressed through the urban infiltration model in subchapter 2.2.1.

3.2 Advice

The main points of advice are:

1. **The Blauwe Agenda does not require significant adjustments to the new climate report**
2. **The Blauwe Agenda should be more tailored to each municipality in order to accelerate disconnection**

3.2.1 No Significants Adjustments Required to the New Climate Report

Extreme weather events and droughts are already integrated in the Blue Agenda

The Blue Agenda warns its policy-makers for an increase in precipitation seasonality; extreme precipitation events and droughts are also included. The difference between KNMI'14 and KNMI'23 is that the latter report *assures* that extreme precipitation events and droughts are guaranteed to occur, whereas in the initial report these events are mere *hypotheses* (see results). However, the Blue Agenda assumes that these hypotheses are accurate, and has projected its findings in line with the assumption that these hypotheses are correct. Therefore, the confirmation of the KNMI'14 hypotheses in the KNMI'23 report does not substantially alter the key arguments of the Blue Agenda.

Evidence

The KNMI'23 report is built on higher resolution models for extreme weather events, thereby increasing the accuracy of extreme weather predictions. Similarly, the annual temperature rise has now been established based on accurate policy implementation following the Paris Agreement, which increases the accuracy of temperature rise estimates (KNMI, 2023). In the Blue Agenda, the NPUH accounts for;

- Extreme precipitation events (short-term)
- Drought stress (long-term)
- Flood risk (long-term)

(NPUH, 2021)

The changes in KNMI scenario should be addressed through effective implementation of disconnection

The major adaptation of the KNMI'23 report is that the new "worst-case scenario" is built upon the assumption that precipitation will decrease by 3%, whereas the '14 report assumes an increase of 5%. This change is only substantially relevant if the supporting prospect of increased evaporative losses is accurate. The implication of this new report is therefore not to elevate the ambitions, but rather to ensure that the current ambitions on urban infiltration rates are employed effectively.

Evidence

Table 6 illustrates the conclusions from the worst-case scenario in the KNMI'14 and the KNMI'23 report.

Indicators	KNMI'14 (*WH*)		KNMI'23 (*Hd*)	
	Climate reference 1981-2010	Climate scenario 2050	Climate reference 1991-2020	Climate scenario 2050
Precipitation				
❖ Annual average	851mm	+5%	851mm	-3%
❖ Seasonal precipitation				
▪ Summer precipitation	224mm	-13%	235mm	-13%
▪ Winter precipitation	211mm	+17%	218mm	+7%
▪ Average highest precipitation shortage during growth season.	144mm	+30%	160mm	+35%
❖ Rainfall intensity				
▪ 1-hour maximum precipitation volume	15,1mm	+13-25%	16mm	+6%
▪ 24-hour precipitation volume that is expected to occur on a 10-year interval.	44mm	+2,5 – 22%	63mm	+6%
▪ Amount of wet days >0,1mm in winter	55 days	+2 days	57 days	0 days
▪ Amount of wet days >10mm in winter	5,3 days	+1 day	5,4 days	+0,4 days
▪ Amount of wet days >0,1mm in summer	43 days	-10%	-	-
Evaporation	559mm	+7%	603mm	+9%

Table 6. KNMI data from 2014 and 2023 showing the predicted change in weather indicators for climate scenarios WH and Hd

3.2.2 Blue Agenda Tailored to each Municipality

Intra-municipal variance explains effective disconnection

Currently, the Blauwe Agenda offers a great policy tool with decoupling measures, however, it appears to nullify the complex hydrological systems that exist by generalising policy measures. In reality, there are a great amount of variables and indicators that shape these eco-hydrological systems with great spatial variability. To encourage municipalities to implement the Blauwe Agenda policy, this deeper understanding might reveal the mutual benefits that are embedded in the agenda.

To accelerate effective urban infiltration, the framework for intra-municipal urban infiltration strategies should be utilised. Especially in the high-potential areas that we established through our GIS analysis (see Table 3.2). Under this framework, measures are described to not only optimize disconnection yield but also to explore measures to increase urban infiltration altogether.

Evidence

Furthermore, within each municipality (*intra*-municipal), it is argued that additional indicators create nuance and context of the current (lack of) effective disconnection policy. To accelerate urban infiltration where it matters (as illustrated by the GIS models), a greater understanding of *intra*-municipal indicators helps the municipality not only to understand the bottlenecks of infiltration but also to see opportunities where they arise. Extending the toolkit of urban infiltration strategies not only accelerates groundwater recharge but also provides a more robust and resilient strategy to approach extreme precipitation- and droughts as projected by future climate scenarios.

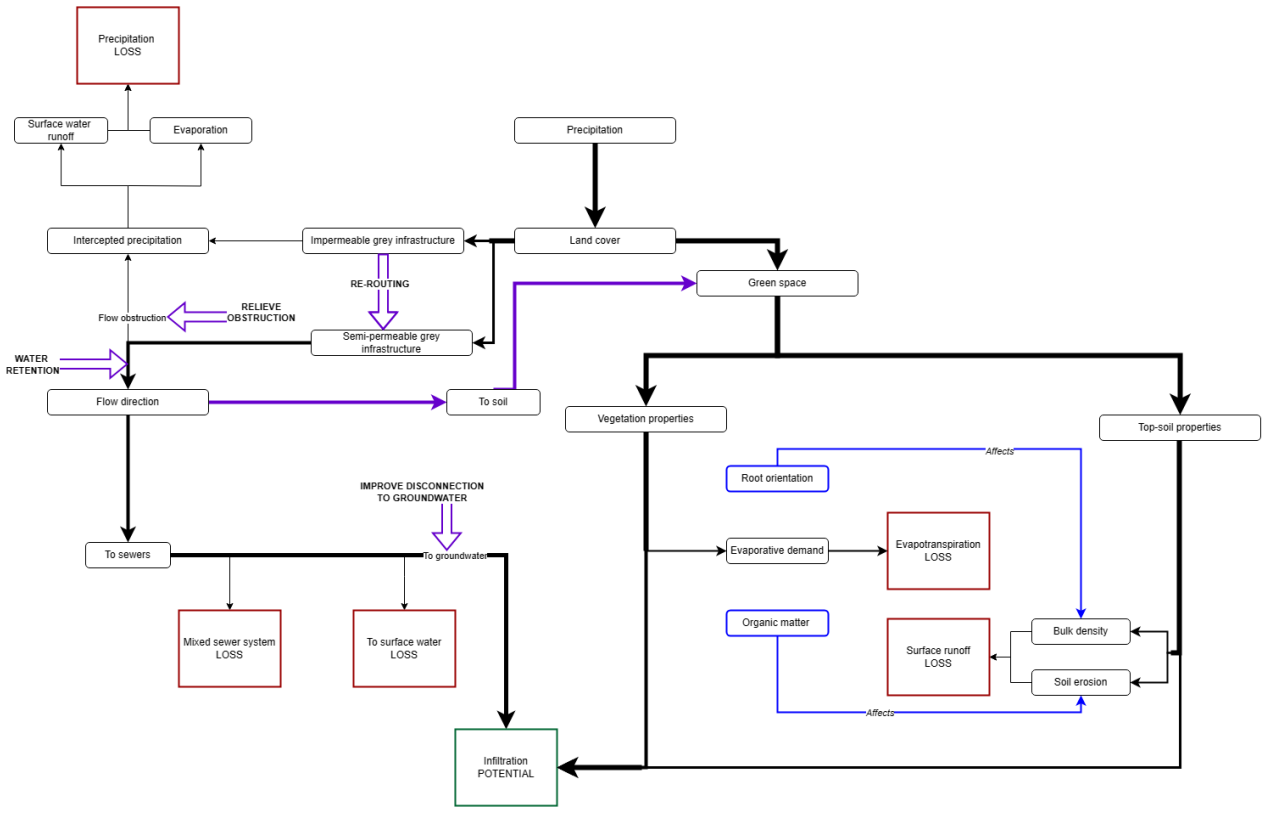


Figure 17.

Municipal variance of hydrological indicators is under-explored

The NPUH does not provide adequate resources on the hydrological situation at the scale of each municipality. It is also acknowledged that opportunities and risks of urban infiltration ought to be further explored. The conducted GIS analysis illustrates that a municipal scope is required to properly determine areas of opportunity, as there is substantial municipal variance in the indicator values that are relevant for infiltration potential. To reach the established potential of groundwater level rise via disconnection to groundwater, local areas of opportunity need to be explored in addition to an integrative approach to analysis.

Evidence

By comparing all the municipalities in the park on 5 crucial indicators, an overview with *decoupling potential* for each municipality was made through our GIS analysis. The analysis illustrated there is substantial variance between relevant *inter*-municipal indicators for infiltration potential. This potential is determined by comparing the amount of urban area and natural properties in a municipality on the one hand, with the current level decoupling. From this, it easily becomes visible which municipality has the most terrain to win and, hence, also requires more attention from the NPUH.

3.3 Results

Table 3.2 visualises the potential for rainwater disconnection. From which it can be seen that municipalities like Hilversum, Laren, Soest and Baarn have very high scores indicating large potential. Meanwhile Woudenberg, Bunnik, Eemnes and Leusden show low potential for rainwater disconnection.

weight	15	15	12,5	20	12,5	25		
Municipality	**Soil type**	**Seepage/ infiltration**	**Elevation**	**GHG**	**GLG**	**Urbanized area**	**weighted average**	percentage scores (WA-1)/2)
Amersfoort	45	45	37,5	40	25	75	2,675	83,750
Baarn	45	45	37,5	60	37,5	50	2,75	87,500
Bunnik	15	45	25	20	25	25	1,55	27,500
de Bilt	45	30	25	40	37,5	50	2,275	63,750
Eemnes	45	45	12,5	20	12,5	25	1,6	30,000
Hilversum	45	45	37,5	60	37,5	75	3	100,000
Laren	45	45	37,5	60	37,5	75	3	100,000
Leusden	45	15	25	20	12,5	50	1,675	33,750
Rhenen	45	45	37,5	60	37,5	25	2,5	75,000
Soest	45	45	37,5	40	37,5	75	2,8	90,000
Utrechtse Heuvelrug	30	45	37,5	60	37,5	25	2,35	67,500
Wijk bij Duurstede	30	45	37,5	20	37,5	25	1,95	47,500
Veenendaal	30	30	25	40	37,5	75	2,375	68,750
Woudenberg	45	15	12,5	20	12,5	25	1,3	15,000
Zeist	45	45	25	40	37,5	75	2,675	83,750

Table 7. A table showing the weighted scores for the indicators per municipality. The weighted average is out of 3. (Three categories, green=large potential, orange= moderate potential, red=low potential)

Figure 17. Map highlighting all municipalities in the Utrechtse Heuvelrug

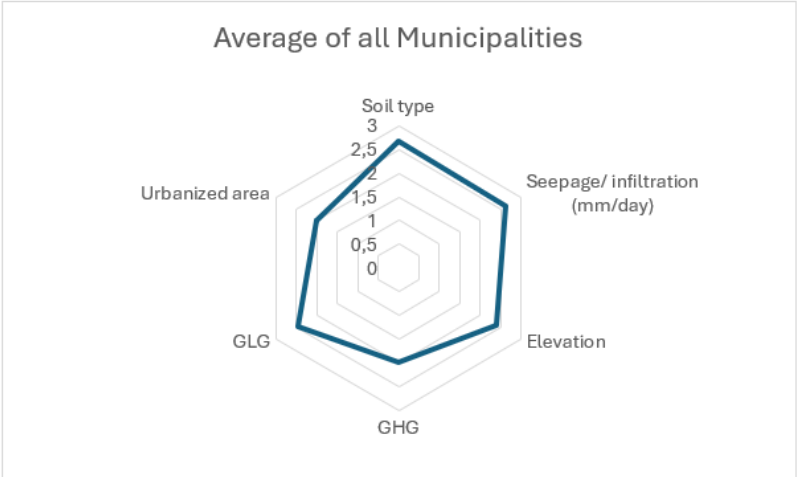


Figure 18. Reader diagram showing the average criteria scores per indicator for all municipalities

Weights	11	18	10	18	18	25	100
Municipality	**Soil type**	**Seepage/ infiltration**	**Elevation**	**GHG**	**GLG**	**Urbanized area**	**Weighted criteria score**
average	2,667	2,6	2,4	2	2,467	2	2,305

Table 8. Average score out of 3 for the five indicators found in the most urban areas of all municipalities

As an overview combining all municipalities in the Utrechtse Heuvelrug the final weighted score is 2.305 showing reasonably large potential for rainwater disconnection. All indicators score at least 2 out of 3, with soil type and Seepage/ infiltration rate being the two areas with the most potential on average. Urbanised area and GHG are the indicators which have the least potential for disconnection.

Amersfoort

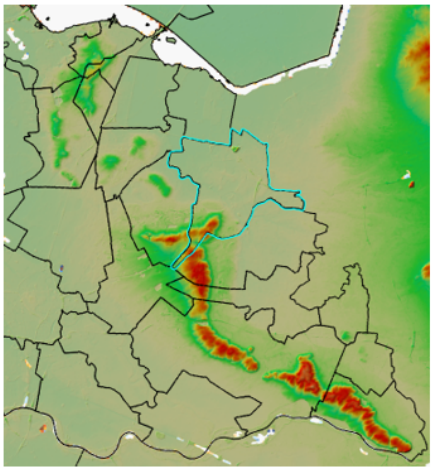


Figure 19. Elevation map of Utrechtse Heuvelrug highlighting Amersfoort

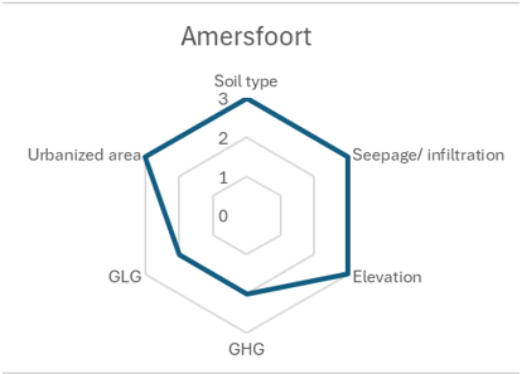


Figure 20. Radar diagram showing the criteria scores per indicator for Amersfoort

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Amersfoort	Sand	0.5 - 1.0 mm infiltration	3 - 45 m	0,8 ->2m	1->2m	41,80%	5/6

Table 9. Values for the five indicators found in the most urban areas of Amersfoort

Baarn

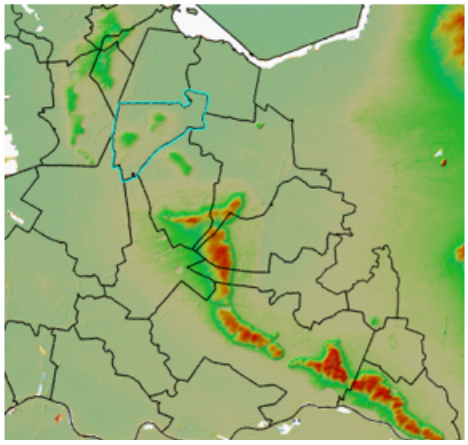


Figure 21. Elevation map of Utrechtse Heuvelrug highlighting Baarn

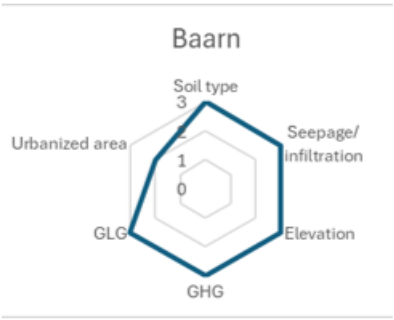


Figure 22. Radar diagram showing the criteria scores per indicator for Baarn

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Baarn	Sand	0.5 - 1.0 mm infiltration	5 m - 18 m	>2m	>2m	18,50%	5,5/6

Table 10. Values for the five indicators found in the most urban areas of Amersfoort

Bunnik

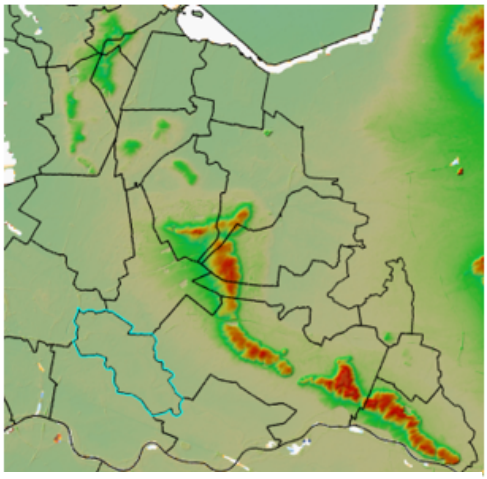


Figure 23. Elevation map of Utrechtse Heuvelrug highlighting Bunnik

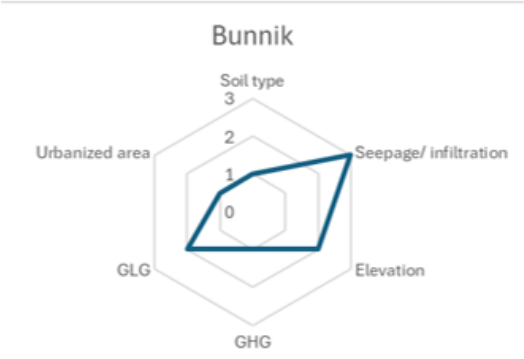


Figure 24. Radar diagram showing the criteria scores per indicator for Bunnik

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Bunnik	Clay and heavy clay	0.5 - 1.0 mm infiltration	4 m - 6 m	0,8-1,5m	1,5-2m	9,70%	2/6

Table 11. Values for the five indicators found in the most urban areas of Bunnik

De Bilt

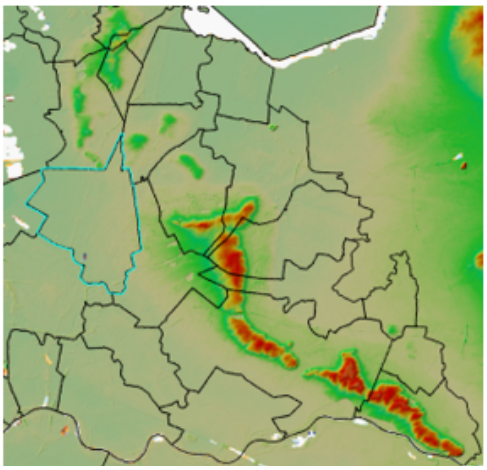


Figure 25. Elevation map of Utrechtse Heuvelrug highlighting De Bilt

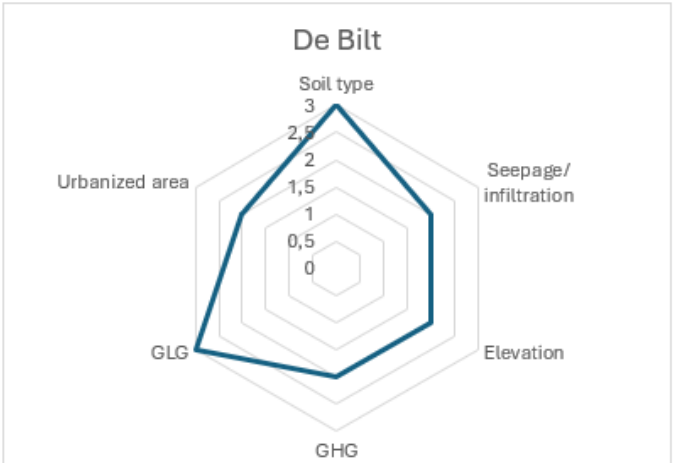


Figure 26. Radar diagram showing the criteria scores per indicator for De Bilt

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
De Bilt	Sand	0.1 - 0.5 mm infiltration	5 m - 7 m	1-2m	2->2m	16,60%	4/6

Table 12. Values for the five indicators found in the most urban areas of De Bilt

Eemnes

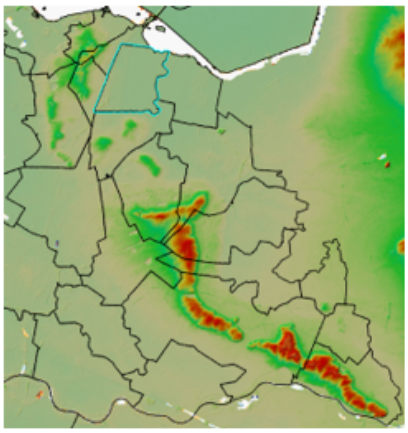


Figure 27. Elevation map of Utrechtse Heuvelrug highlighting Eemnes

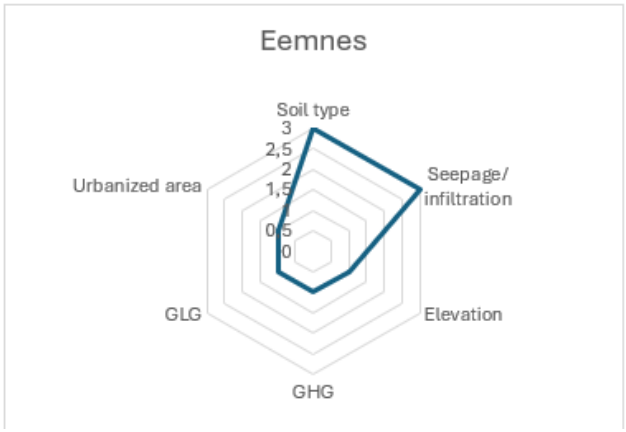


Figure 28. Radar diagram showing the criteria scores per indicator for Eemnes

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Eemnes	Sand	0.5 - 1.0 mm infiltration	2 m	0,6-1,5m	1-1,5m	6,30%	2/6

Table 13. Values for the five indicators found in the most urban areas of Eemnes

Hilversum

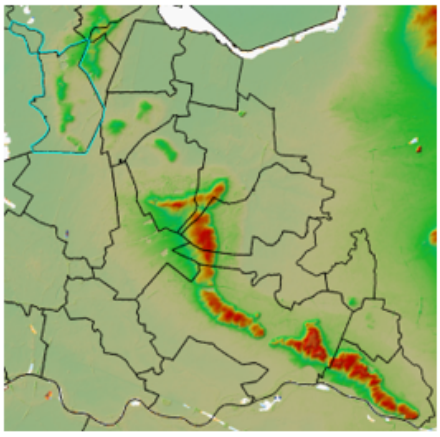


Figure 29. Elevation map of Utrechtse Heuvelrug highlighting Hilversum

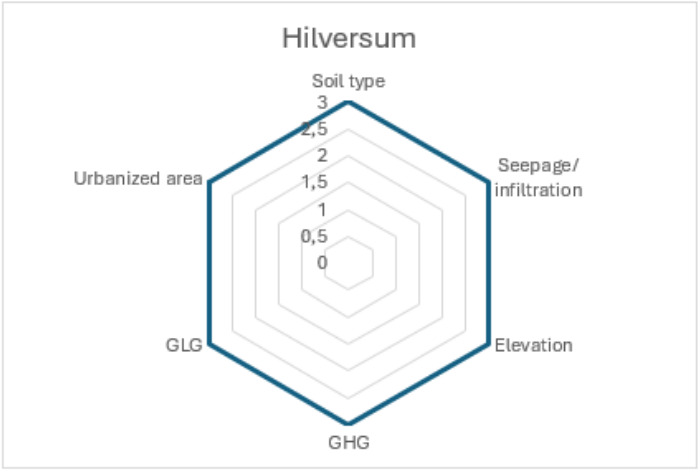


Figure 30. Radar diagram showing the criteria scores per indicator for Hilversum

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Hilversum	Sand	0.5 - 1.0 mm infiltration	3 m - 24 m	>2m	>2m	32,60%	6/6

Table 14. Values for the five indicators found in the most urban areas of Hilversum

Laren

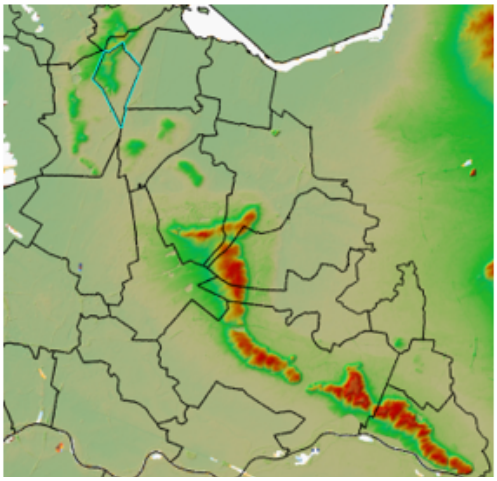


Figure 31. Elevation map of Utrechtse Heuvelrug highlighting Laren

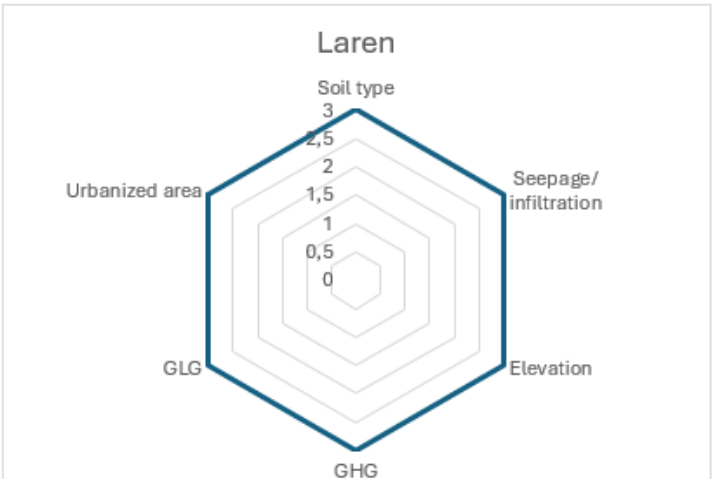


Figure 32. Radar diagram showing the criteria scores per indicator for Laren

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Laren	Sand	0.5 - 1.0 mm infiltration	4 m - 20 m	>2m	>2m	35,00%	6/6

Table 15. Values for the five indicators found in the most urban areas of Laren

Rhenen

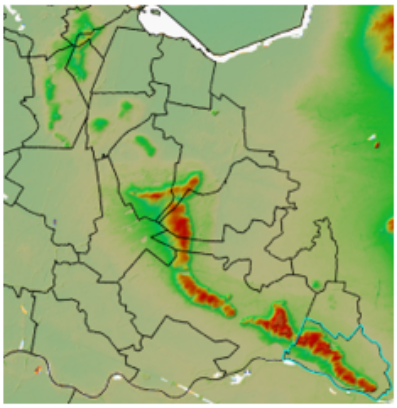


Figure 33. Elevation map of Utrechtse Heuvelrug highlighting Rhenen

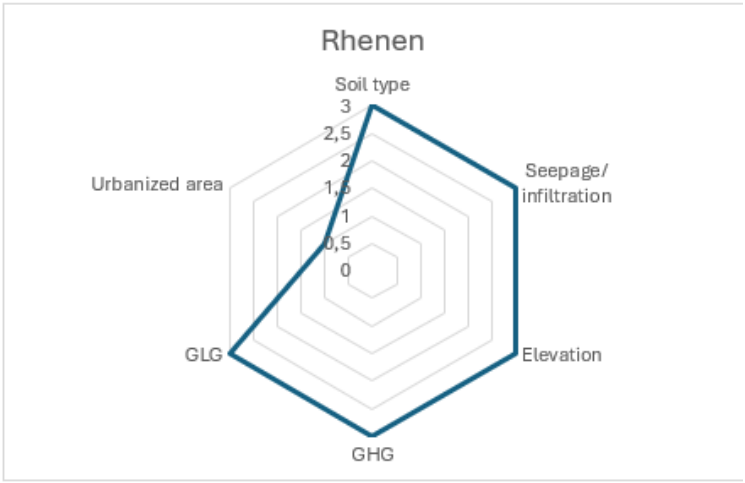


Figure 34. Radar diagram showing the criteria scores per indicator for Rhenen

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Rhenen	Sand	0.5 - 1.0 mm infiltration	8 m - 52 m	>2m	>2m	9,80%	5/6

Table 16. Values for the five indicators found in the most urban areas of Rhenen

Soest

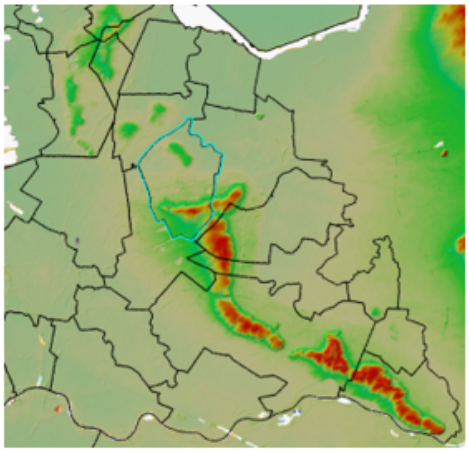


Figure 35. Elevation map of Utrechtse Heuvelrug highlighting Soest

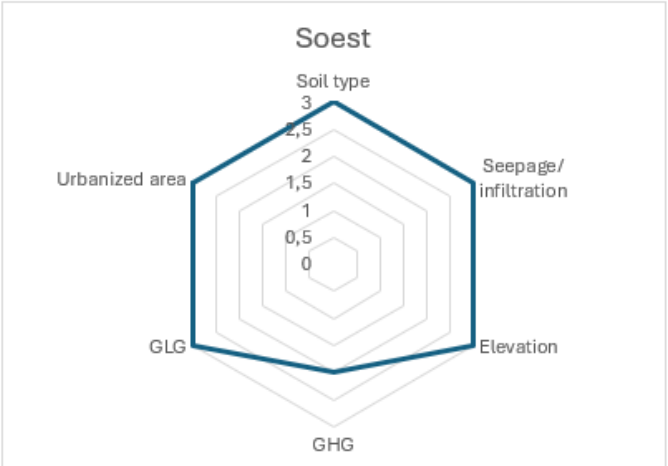


Figure 36. Radar diagram showing the criteria scores per indicator for Soest

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Soest	Sand	0.5 - 1.0 mm infiltration	4 m - 21 m	1->2m	1,5->2m	25,00%	5,5/6

Table 17. Values for the five indicators found in the most urban areas of Soest

Utrechtse Heuvelrug

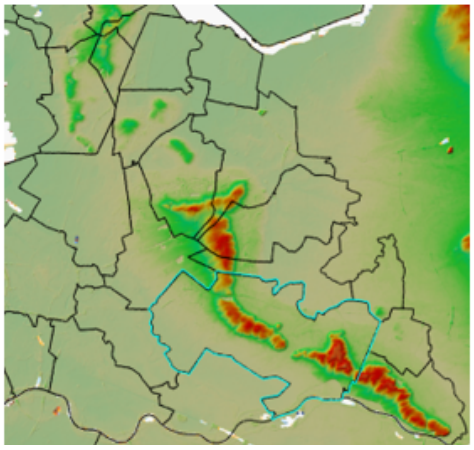


Figure 37. Elevation map of Utrechtse Heuvelrug highlighting Utrechtse Heuvelrug

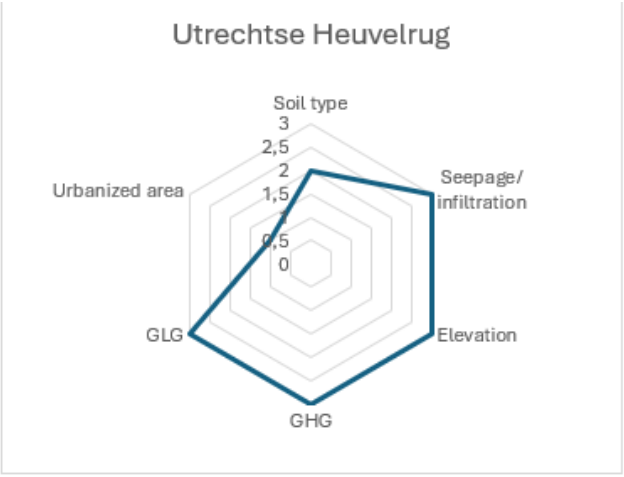


Figure 38. Radar diagram showing the criteria scores per indicator for Utrechtse Heuvelrug

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Utrechtse Heuvelrug	Sand slightly clay and sandy loam	1 - 2 mm infiltration	9 m - 69 m	>2m	>2m	8,90%	4,5/6

Table 18. Values for the five indicators found in the most urban areas of Utrechtse Heuvelrug

Wijk bij Duurstede

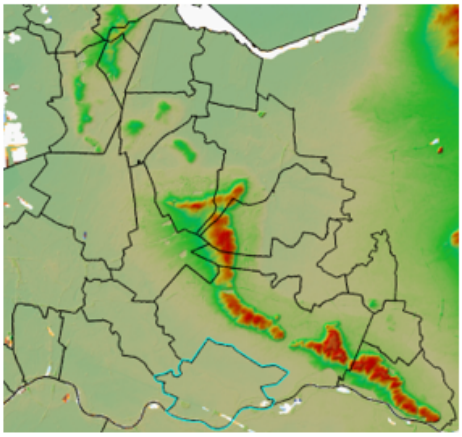


Figure 39. Elevation map of Utrechtse Heuvelrug highlighting Wijk bij Duurstede

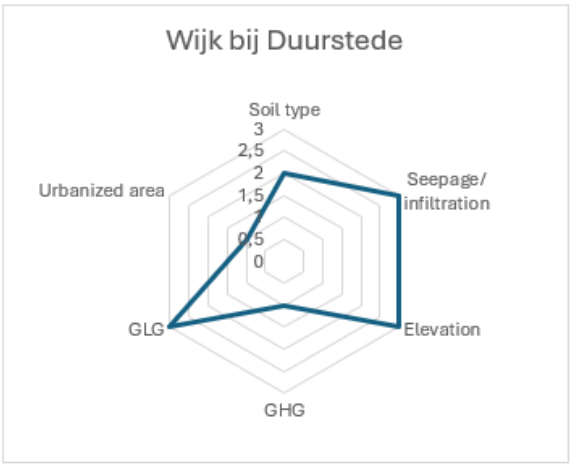


Figure 40. Radar diagram showing the criteria scores per indicator for Wijk bij Duurstede

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Wijk bij Duurstede	sandy loam and clay	0.5 - 1.0 mm infiltration	7 m - 10 m	0,8-1,5m	>2m	7,90%	3,5/6

Table 19. Values for the five indicators found in the most urban areas of Wijk bij Duurstede

Woudenberg

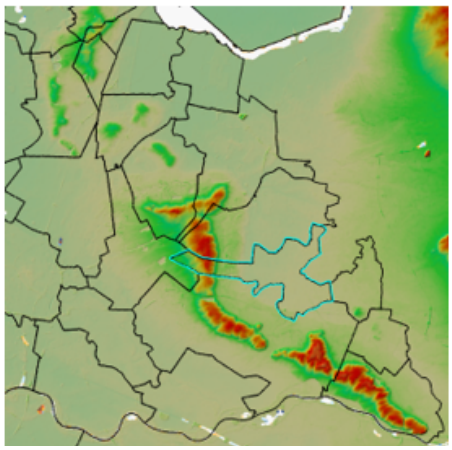


Figure 41. Elevation map of Utrechtse Heuvelrug highlighting Woudenberg

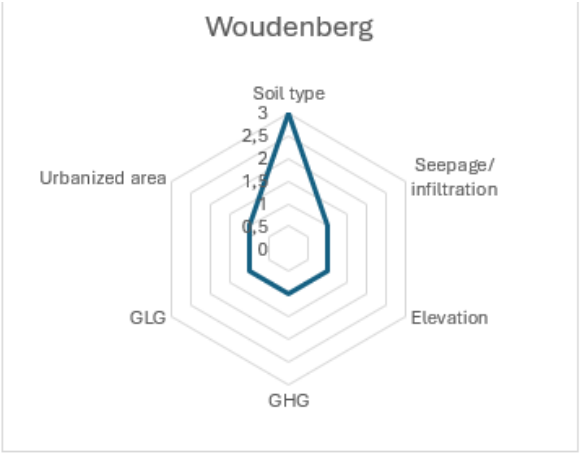


Figure 42. Radar diagram showing the criteria scores per indicator for Woudenberg

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Woudenberg	Sand	1.0 - 2.0 mm seepage	6 m	0,4-0,8m	1-1,5m	7,00%	1,5/6

Table 20. Values for the five indicators found in the most urban areas of Woudenberg

Zeist

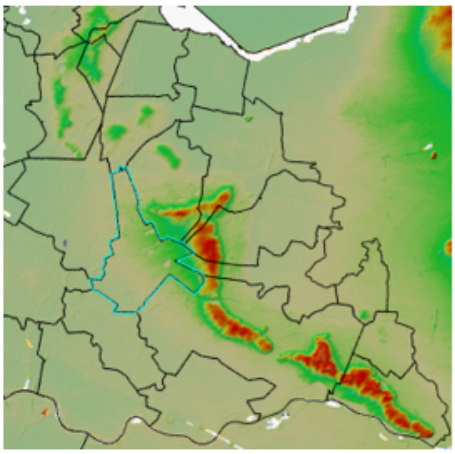


Figure 43. Elevation map of Utrechtse Heuvelrug highlighting Zeist

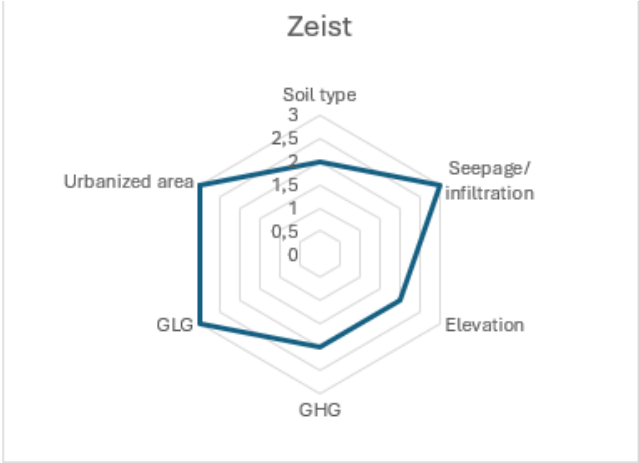


Figure 44. Radar diagram showing the criteria scores per indicator for Zeist

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Zeist	Sand and a little sandy loam	0.5 - 1.0 mm infiltration	4 m - 13 m	1->2m	1,5->2m	30,30%	4/6

Table 21. Values for the five indicators found in the most urban areas of Zeist

Veenendaal

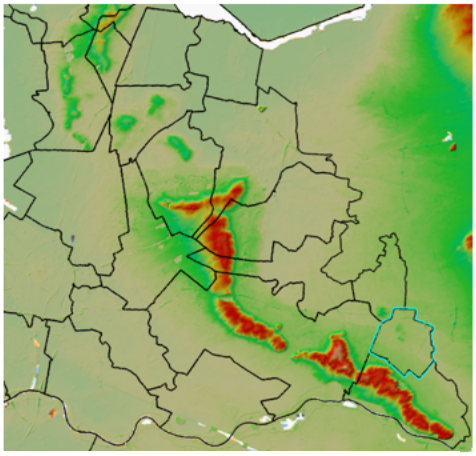


Figure 45. Elevation map of Utrechtse Heuvelrug highlighting Veenendaal

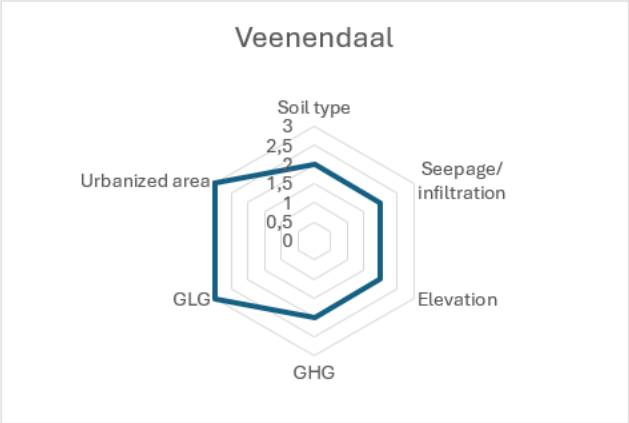


Figure 46. Radar diagram showing the criteria scores per indicator for Veenendaal

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area	Criteria score
Veenendaal	sand and little peat	0,1-0,5 mm inf	9 m	1-2m	1,5->2m	61,70%	4/6

Table 22. Values for the five indicators found in the most urban areas of Veenendaal

3.4 Methodology

3.4.1 KNMI

To define spatial differences of relevant indicators, these must first be selected and explained.

The KNMI is the Dutch meteorological research institute responsible for the translation and application of global climate change research by the IPCC to a national scope. Global measurements of GHG emissions, air pollution and land-use change are applied to climate models for 2050 to estimate trends based on four scenario types, varying between a "worst-case scenario" and a "best-case scenario". Consequently, such climate scenarios are employed as primary indicators for environmental impact assessments and risk management. As such, the likelihood of detrimental climate hazards is weighed against the investment costs of precautionary legislative measures. In 2014, the KNMI launched the KNMI'14 climate scenario report based on the latest research findings by the IPCC. The four scenarios depicted are based on two prospected parameters values, and are defined as follows:

I. *GL*: Moderate temperature rise (+1°C); Low impact of changing airflow patterns.
II. *GH*: Moderate temperature rise (+1°C); High impact of changing airflow patterns.
III. *WL*: High temperature rise (+2°C); Low impact of changing airflow patterns.
IV. *WH*: High temperature rise (+2°C); High impact of changing airflow patterns.

(KNMI, 2014)

With respect to probability, the KNMI established several criteria in selecting these four climate scenarios, namely *believability*, *relevance* and *clarity*. The purpose of these scenarios is therefore to develop acceptable and probable climate scenarios, disregarding extreme, but improbable outliers. The research framework elaborates on the extensive list of relevant indicators for water infiltration. A number of these indicators are also established in the KNMI´14 report:

- Precipitation
  - Annual average
  - Seasonal precipitation
    - Amount of dry days

- Rainfall intensity
  - 24-hour precipitation volume that is expected to occur on a 10-year interval.
  - Amount of wet days >0,1mm
  - Amount of wet days >10mm
  - 1-hour maximum precipitation volume

❇ Evaporation rate

The annual precipitation is the volume of water that can potentially infiltrate into the groundwater, and can be used as a primary input for the infiltration model; however, numerous indicator values may alter the volume that is effectively infiltrated. Seasonal precipitation and rainfall intensity further describe the spread of the annual precipitation volume. Relative indicators to determine the infiltration rate- and capacity (i.e. soil type, porosity and groundwater level) are not included independently in the KNMI'14 report but may be interpreted as originating causes of the evaporation potential, considering that water that does not infiltrate the soil remains as surface water. Upon the release of the latest upgraded climate report by the IPCC, the KNMI has developed the KNMI'23 report. This report builds on the findings of its 2014 precedent, with updated figures and methodologies.

Adaptations

Both the KNMI'14- and '23 reports provide measurements and future projections for the same parameters. As such, the climate scenarios may be compared uniformly. However, there are relevant differences in the methodology between the two reports. These differences and their implications on the validity of the climate ambitions of the NPUH Blue Agenda will be discussed in this section.

Firstly, the most prevalent difference between the two reports is that the 2023 report has opted for a new definition of each climate scenario. Whereas the KNMI'14 developed its scenarios based on *temperature rise* and *impacts of changing airflows*, the 2023 equivalent has opted to exchange the latter indicator for *annual precipitation*. By doing so, the KNMI'23 report includes scenarios for increasing- and decreasing precipitation volumes, which more accurately represents future risk hazards in terms of droughts (KNMI, 2023).

Then, the KNMI'23 report is built on higher resolution models for extreme weather events, thereby increasing the accuracy of extreme weather predictions. Similarly, the annual temperature rise has now been established based on accurate policy implementation following the Paris Agreement, which increases the accuracy of temperature rise estimates (KNMI, 2023).

Figures

For each of the four scenario types, the KNMI has specified future prognoses for the year 2050. However, only the *WH*-scenario will be extracted, as this reflects the methodology of the NPUH Blue Agenda, in which the climate models for the Utrechtse Heuvelrug for 2050 are established based on this worst-case scenario.

Table 6 presents for both the KNMI´14-and '23 report the climate reference period and the prospected 2050 "worst-case-scenario". To clarify, for the 2014 report, this entails a temperature rise of 2°C and a high impact of changing airflows; for its 2023 counterpart, this entails a temperature rise of 1,6°C and a reduction in annual precipitation.

Indicators	**KNMI'14 (*WH*)**		**KNMI'23 (*Hd*)**	
	Climate reference 1981-2010	Climate scenario 2050	Climate reference 1991-2020	Climate scenario 2050
Precipitation				
❖ Annual average	851mm	+5%	851mm	-3%
❖ Seasonal precipitation				
▪ Summer precipitation	224mm	-13%	235mm	-13%
▪ Winter precipitation	211mm	+17%	218mm	+7%
▪ Average highest precipitation shortage during growth season.	144mm	+30%	160mm	+35%
❖ Rainfall intensity				
▪ 1-hour maximum precipitation volume	15,1mm	+13-25%	16mm	+6%
▪ 24-hour precipitation volume that is expected to occur on a 10-year interval.	44mm	+2,5 – 22%	63mm	+6%
▪ Amount of wet days >0,1mm in winter	55 days	+2 days	57 days	0 days
▪ Amount of wet days >10mm in winter	5,3 days	+1 day	5,4 days	+0,4 days
▪ Amount of wet days >0,1mm in summer	43 days	-10%	-	-
Evaporation	559mm	+7%	603mm	+9%

Table 6. KNMI data from 2014 and 2023 showing the predicted change in weather indicators for climate scenarios WH and Hd

3.4.2 Research Framework

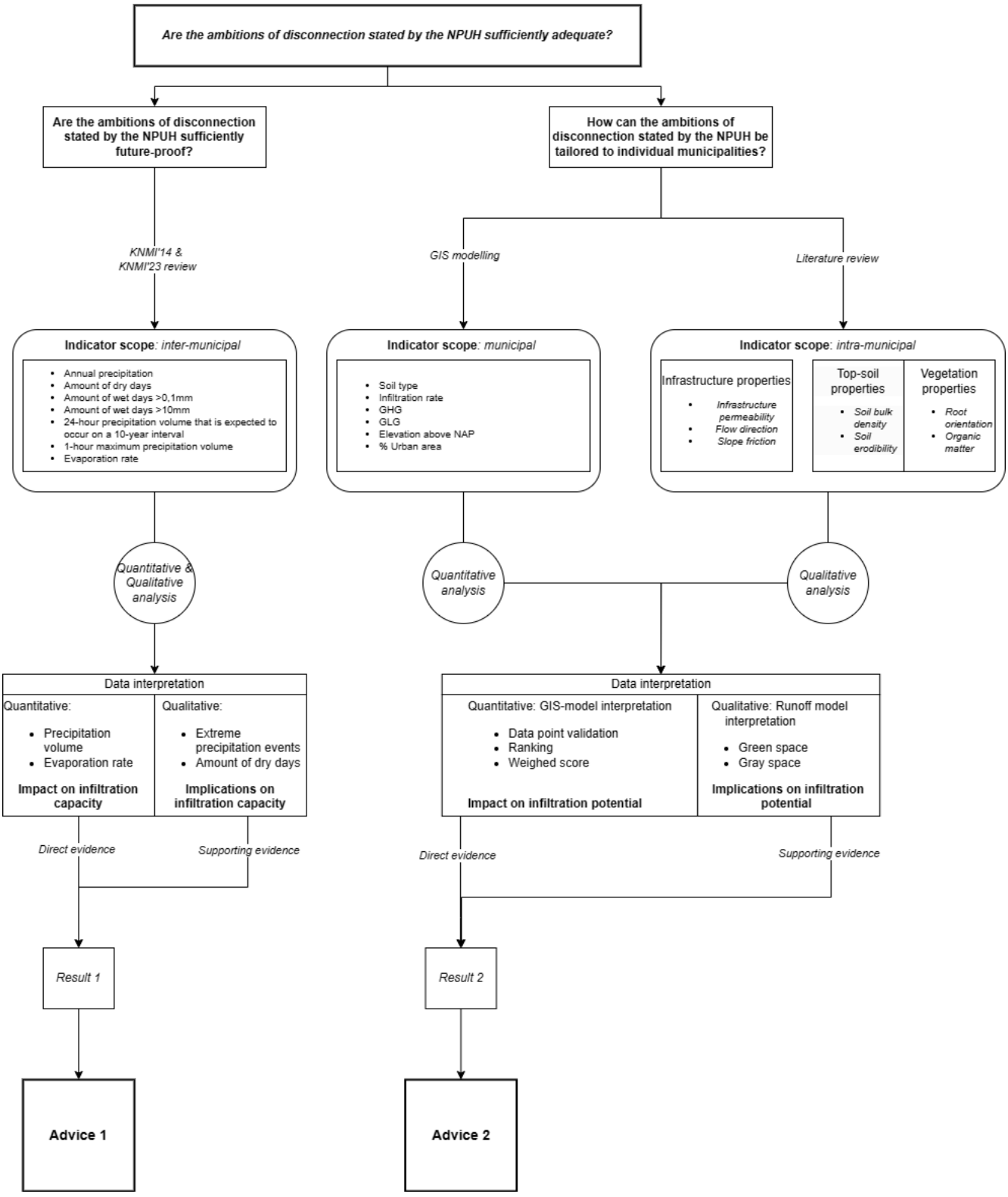


Figure 47. The research framework and steps take while writing the report

3.4.3 Data Collection

GIS maps representing the aforementioned indicators; soil type, infiltration/ seepage, elevation, GHG and GLG were compiled into a single composite map with multiple layers, accompanied by municipality borders. Municipality borders map was published by KROJ03 the ground type map published by j.j.blum@students.uu.nl and groundwater level, elevation and seepage/infiltration maps were published by ESRI Nederland. Links to these can be found in the references. A focus was set on recording the data in the most urbanised areas as that is where the ability to disconnect rainwater is the largest, so this is where values for each indicator were extracted. In cases where multiple values were present within these highly urbanised zones, the entire range was recorded to capture the variability across the area. This was then repeated for all municipalities in the Utrechtse Heuvelrug and the data collected in a table ready for further interpretation.

Research method	KNMI'14- and KNMI'23 report analysis
Relevance to subquestion	1
Indicator scope	Inter-municipal / National
Data- and evidence type	**Quantitative data: direct evidence** Direct value changes in future prospects of the following indicators: • Annual precipitation • Evaporation **Qualitative data: supporting evidence** Indirect effects or non-quantifiable indicators: • Amount of dry days • Amount of wet days >0,1mm → *reported as "dry periods".* • Amount of wet days >10mm • 24-hour precipitation volume that is expected to occur on a 10-year interval • 1-hour maximum precipitation volume → *reported as "extreme weather events".*
Data interpretation	Not specified

Table 23. Data collection; KNMI'14- and KNMI'23

Research method	GIS-modelling
Relevance to subquestion	2
Indicator scope	Inter-Municipal
Data- and evidence type	**Quantitative: direct evidence** Direct values extracted for the following indicators: • Soil type • Infiltration rate • GHG • GLG • Elevation above NAP • % Urban area
Data interpretation	Attributed 3-level rank system to indicator values; indicator ranks established based on **KNMI'23 report; STOWA report ; FAO report.** GIS-data point validation: extract indicator values at data point with the highest density of urbanized area.
Key search phrases	• "afkoppelen"/"disconnection" • "hemelwater"/"rainwater"/"precipitation" • "infiltratie, inlaatwater"/"infiltration" • "grondwater"/"groundwater" • "riolering"/"sewage" • "afvoer"/"runoff" • "Utrechtse Heuvelrug"

Table 24. Data collection; GIS-model indicators

Research method	Literature review
Relevance to subquestion	2
Indicator scope	Intra-municipal
Data- and evidence type	**Qualitative data: supporting evidence** Indirect indicator values supporting- or inhibiting GIS indicator values: • Infrastructure permeability • Flow direction • Slope friction → *reported as "infrastructure properties".* • Soil bulk density • Soil erodibility → *reported as "top-soil properties".* • Root orientation • Soil organic matter → *reported as "vegetation properties".*
Data interpretation	Indicators plotted in flow diagram; arrow size defines a **relative** indication of the perceived measure effects.
Key search phrases	"runoff model" "DGM model" "routing"/ "wegwijzing" "green space" "land use" "vegetation cover" "Slope friction"

Table 25. Data collection; runoff model indicators

3.4.4 Data Interpretation

Ranking

To assess the relative importance to the problem, indicators must be scaled by ranking to compare the values of different indicators with each other. The goal of ranking each indicator parameter is to develop a scale of contributing and hindering factors in terms of urban groundwater recharge. It is important to stress that a lower ranking in one or several indicators does not imply that infiltration strategies are ineffective, but rather invites a wider range of strategies to mitigate these issues. Inversely, if all indicators for a municipality are ranked highly, it does not imply that

there are no barriers to groundwater infiltration, but rather indicates that the potential for infiltration of this particular area is substantial. Therefore, the higher-scoring municipalities are prompted to analyse the obstacles inhibiting its infiltration potential, whereas the lower-ranking municipalities are implored to pursue alternative strategies to contribute to the groundwater recharge of the Utrechtse Heuvelrug.

Each indicator is evaluated based on a 3-term- ranking system. These ranks are established based on the proposed KNMI'23 future climate scenario parameters, and the extent to which each of the indicators has sufficient capacity under these conditions. The 3-term ranks are defined as follows:

- A *Green* rank means that this particular indicator value for this area is considered sufficiently resilient to both extreme and common precipitation- and drought events.
- An *Orange* rank means that this particular indicator value for this area is considered sufficiently resilient to common precipitation- and drought events, but has insufficient capacity to absorb extreme weather events.
- A *Red* rank means that both common- and extreme precipitation events pose potential hydraulic hazards to this particular area for this indicator value. Instead of *opportunity*, this indicator value is considered a *threat* to socio-economic well-being.

Table 26 illustrates the classification of each indicator by each rank. The following section will elaborate on the methodology used to determine the rank boundaries.

	Green rank values	*Orange rank values*	*Red rank values*
Soil type	> 17mm/hr	10- 17mm/hr	< 10mm/hr
Seepage/ infiltration	> 50,4mm/day	34,1-50,1mm/day	< 34,1mm/day
GHG/ GLG	> 2m	1,5-2m	< 1,5m
Elevation	> 10m + NAP	3-10 m + NAP	< 3m + NAP
Urbanized area	> 18,6%	9,3-18,6%	< 9,3%

Table 26. Classification of indicators by rank

In this case, the *extreme weather event* refers to the Maximum hourly precipitation volume of 16 + 6% mm from the KNMI'23 report. The *common precipitation event* refers to the Amount of wet days >10mm; in addition, it is established that for the sake of precaution, the 10mm volume may precipitate within a one hour timeframe and to assess the feasibility of each indicator, it should have the capacity to absorb this volume in a one hour timeframe.

The *soil type* is established by GIS models and utilises the nomenclature of NEN5104 - the national standard of sediment classification. Soil categories are classified based on its share of sand, silt and clay. These soil classifications have subsequently been tested by the Food and Agriculture (FAO) to assess the basic infiltration rate of each soil type. These findings are found in table X (FAO, 2001).

Soil type	Basic infiltration rate (mm/hour)
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Table 27. Basic infiltration rates for different soil types in mm per hour

As such, *sand* and *sandy loam* soil types receive a green rank; *loam* receives a yellow rank, and; *clay loam* and *clay* receives a red rank.

As for *seepage/infiltration,* it is established that the indicator for extreme precipitation events established by the KNMI'23 is insufficient. The report refers to an extreme precipitation event of 61 +6% mm at a 10-year interval; it is instead opted for a 2-year interval, in which the maximum daily volume of precipitation is anticipated at 50,1 mm. The daily precipitation volume that is considered "common" is established at a 0,5-year interval, which is anticipated to be 34,1 mm (STOWA, 2019).

As such, municipalities with an infiltration rate of 50,1mm/day or higher are ranked green; municipalities with an infiltration rate between 34,1mm/day and 50,1mm/day are ranked orange, and; municipalities with an infiltration rate of 34,1mm/day or lower or any rate of seepage are ranked red.

The indicators *GHG* and *GLG* are not specified as parameters by the KNMI'23; hence, instead it is opted to assess the ranks based on the effects from 50% disconnection including mixed measures and 100% disconnection individually on groundwater levels established in the NPUH Blue Agenda. In the report, it is established that 50% disconnection with supporting external measures may potentially increase groundwater levels with 2m or more; the 100% disconnection scenario without external supporting measures may realise an increase in groundwater levels of 1,5m. Hence, green ranks are established for GHG and GLG values of >2m; orange ranks are established for values between 1,5m-2m, and; red ranks are established for values <1,5m.

The three ranks in *elevation* are defined as follows: green ranks are municipalities at the *plateau* of the Utrechtse Heuvelrug and *high on the flanks* (10m+ above NAP); orange ranks are municipalities at the *lower flanks* (3-10m above NAP), and; red ranks are municipalities at the *foot* of the Utrechtse Heuvelrug (<3m above NAP).

The *share of urbanised areas* of each municipality are ranked as *above average, below average, and far below average*. The median share of grey infrastructure among the 14 participating municipalities is 18,6%; it is assessed that the red rank will be set at half of this value. Hence, green ranks are 18,6% and above, orange ranks are between 9,3% and 18,6%, and red ranks are 9,3% and below.

Weights

Throughout the literature review and data collection we came to the realisation that not all indicators have the same effect on whether it is worth it or not for rainwater disconnection. This is when we decided to give each indicator a weight that contributed to the final criteria score. Within our group we used the literature review to assign weights to the indicators. Expert advice was also sought after with members of the water board and university giving their opinions on the indicators. We started by ordering the indicators by importance. Once the ranks were assigned the weights were distributed according to add up to 100. This resulted in the following weights as can be seen in table 28.

Municipality	Soil type	Seepage/ infiltration (mm/day)	Elevation	GHG	GLG	Urbanized area
importance	**3**	**3**	**4**	**2**	**4**	**1**
weight	15	15	12,5	20	12,5	25

Table 28. Weighted scores given to each indicator used for data analysis

As stated above, each municipality were given ranks per indicator, ranking from 1-3 with 1 being lowest. These ranks were then multiplied by the weights from which a weighted average could be calculated. To acquire a percentage score the following equation was used ((weighted average - 1)/2)*100.

Appendices

I. Appendix Chapter 1

A) Interview questions for this subquestion

General

1. Do you know what the Blue Agenda is?
2. Is the Blue Agenda mentioned in your policies?
3. Is the decoupling of the rainwater seen as an urgent problem or is it more in the background?

Policies

4. What type of policies are currently in use for rainwater disconnection?
    1. Do the policy documents formulate specific targets and/or goals?
        1. If yes, are the targets divided into (quantifiable and temporal) sub-targets?
    2. Does the municipality engage in municipality-wide projects (wadi)?
5. Have the policies changed in recent years?
    1. So is there already more focus on this issue than in previous years?
6. What are your ambitions for developing current policies?
    1. Are there already any plans for new policies that will be implemented in the coming years?
    2. Stated earlier was a disconnection of …%, why this percentage and is that based on particular data?

Sectors involved

7. Are there any differences between domestic, corporate and public sectors for certain policies?
    1. Does the municipality delegate a budget to public decoupling?
    2. Can inhabitants get a subsidy for decoupling?
    3. Are inhabitants (and companies) motivated to decouple the rainwater?
8. Does the municipality think all sectors involved are equally important for the disconnection of rainwater?

B) Table overview of all relevant municipality measures

Because of the big amount of data, the spreadsheet is too big to add in the report directly, however the link is provided below:

https://docs.google.com/spreadsheets/d/1vuNJVy-SrDLwDhcD-Gfj48OAT6Zy6cVDcwt0eYWHsCo/edit#gid=0

C) Table of indicators for municipality potential

TOPIC	High Potential	Medium Potential	Low Potential
Subsidies	0	1/2	3
Meekoppelen'	No		Yes
Goals	General Ambitions	Percentages	Percentages with disconnection types
Sewage Charges	Decrease	Similar	Increase
Projects	No		Yes
Future Scenario's	50mm/year and under	Between 50 and 70mm/year	70mm/year and more
Stimulating Inhabitants	No focus	Passive stimulation	Active stimulation (afkoppelcoaches)
Participiation Inhabitants	Low	Medium	High

Table 1C. Indicators for municipality potential

D) Table topics explanation

In this section, the topics that are mentioned in the table are explained as well as their importance and when they are beneficial or not.

Subsidies

Firstly, subsidies for green roofs, rainwater barrels and the disconnection of rainwater pipes are included. These three things all provide ways in which less rainwater flows towards the sewage systems, and are therefore very helpful measures. Subsidies act as a cue for action towards the inhabitants (Van Valkengoed & Van Der Werff, 2022), so when a municipality offers subsidies to their inhabitants, this would likely cause more inhabitants to disconnect the rainwater. Therefore, three subsidies would be most positive, while municipalities with less subsidies have room for improvement.

Meekoppelen

"Meekoppelen" also shows how much focus there is on the disconnection of rainwater per municipality. "Meekoppelen" indicates that municipalities always construct separated sewage systems in places where other constructions take place. This is beneficial, as this would then limit the amount of hindrance for inhabitants, as both these actions are tackled at the same time, instead of different times. Therefore, it would be more positive if municipalities "meekoppelen" then when they do not.

Goals

In this section, the future goals of the municipalities are explored. It is important for municipalities to have clear numerical goals, with elaborate plans on execution of these goals, as this allows them to have most of the process in a certain period of time without any unclarity on what to do. Clear numerical goals without any elaborate execution plans would lead to more difficulties and general ambitions would have the least amount of efficiency.

Sewage Charges

With regards to the sewage charges, this money is used by the municipality to be able to construct new sewage systems and maintain current systems. When the municipality increases these sewage charges, this means that the municipality will have more money to spend on these systems, and therefore also on the construction of separated sewage systems. However, when sewage charges decrease, this would cause less money to be available for this construction, which is therefore less positive.

Projects

Some municipalities are also active in municipality-wide projects. When municipalities collaborate with other municipalities or organisations, this could be beneficial as they may exchange information with each other, which could be helpful in regards to the disconnection of rainwater. Therefore, municipalities that engage in projects have the least potential to improve, while municipalities who do not engage in this have the most potential to improve.

Future Scenarios

It is also important to focus on the future scenarios of all municipalities, and how much rainfall they want to be able to withstand with their future goals. According to Deltares (2018), peak rainfall events of 70 mm/hour have a return period of 100 years, and can cause 10-20% of the land surface to flood. With this information, it would be best for the municipalities to implement policies based on this scenario, making sure that they prevent problems caused by this amount of rainfall. When municipalities take into account lower peak precipitation in the future, this might cause problems such as flooding.

Stimulating Inhabitants

The role of inhabitants is also good to mention, as they can help with disconnecting rainwater as well. Therefore, it would be positive for municipalities to also focus on inhabitants and motivate them to also do their part. Active stimulation, with for example the help of disconnection coaches, is most positive, as this shows that information is provided based on the specific possibilities for the inhabitants based on living environment and their own preferences. Passive stimulation, with for example posters, has medium potential, as it might not be as efficient. And without any focus on inhabitants, there is lot of potential to improve.

Participation of Inhabitants

Lastly, it is important to look at the participation of inhabitants, as this shows if the municipality is reaching them in an effective way, or if there might be some additional actions that can be taken. When the participation of inhabitants is high, this is most positive.

II. Appendix Chapter 2

A) Literature review and DPSIR Framework for non-interviewed municipalities

Baarn

Baarn is situated on a hill, causing high elevation and low groundwater levels in some parts of the municipality, which results in water scarcity in these areas. Another driver is to save money, by preventing extra costs from sewage water treatment (Gemeente Baarn, 2022).

Promotion of domestic disconnection is done through the use of a disconnection coach, spreading information on practicalities of disconnection and subsidies (Gemeente Baarn, 2022), there are multiple subsidies available for varying disconnection practices (Baarn, 2018). Other barriers are overcome through regulations for new projects, combined disconnection, and collaborations with neighbouring municipalities.

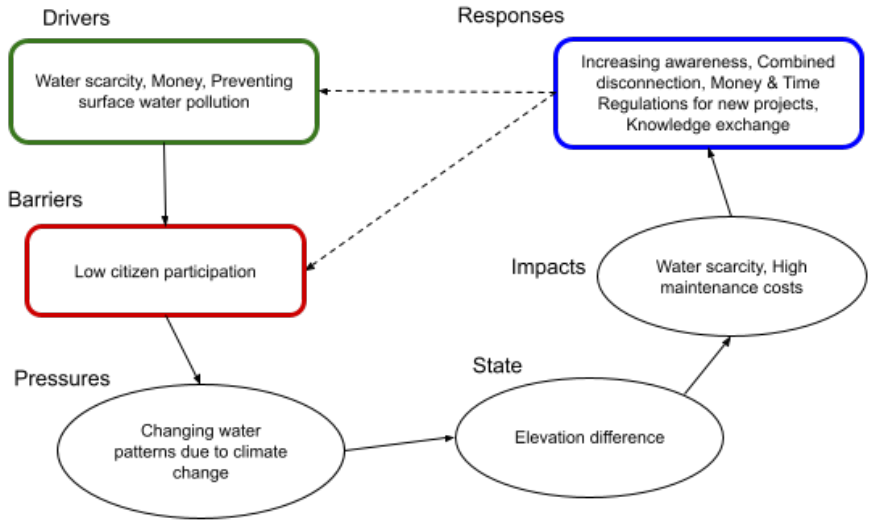


Figure 2A.1. DPSIR model of the municipality Baarn based on literature review.

De Bilt

Due to recent climate change, de Bilt expresses an increased urgency towards realising resilience to climate change, reflected in the ambition to store precipitation up to 70 mm per hour in 2050. Recent precipitation of 20 mm per hour has caused sewage overflow due to an increase in hardened surfaces, which resulted in surface water pollution (*Wateroverlast Door Hoge Grondwaterstand*, 2024). Additionally, drought and heat stress occur frequently in summer, resulting in an imbalance in the hydrological cycle.

Therefore, the municipality hopes to mitigate problems regarding water scarcity and excess via rainwater disconnection. Lastly, a favourable cost-benefit balance and duty of care are identified as drivers (*Water- En Rioleringsplan 2022-2026 Gemeente De Bilt*, 2021).

Identified barriers in the municipality of de Bilt are money and the preservation of the current sewage system. The municipality states not to implement rainwater disconnection in the public sector if costs are too high. The same applies to houses with front gardens in the private sector, as this is relatively costly. To overcome domestic disconnection barriers, de Bilt implements a rainwater advisor and stimulates citizens through community activities (Blommendaal, 2023). Combined disconnection and regulations for new projects are implemented to overcome barriers in the public sector.

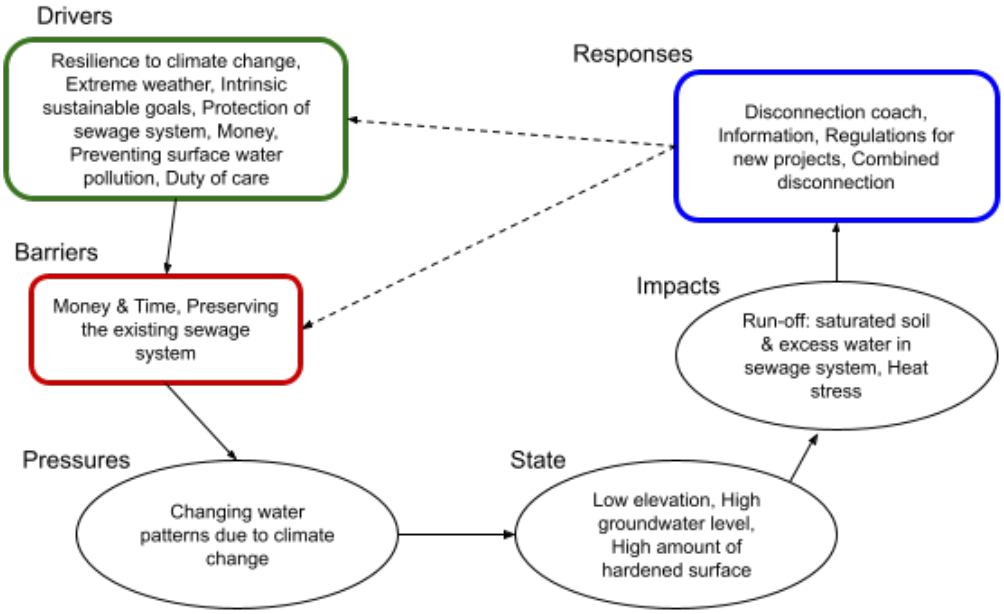


Figure 2A.2. DPSIR model of the municipality De Bilt based on literature review.

Hilversum

The municipality of Hilversum, located on the north side of the Heuvelrug, aims to actively improve climate resilience, with a focus on future insecurities. Through rainwater disconnection they hope to address both increasingly frequent heavy rainstorms and periods of drought, as a result of climate change. Additionally, preventing surface water pollution and duty of care are identified as drivers (Gemeente Hilversum, 2020). However, limited monetary and workforce resources have restricted the process of rainwater disconnection. Other identified barriers are the desire to preserve the current sewage system and the high groundwater level in some areas of the municipality, which decreases the capacity for rainwater infiltration (Gemeente Hilversum, 2020).

To overcome barriers Hilversum has increased sewage charges and implemented combined disconnection to optimise the budget for rainwater disconnection. This money is used to implement rainwater disconnection on large roof surfaces for the domestic and private sector. For domestic disconnection, information is actively spread to citizens, especially in areas at higher risk of flooding during rainstorms (Gemeente Hilversum, 2020). In addition, citizens are given infiltration crates by the municipality and subsidies for domestic disconnection are provided by the waterboard (Gemeente Hilversum, 2024). Lastly, there are regulations for new projects regarding rainwater infiltration.

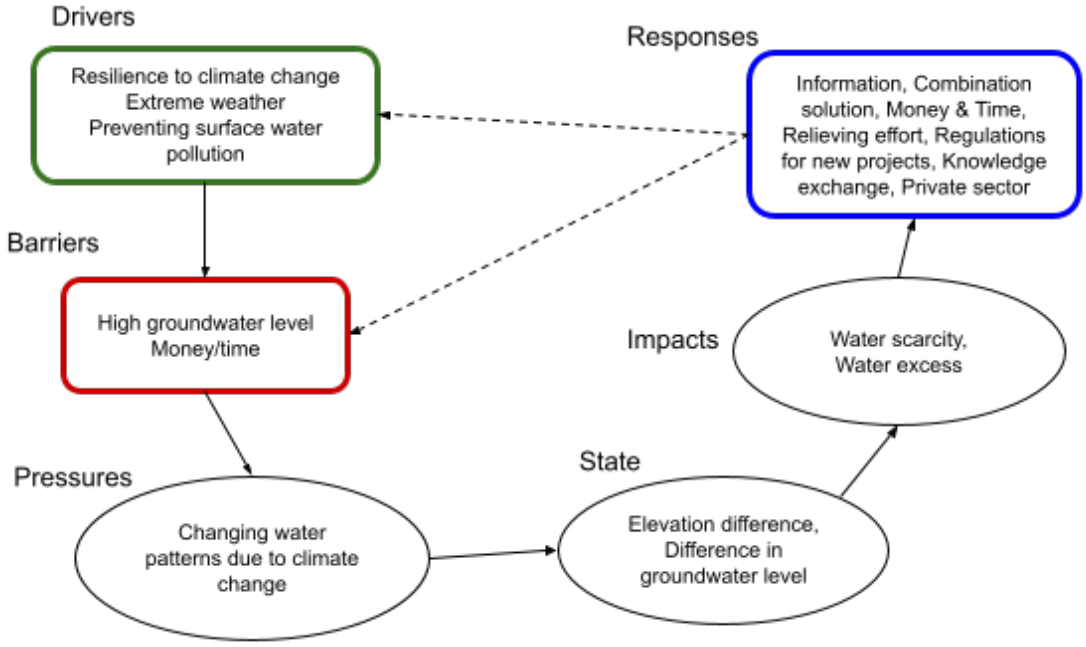


Figure 2A.3. DPSIR model of the municipality Hilversum based on literature review.

Rhenen

The municipality of Rhenen believes that rainwater disconnection can increase climate resilience through natural maintenance of the groundwater level, in addition to mitigation of nuisance due to water excess. Problems due to water excess that the municipality aims to relieve include local flooding and damage to the current sewage system. Lastly, Rhenen believes that transporting clean precipitation to the wastewater treatment plant is unsustainable and inefficient.

To accelerate rainwater disconnection in the domestic sector Rhenen provides a subsidy of €5 for every square metre of disconnected roof surface, the total budget for subsidies is €50.000 annually. Additionally, the municipality focuses on information and knowledge exchange, this is done between municipalities, organisations, and citizens.

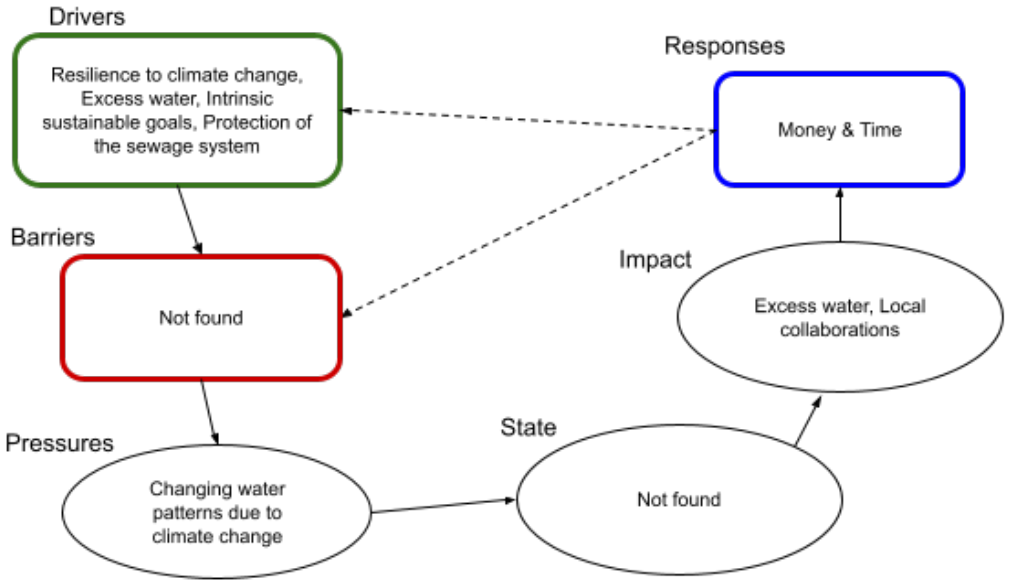


Figure 2A.4. DPSIR model of the municipality Rhenen based on literature review.

Leusden

Leusden aims for a future-proof sewage system to prevent overflowing and floods, which result in surface water pollution with sewage water and damage to properties. Additionally, the duty of care regarding rainwater is identified as a driver. However, barriers including low citizen participation (33%) and high groundwater levels have hindered the local implementation of disconnection (Leusden, 2020). Additionally, errors have been made during the establishment of a separated sewage system, resulting in pollution and additional costs.

To overcome barriers of domestic disconnection the municipality uses subsidies from the waterboard and arranges local projects to create awareness and engage citizens in disconnection. Additionally, the municipality has established regulations for new projects and collaborates with neighbouring municipalities (Leusden, 2020).

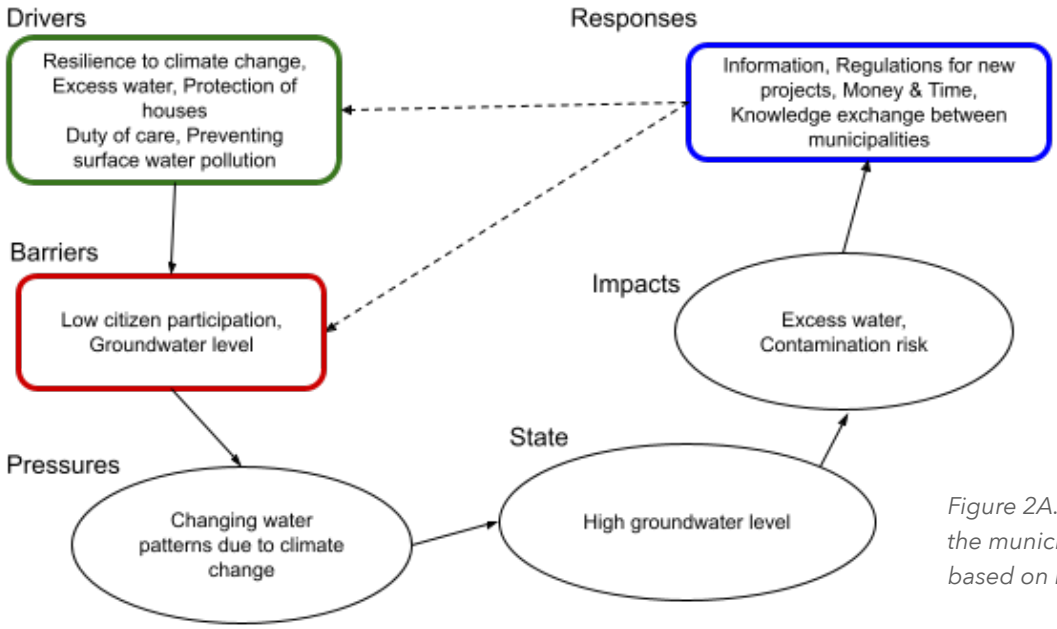


Figure 2A.5. DPSIR model of the municipality Leusden based on literature review.

Wijk bij Duurstede

The municipality of Wijk bij Duurstede, is located to the southwest of the NPUH, at the flank of the Heuvelrug. Their focus is on climate resilience, especially through the prevention of problems due to excess water, like high groundwater levels and floods (*Water En Klimaat*, n.d.). Research has shown that disconnecting 30% of the hardened area would reduce the risk of water nuisance significantly. Another driver for the municipality is the prevention of surface water pollution to maintain balanced ecosystems.

A lack of workforce was identified to be the main barrier in Wijk bij Duurstede, which, in combination with high groundwater levels, hinders the rainwater disconnection rate. The main efforts of the municipality to overcome barriers include increase of citizens' awareness through information (Leusink, 2019) and combined disconnection with construction work (*Regenwater Afgekoppeld in Koninginnebuurt Langbroek*, 2022).

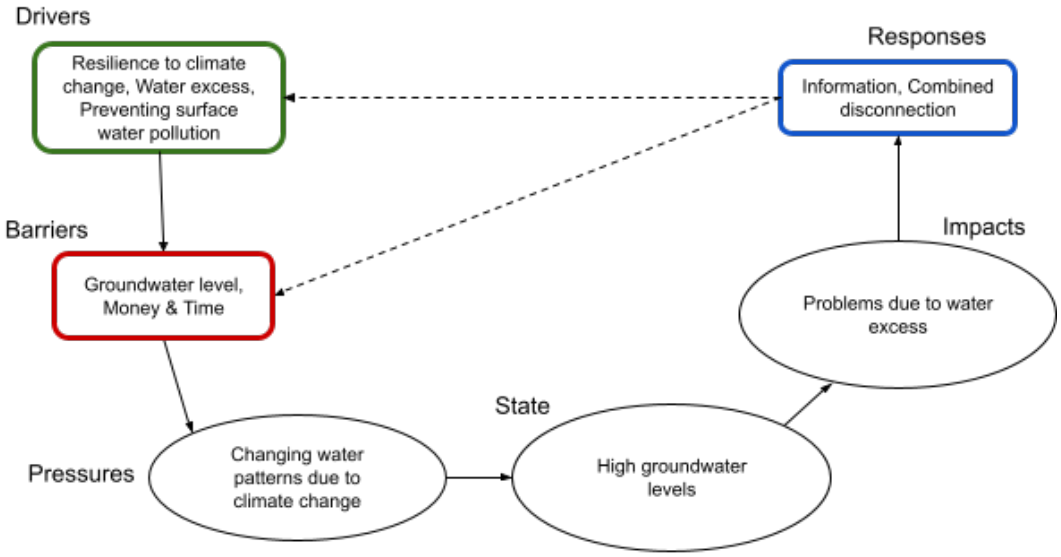


Figure 2A.6. DPSIR model of the municipality Wijk bij Duurstede based on literature review.

B) Potential for non-interviewed municipalities

Municipality	Drivers	Barriers	Responses	Overall potential	Willingness to collaborate with Blauwe Agenda
Baarn				63 %	Not known
De Bilt				50 %	Not known
Hilversum				57 %	Not known
Rhenen				57 %	Not known
Leusden				70 %	Not known
Wijk bij Duurstede				43 %	Not known

Table 2B. Potentials and willingness to collaborate for non-interviewed municipalities

C) Coding of interviews

Drivers	Keywords
Climate adaptation	Klimaat, duurzaam, visie, toekomst
Extreme weather	Droogte, hittestress, water excess, grondwater peil
Protecting infrastructure	Historische/culturele waarde, schade aan huizen
Intrinsic sustainability goals	Duurzamer, toekomst
Preventing surface water pollution	Overstort, drinkwater, vervuiling, oppervlaktewater
Duty of care	Wetten

Barriers	Keywords
Lack of citizen participation	Bewonersparticipatie
Awareness	Bewustwording, kennis, informatieavond
Physical aspects	Bodemtype, klei, grondwater peil, hoogte, berg, laag, hoog, kom, depressie, ondergronds/bovengronds afkoppelen, volgebouwd
Money/Time	Geld, subsidies, budget, werknemers
Preserving existing sewage system	Robuust, goede staat, moeite, waarde
Conflicting interest	Verschillende wensen, onenigheid
Under prioritising	Geen prioriteit

Overcoming barriers	Keywords
Disconnection coach/Communication	Afkoppelcoach, keukentafel langsgaan, regenwater adviseur, maatwerk, thuis
Combined disconnection	Werk voor werk, constructie, verbouwing, aanbellen,
Money/Time	Geld, subsidies, budget
Relieving effort	Ontzorgen, installatie, bekostigen
Enforcing laws	Verplichten, wet invoeren
Regulations new projects	Nieuwbouw, niet aankoppelen
Knowledge exchange between municipalities	Kennisuitwisseling, andere gemeenten

Collaboration with Blue Agenda	Keywords
Sharing information	Samenwerken, informatie delen
Money	Geld, subsidies, budget
Collaboration	Link, gemeentes, samenwerken
Coordination of groundwater levels	Coördinatie grondwater niveau
Workforce	Werknemers

Soest

Drivers	Keywords	Explanation
Climate adaptation	Belangrijkste argument is in te spelen op klimaatverandering en extremere buien	The most important driver is to be prepared for climate change
Extreme weather	eerst 25 mm bui, sinds 2 jaar 40 mm bui Belangrijkste argument is in te spelen op klimaatverandering en extremere buien	They want the sewer system to be able to hold a rainstorm of 40 mm. The most important driver is to withstand extreme rain showers
Protecting infrastructure	schade beperken richting de toekomst als er heftigere regenbuien vallen	They want to prevent damage for more extreme rain showers in the future
Intrinsic sustainability goals		
Preventing surface water pollution	Als er vanuit Soesterberg een grote bui valt dan gaat de overstort op het bos en vervuil het de Soestduinen, waar ook drinkwaterwinning is	With heavy rainfall in Soesterberg, the excess water will go into the forest and pollute the Soestduinen, where drinking water is also collected.
Duty of care		
Awareness	voor zichtbaar water afvoeren is goedkoper en worden mensen bewuster wat er met het water gebeurt en het minder vervuilen	For the disposal of water on the surface, the driver is that it is cheaper and that the citizens can see where there water goes and thus don't pollute the water

Barriers	Keywords	Explanation
Lack of citizen participation	mondjesmaat gebruik subsidie. moest meer energie in particulier afkoppelen afgelopen 10 jaar, maar amper uit de verf gekomen. Particulier vs openbaar afkoppeling is totaal uit verhouding Ze kunnen niet verplichten. Mensen hebben er geen woorden naar/ mensen snappen het niet. zelfs met afkoppelcoach haal je maximaal 70%	Only a few people have used the subsidies for disconnection at home. They wanted to put more attention on domestic disconnection, but that failed. In public areas the disconnection was about 20 times more than in domestic space. They cannot make the citizens disconnect their houses. Citizens don't want to listen to the talk about disconnection or they just don't get it Even with disconnection coach, max of 70% domestic disconnection is reached
Awareness	plannen voor bewonersavonden en afkoppelmarkten, maar nooit wat van terecht gekomen. dat lag aan ons, geen prioriteit aan gegeven	They had plans for citizen night and disconnection markets to explain the disconnection, but they never really took place. They blame themselves for not giving the communication priority
Physical aspects	niet echt, het grondwater zit erg diep dus ondergronds afkoppelen gaat goed Regenwater in het zich afvoeren is eerder een probleem, want sommige wijken zijn volgepropt Afkoppelen in hellend gebied is nog lastig. daar proberen we nu goede ontwerpen voor te maken	The groundwater is quite deep, so there are no physical problems Discharging the rainwater above ground in sight (one of their goals) is a bigger problem as some neighbourhoods are already very full so there is no green space where the water can run to The disconnection in a sloped area is hard. they are working on that now
Money/Time	Weinig aandacht particulier afkoppelen. afkoppelcoach is intensief en kostbaar, gaan heel veel uren in zitten aan de kant van de gemeente is geld geen probleem, de rioolvoorziening pot is hartstikke ruim Voor de particulier kan het wel een drempel zijn omdat er maar 30% vergoed wordt niet afkoppelen om het afkoppelen.	They have paid little attention to the domestic disconnection The disconnection coach is an intensive job which costs a lot of hours Money is not a problem on the side of the municipality, as there is a lot of money for the sewer systems For the citizens, money can be a barrier, as only 30% of the costs will be subsidised. They will not break up the street just for the disconnection, as it is very expensive
Preserving existing sewage system		
Conflicting interests	landgoed Pijnenburg wil hoge grondwaterstanden, de woonwijk ernaast natte kelders en kruipruimtes	At the Soesterveen, there is landgoed Pijnenburg and there Natuurmonumenten wants to have a high groundwater level to return the hoogveen, and turn it into a bog. but in the neighbouring residential area, the cellars will be much wetter and these people complain about it
Under prioritising		

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication	dus je moet om de keukentafel. externe man die bij iedereen aan de keukentafel gaat zitten	They have to go to citizens houses and talk to them. So they hired a disconnection coach who will go to people's houses and talk to them.
Combined disconnection	integraal	They always tackle multiple issues at once, like the sewer system, green spaces, trees, street lights, and the disconnection. They have been doing this for 20 years
Money/Time	subsidieverordening, af en toe artikel in de krant en op de website	They have subsidies for disconnection. Every now and then, an article is published in the local newspaper and there is information about it on the website.
Relieving effort		
Enforcing laws	kijken of we bewoners zeggen van u moet afkoppelen	They are discussing whether they are going to put something about forcing citizens to disconnect in the new Omgevingsvisie for 2025.
Regulations new projects		
Knowledge exchange between municipalities		

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information	nee, we zijn prima in staat dat soort dingen zelf uit te zoeken. zoals met Baarn en allerlei samerwerkingsverbanden met 19 gemeentes. De Blauwe Agenda kan wel bestaande platforms gebruiken om daar hun verhaal te doen	They don't directly need anything from the Blauwe Agenda. They already have collaborations with a lot of municipalities and share information through that platform. The Blue Agenda can use the existing collaboration platforms to tell their story and share their knowledge there, but not make a new platform
Money		
Collaboration		
Coordination of groundwater levels		
Workforce		

Table 2C.A Coding interview Soest

Veenendaal

Drivers	Keywords	Explanation
Climate adaptation	En mijn collega's gaan uiteraard mee met de trends van alle weersvoorspellingen en klimaatadaptieve gebeuren, waardoor we nu 10 jaar later natuurlijk op een heel ander scenario uit zijn gekomen. En daar gaan zij zeker in mee.	The municipality acknowledges the upcoming climate change and want to keep up with the most recent climate forecasts
Extreme weather	Weersvoorspellingen, droogte, hittestress	The municipality experiences drought and heat stress and expects these to occur more frequently due to future meteorological predictions. Water excess is more likely than a shortage, the municipality would flood easily.
Protecting infrastructure	Gemengd riool belasten, veel minder druk,	The municipality wants to decrease pressure on the existing mixed sewage system by disconnection of rainwater.
Intrinsic sustainable goals	Duurzaamheid, klimaatadaptatie, streven volledig circulair te zijn in 2050, progessief, ideaal, visie	The municipality claims to be progressive and have a future-looking perspective. Many people working at the municipality have a sustainable vision for the future. There is an aim to be circular in 2050.
Preventing surface water pollution		
Duty of care		

Barriers	Keywords	Explanation
Lack of citizen participation	Subsidie te laag, aanvraagformulier op papier, niet bewust van subsidie, aanvragen te veel werk, manier van aanvragen, moeite doen Laag aantal mensen laat regen adviseur komen	The experience is that the subsidy of 50 euros is not enough to motivate the citizens to take action. Only a few people let a rain advisor come to their house
Awareness	Bewustzijn/klimaatadaptatie meer effectief als driver dan geld	They saw that awareness and climate adapting was more effective than money
Physical aspects	Kommetje, zeer lage grondwaterstand niet veel voorkomend, Veenendaal onder water, water is een plaag Grondsoort (veen, zand, klei), water in tuin,	The municipality is situated in a depression, therefore extreme low groundwater levels do not occur often. Additionally, the municipality has varying soil types (peat, sand, clay), on clay, disconnection could easily lead to the flooding of gardens.
Money/Time	bovengronds afkoppelen is het makkelijkst,	Underground disconnection is more difficult and costly than above ground
Preserving existing sewage system		
Conflicting interest		
Under prioritising	Geen vaste target, anders aanpakken Blauwe agenda algemeen, helemaal lezen, niet van toepassing	There is no set target for disconnection, the municipality assumes that a target would encourage them to take disconnection more seriously. The Blue Agenda is too general, reading through a super large document that is mainly not applicable to your municipality is not motivating.

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication	Regenwater adviseur, bij mensen thuis, afkoppel coaches, visite, maatwerk Adverteren in krant, kraam in gemeentehuis - visueel voorbeeld	There is a rainwater advisor who visits citizens to apply custom disconnection. Before, there were disconnection coaches. The municipality advertises weekly in the local newspaper. Additionally there is a stand in the city hall, which creates a visual example of disconnection.
Combined disconnection	Afkoppelen in grote projecten, reconstrueren, nieuwe woningen, nieuw wegdek, werk met werk, ondergronds aansluiten Bij regenton gratis vulautomaat en aansluiten,	Work for Work: in large projects, reconstructions, new buildings, and new roads, the sewage system is changed to a separate system. Either the municipality pays to automatically connect the citizens to the separate system or the rainwater advisor form the building company visits citizens to ask to be disconnected at their own costs. Additionally, there is collaboration in which local rain barrels came with a free attachment and the municipality pays people to come connect it.
Money/Time	Er is subsidie	There is a subsidy of 50 euro per household
Relieving effort	Ontzorgen, aannemer komt gratis afkoppelen, afkoppel kits,	Relieving effort/unburdening seems like the most effective solution for private disconnection. Especially if the municipality pays the contractor (instead of subsidies). Another idea could be disconnection kits.
Enforcing laws		
Regulations new projects	Nieuwe groene en blauwe wetten → nieuwe gebouwen worden niet aangekoppeld	There are laws which say new buildings cannot be connected to the sewage system
Knowledge exchange between municipalities		
Monitoring drivers	Hoe ons/regenwater adviseur gevonden,	Citizens are asked how and why they have found the rain water advisor.

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information	Per gemeente, op een kaart	The municipality would prefer information to municipality-based. Also visualised on a map.
Money		
Collaboration		
Coordination of groundwater levels		
Workforce	een man of vrouw sturen, handen, geen info maar handelen	The municipality does not care much for information, that is just extra work to do for them. Instead they would prefer to be sent extra people to help relieve some work. This could be through helping spread awareness locally at the market, having a disconnection day where they go by houses etc.

Table 2C.B Coding interview Veenendaal

Zeist

Drivers	Keywords	Explanation
Climate adaptation		
Extreme weather	De grootste focus ligt denk ik wel op wateroverlast en dat is ook in die gebieden waar we die 30% willen afkoppelen. Dat is in gebieden waar we wateroverlast ervaren, dus daar zijn we heel gericht al mee bezig alles wat ten noorden zit, daar zit grondwater dieper maar juist tegen die rand aan tegen de Utrechtse weg, daar hebben we nu dus heel veel meldingen dat grondwater daar opeens omhoog komt en allemaal kelders onder water staan.	The main reason for Zeist is to protect the municipality from extreme weather events and to prevent nuisance. On the edges of the area, basements are being flooded.
Protecting infrastructure		
Intrinsic sustainability goals		
Preventing surface water pollution	een andere belangrijke is ook nog wel het riool open storten En daarvoor zijn externe overstorten. Als je een externe overstort hebt, die zit vaak langs een water gang en dan gaat het eigenlijk gewoon over de rand op het oppervlaktewater. Maar dat is verdund afvalwater wat je in de sloten krijgt. Nou als je daar heel veel van hebt, dan sterven de vissen af en dan kun je vervolgens dode vissen gaan scheppen en het is voor de flora en fauna sowieso niet heel best. Maar die overstorten dicht zetten, dan staat het op straat. Ja, dat willen we ook niet	The municipality wants to avoid sewer overflows, because that means that the polluted sewage water will mix with the surface water.
Duty of care	wetgeving is voor mij nu echt een drijfveer. Die hadden te meer een randvoorwaarde,	According to legislation, disconnection is mandatory.

Barriers	Keywords	Explanation
Lack of citizen participation	Leuk om die ambitie te hebben en om het geld te hebben, maar het blijft eigendom van een particulier. Je kunt ze niet dwingen en het is best ingewikkeld om iemand in beweging te krijgen die denkt, dat boeit mij het, ik geloof het wel.	It is one thing to have money and ambitions as a municipality, but a lot of ground is property of individual citizens, who can not be forced into disconnecting.
Awareness	Het belangrijkste is, denk ik een stukje bewustwording, een omslag bij inwoners. En, dat is gewoon een hele lastige	Awareness of the public is very important, but that still misses a lot.
Physical aspects		
Money/Time	En dan kom je op een gegeven moment ook gewoon op een lange adem en personele capaciteit om dat voor elkaar te krijgen	The whole disconnection process takes a long time and enough staff capacity.
Preserving existing sewage system	Probleem is alleen dat die buizen technisch gezien nog heel erg goed zijn en ook nog niet vervangen hoeven te worden. Dus eigenlijk kapitaalvernietiging om die te gaan vervangen. Maar tegelijkertijd wil je afkoppelen,	Zeist disconnects water when they have to repair the sewage system, but the sewage system is of such good quality that it is not necessary to break the street open. That would cost too much money, time and work.
Conflicting interest		
Under prioritising		
Lack of participation of private sector	Ja bedrijfsterreinen zijn vaak nog wat lastiger, omdat je ook met vervuiling zit en we zitten in Zeist ook boven het grondwaterwingebied, dus het drinkwaterwingebied. En daar wil je geen vervuiling in hebben, dus dat is altijd een beetje moeilijk.	Companies are difficult, because you have to be really careful, because of the drinking water collection, and there can be a lot of pollution in industrial areas

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication		
Combined disconnection	bij reconstructies van wegen, dus al de weg aangepakt wordt, dan gaan we kijken, kunnen we zoveel mogelijk vergroenen en hemelwater lokaal infiltreren	Reconstruction of roads or sewer system will be combined with disconnection
Money/Time	Voor inwoners gratis afkoppelen	They will do the disconnection for free
Relieving effort	Een subsidie daar zitten heel veel handelingen aan vast. Dat betekent gewoon dat je ook iemand op kantoor moet hebben zitten, die de subsidies gaat beoordelen, gaat afhandelen en er moet een factuur betaald worden en daar zit gewoon heel veel bureaucratie aan vast. En daarom hebben we gezegd, daar gaan we niet aan beginnen. Wij stimuleren door gewoon langs te komen met de zaag en iemand die adviseert en wij komen het voor u doen.	There are far too many procedures associated with subsidies. Therefore, the municipality has decided to just come over and do it for the people.
Enforcing laws		
Regulations new projects	Alleen Zeist west is in de jaren '60 '70 ontwikkeld en voor 80% is dat al afgekoppeld, gescheiden en geïsoleerd, dus dat hemelwater gaat daar al gewoon naar de sloot toe en daar voeren we alleen afvalwater af wij hebben een hemelwater verordening	New neighbourhoods in Zeist are being disconnected from the start. The municipality has a rainwater regulation.
Knowledge exchange between municipalities		
Analysation of types of inhabitants	Er zijn hele analyses van wat voor type mensen heb je nu in de wijk en waar is iemand gevoelig voor. De een die is bijvoorbeeld heel gevoelig voor het woordje gratis en als die gratis hoort, dan denkt hij ik wil en de ander die denkt van ja, ik wil het eerst feitelijk onderbouwd hebben en de ander die denkt de overheid, ik vertrouw ze voor geen meter, dus laat maar zitten. Zo heb je heel veel verschillende type mensen en hoe je dat kunt benaderen en dat is wel echt een hele lastige en die ambitie van 30% in 5 jaar, ik denk dat we die niet gaan halen.	They analyse the specific people in a neighbourhood and how they can be convinced to disconnect. This creates a specific strategy for each neighbourhood.

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information		
Money	Dus ja, geld zou kunnen helpen, maar wil je echt meters maken, dan heb je wel een hele grote zak met geld nodig.	Money could help overcome a barrier, but it has to be an extreme amount of money in that case.
Collaboration	Weet je, dat daar de blauwe agenda, is een wat verbindende rol, en ook capaciteit die gezamenlijke ambitie is er wel en dat beleid en dat is ook goed	The role of the Blue Agenda could be to connect all municipalities and to deliver capacity.
Coordination of ground water levels in municipalities	Het is meer een randvoorwaarde waar je heel goed over na moet denken als je het gaat doen.	If all municipalities in the Utrechte Heuvelrug were to disconnect and integrate all rainwater, this could lead to problems. Therefore, that has to be thought out very clear.
Workforce		

Table 2C.C Coding interview Zeist

Laren

Drivers	Keywords	Explanation
Climate adaptation	Heel Nederland heeft last van klimaatverandering, maar de heuvelgemeentes zijn het eerste aan de beurt infiltreren zorgt ook voor het vasthouden van water op de plek waar het valt en dit verminderd verdroging (bijvangst)	In the whole Netherlands, climate change has an impact, but the hilly municipalities are most heavily affected The rainwater infiltration causes the rainwater to stay at the place it falls, so the dehydration of the soil is battled (but they see this as a secondary driver)
Extreme weather	echt naar aanleiding van een extreme bui van 46mm in een uur → rioolwater tot aan je knie in het centrum	The biggest driver was a heavy rain shower of 46mm/h, which resulted in sewage water at knee height in the centre of Laren
Protecting infrastructure	vele euro's schade, veel leed, veel problemen, gezondheidsrisico's water komt het eerst het riool uit in het historisch centrum, willen we beschermen	The flooding lead to a lot of monetary damage, a lot of sorrow and health problems Water comes out of the sewer system in the historical centre first, and we want to protect that
Intrinsic sustainability goals		
Preventing surface water polution		
Duty of care		

Barriers	Keywords	Explanation
Citizen participation	Deelnemerspercentage van particulieren is rond de 90% (dus geen barrier) Mensen die plekken als heilig ervaren en dus niet willen dat monumentale plekken worden veranderd	Citizen participation is around 90%, so this is not a barrier. This is because of their disconnection coach. There are citizens that don't want monumental places changed so they protest
Awareness		
Physical aspects	Laren kent veel hoogteverschillen het historisch centrum is het laagste punt en dat is helemaal volgebouwd, dus er is een soort putje gecreeërd weinig open water in Laren om regenwater kwijt te kunnen in de lage delen is het afkoppelen moeilijk omdat je dicht op het grondwater zit, dus je kan niet diep de bodem in In het centrum zitten veel huizen dicht op elkaar, dus weinig plek om maatregelen te nemen Hoog grondwater bij lange periodes van regen, waardoor kruipruimtes en kelders nat worden Deel van het gebied is niet van de gemeente, snelweg is van rijkswaterstaat. Ook de delen van het waterschap	Laren has a lot of height difference The historical centre is the lowest point in the area and the surrounding area is fully covered in buildings now, so a pit is created There is little open water in Laren to get rid of rainwater In the lower parts, the disconnection is hard, because you are close to the groundwater, so you cannot go deep into the ground In the city centre, the buildings are close to each other, so there is little space for measures After long periods of rain, the groundwater level gets high, making the cellars wet in the lower areas. They don't have a say on the highway, because it is owned by Rijkswaterstaat. Also the areas owned by the waterboards.
Money/Time	bij hoge grondwaterstand is afkoppelen duurder in eerste instantie iedereen gewezen op afkoppelen, maar mensen in het centrum moesten veel meer betalen dan mensen op de heuvel. En de rijken wonen op de heuvel en de armen in het centrum, dus de rijken worden rijker en de armen worden armer	With high groundwater levels (in the lower areas) the disconnection is more expensive At first, the municipality said to everyone they had to disconnect. But the people in the city centre had to pay much more that people on the hill. Rich people live on the hill, poor people in the city centre, so the rich get richer and the poor get poorer
Preserving existing sewage system		
Conflicting interest	Geen veen of landbouwbedrijven die hoog grondwater willen Het infiltreren van water mag niet overal (van het waterschap)	There is no reason to keep the groundwater level high for either peat or agriculture The infiltration of water is not allowed everywhere (by the waterboard)
Under prioritising		

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication	vertellen aan de bewoners op de heuvel dat het afkoppelen helpt tegen droge zomers waardoor hun tuin mooi blijft Participatieavonden gehad/folders/flyers/kunnen mensen de gemeente bellen De 2 afkoppelcoaches + communicatieadviseur gaat echt met mensen in gesprek van waar ze zich zorgen over maken in hun tuin. Ook compenseren ze als mensen niet tevreden zijn of herstellen ze de afkoppeling Filmpje gemaakt over wat er wordt aangelegd, wat er gebeurd en waarom het gebeurd Inspraak bij de bewoners gevraagd voor openbare gebieden waar veel weerstand was tegen plannen	They tell the residents on the hill that the disconnection can help battle the dry summers and keep their garden pretty They organized participation evenings/flyers/ citizens can call a person from the municipality especially for disconnection The 2 disconnection coaches + communication advisor talks with the citizens and does the disconnection together with the citizens. They will also compensate when people are not happy or they reverse the disconnection They have made videos explaining what happens, why it happens and what is changed in the garden They asked for ideas from citizens to tackle areas where there was a lot of public resistance against municipal plans
Combined disconnection	Als een andere afdeling dingen in de straat wil vervangen koppelen ze mee, waardoor de straat niet 2 keer opengemaakt hoeft te worden	The disconnection under the streets will happen together with other work, to prevent the street having to be opened twice.
Money/Time	Rioolheffing is verhoogd, wat een grote pot geld van 13 miljoen heeft opgeleverd Hierdoor kan de gemeente zelf beslissen hoe ze het uitgeven en kan je ook de particuliere ruimte afkoppelen en hoef je niet te hopen dat mensen het gaan doen Wanneer een riool is afgeschreven is het veel meer rendabel om het te vervangen, dus kost het veel minder geld	The sewage charges were increased, which gave a big stack of money (13 million) With this money, the municipality can choose for themselves how they want to spend the money and they can disconnect domestic areas, so you don't have to hope people will do it themselves When a sewer system is out of date, it is much cheaper to disconnect the rainwater from it, so it costs a lot less money.
Relieving effort	De gemeente doet op particulier terrein (afkoppelen), en niet alleen in openbare ruimte	The municipality will do the disconnection on private property, not only on public property.
Enforcing laws	Dreigen dat bewoners in de toekomst verplicht moeten afkoppelen en dat ze dan zelf moeten betalen, in plaats van dat de gemeente nu betaalt	They threaten that citizens that when, in the future they must disconnect they would have to pay it themselves, instead of paid by the municipality now
Regulations new projects		
Knowledge exchange		

Choice of area to disconnect	Elk gebied heeft zijn eigen uitdagingen, maatregelen en risico's, bewoners en participatie, dus opgedeeld in 7 deelgebieden op de heuvel staan villa's met fantastische tuinen en bos waar je het veel goedkoper kan doen Doelmatig kiezen waar je afkoppelt, paar tientjes in hoog gebied en paar duizend in laag gebied alle oppervlaktes van Laren waar we afkoppelpotentie zien, 6 meter plus NAP Kijken naar potentie van percelen, verhouding dakoppervlak tot tuin. Als de voorkant heel makkelijk is en de achterkant niet, dan laten we de achterkant gewoon zitten In de lastiger af te koppelen delen doen ze ook nog wel een klein beschermsysteem, niet dat ze daar helemaal niks doen	Every area has its own challenges, with different risks and different citizens with different participation. So the municipality of Laren has been divided into 7 areas. On the hill are villas with gardens and forest where the disconnection is much easier and cheaper They choose where they are going to disconnect, which costs tens of euros at high areas vs thousands at low area all areas of Laren where there is potency for disconnection, 6 meter plus NAP They look at the potency of a plot, what the ratio is between the surface of the roof vs area of the garden. Also within the plots they look at what is most effective to disconnect In the lower areas, where it is harder to disconnect, they still install small protection systems, so there is still some disconnection.

Collaboration with Blue Agenda	**Keywords**	**Explanation**
Sharing information	Lokale kennis en know-how Een soort handboek van hoe je met regenwater om moet gaan en wat de meest wenselijke situatie is Informatie over de financiële situatie, of je als gemeente wel voor de bewoners mag betalen. Ze hebben het nu zelf uitgezocht, maar deze informatie kan wel gedeeld worden binnen de NPUH	They want to have local information and knowledge Creating a guide on how to deal with rainwater and what the most ideal situation is. Information about the financial situation, whether you can pay for the citizens as the municipality. They got the knowledge themselves now, but this can be shared within the NPUH
Money	Geld is altijd goed	They would always know how to use extra money
Link between organisations	Als de NPUH als link kan dienen tussen de verschillende organisaties	The NPUH can be a link between different organisations
Coordination of groundwater levels		
Workforce		

Table 2C.D Coding interview Laren

Utrechtse Heuvelrug

Drivers	Keywords	Explanation
Climate adaptation	Goed en nodig voor de natuur, herstel van vegetatie. voorkomen dat extreem weer vaker voorkomt	The municipality focuses on nature, biodiversity and preservation and recovery of nature. Additionally, climate adaptation is focussed on to prevent the frequent occurrence of extreme weather in the future.
Extreme weather	Water vasthouden, droge periode. meer extremen door klimaatverandering, natuurbranden bij extreme droogte, modderstromen bij korte hevige neerslag, verdroging	The focus is on water retention, especially because of periods of drought in summer. Due to extreme weather, caused by climate change, forest fires, extreme drought, mud streams and desiccation occur.
Protecting infrastructure		
Intrinsic sustainability goals		
Preventing surface water pollution		
Duty of care		
Physical aspects	Op de heuvelrug, laag grondwaterpeil. overlast riolering → veel kosten,	The municipality is situated on top of the heuvelrug, inducing a relatively low groundwater level. Additionally, the sewage system deals with excess water due to runoff, for which maintenance is costly.

Barriers	Keywords	Explanation
Lack of citizen participation	Bewoners willen niet afkoppelen, dan wordt het nog natter. Geen gevoel voor/niet bewust van milieu. Mensen vinden afkoppelen technisch ingewikkeld. Budget is niet groot. Mensen bieden weerstand. Bewoners denken dat de hoge waterstand door afkoppelen komt. Het is voor bewoners ingewikkeld om te begrijpen.	Due to exceptional wetness the past months, citizens are scared disconnection will lead to water excess in gardens. People believe the high water level is caused by disconnection. Additionally, disconnection is found too technical or complicated and is hard to understand by citizens. Additionally, the budget (for subsidies) is not large. Lastly, some people do not prioritise the environment or sustainability.
Awareness	Veel bedrijven/organisaties zijn er niet mee bezig	Many businesses or organisations are not focussed or aware of disconnection and the environment.

Physical aspects	Exceptioneel nat jaar. Technisch (flatgebouw), ingewikkeld. Hoge grondwaterstanden.	The past months had been exceptionally wet, this hinders disconnection, as high groundwater levels lead to contamination risks from disconnection. Additionally, some locations (such as high buildings or industry locations) are technically difficult to disconnect.
Money/Time		
Preserving existing sewage system		
Conflicting interest		
Under prioritising		

Overcoming barriers	**Keywords**	**Explanation**
Disconnection coach/ Communication	Afkoppel coaches, lokale clubs Communicatie voor uitleg van het systeem, gemeenschapsgevoel waarbij bewoners elkaar stimuleren. Actief naar bedrijven/organisaties toe gaan.	There are disconnection coaches and local clubs available in the municipality. The municipality focuses on communication to explain the system and necessity of disconnection to citizens. They have realised that the mutual stimulation of citizens works better, as well as a community feeling. Additionally, they approach businesses and organisations actively to increase awareness.
Combined disconnection		
Money/Time	Cofinanciering met HDSR en Blauwe Agenda	There is a collaboration on projects with HDSR and the Blue Agenda, which are co-financed, increasing the budget.
Relieving effort	Faciliteren van bedrijven met onderzoek voor afkoppelen	The municipality facilitates research for disconnection for companies, therefore they don't have to do that themselves.
Enforcing laws		
Regulations new projects	Eisen tot afkoppelen nieuwbouw en verbouw,	For new buildings and construction, the municipality requires that disconnection of the sewage system is done.
Knowledge exchange between municipalities	Projecten met HDSR en Blauwe Agenda.	Collaboration on projects with HDSR and the Blue Agenda.

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information	Communicatieplan, communicatie en uitleg,	From the Blue Agenda, the municipality uses the communication plan and focuses on communication and information/explanations.
Money		
Collaboration		
Coordination of groundwater levels		
Workforce		

Table 2C.E Coding interview Utrechtse Heuvelrug

Bunnik

Drivers	Keywords	Explanation
Climate adaptation		
Extreme weather	We praten nu al over overlast, maar onderlast, dus droogte, is eigenlijk een veel groter probleem. Dus op het moment dat je die hoeveelheid water in een badkuip krijgt die niet meer weg gaat.	The water scarcity is the biggest issue. However, the water excess after long periods of rain is also an important issue, because Bunnik acts as a bathtub and will fill with water.
Protecting infrastructure		
Intrinsic sustainability goals		
Preventing surface water pollution		

Duty of care	Je praat over de zorgplicht voor afvalwater, zorgplicht voor regenwater en grondwater. Dat betekent ook dat je als gemeente meer watertaken hebt.	The municipality is tasked with the care of sewage water, rainwater and groundwater.
Keeping clean water clean	Nou, de intrinsieke motivatie is eigenlijk van waarom zou je schoon water met vies water afvoeren. Het is eigenlijk een beetje vreemd dat je schoon water of relatief schoon water vies gaat maken. En vervolgens moet je daar weer schoon water van maken.	The municipality thinks it is weird that we mix the clean rainwater with the sewage water and thus make it dirty. Then you need to clean it again. This feels like doing extra work for the municipality

Barriers	**Keywords**	**Explanation**
Lack of citizen participation	dat ze ook nog niet altijd per se zelf zin hebben om hun regenpijp door te zagen Daar zijn dus, de mogelijkheid is geboden om daar op aan te sluiten als particulier. Nou, en met name dat aansluiten, dat kost nog wel wat hoofdbrekers. Omdat dat, nou ja, één, je moet er wat voor doen. Twee, het kost dan ook wel, eh, ja, je moet daar toch iets voor doen, dus het kost geld. En drie, niet iedereen is bij machten om dat bijvoorbeeld zelf te doen.	Citizens don't want to put effort in disconnecting. Additionally, they don't want to invest money in this. Thirdly, not everybody is capable of doing it
Awareness	dat mensen zeggen van, ja, ik zie het belang daar niet van	Not everybody sees the purpose of the disconnection
Physical aspects	Omdat je ook met klei te maken hebt. Ja goed, dat levert weer, nou ja, andere beperkingen op. Anders dan dat je heel erg op moet passen als je in klei-gebieden zit. En dat je niet een soort, soort, eh, badkuip creëert.	There is a clay soil, in which it is hard to disconnect. You need to prevent that it becomes a bathtub in which the groundwater level only gets higher
Money/Time		
Preserving system	En de meeste rioolstelsels hier zijn nog gemengd. Nou ja, goed dat geeft dan ook gelijk de uitdaging aan om een gescheiden systeem van te maken.	Most current sewer systems are still mixed, but it is a challenge to create a separated system from this
Conflicting interest		
Under prioritising	Intern, om op mensen af te stappen en, hoe heet het, afkoppelen op de een of andere manier onder de aandacht te brengen. Maar dat is één. Twee is om het dan ook daadwerkelijk te doen.	They do have the intention to promote and advertise the disconnection among the citizens, but they never really got to doing it.

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication		
Combined disconnection	nee, dat wordt toegepast bij elke, alles wat hier op de kop gaat. Daar wordt afkoppelen eigenlijk of het, nou ja, het gescheiden afvoeren wordt integraal in meegenomen.	When other roadwork or sewer work is done, the disconnection is done as well
Money/Time		
Relieving effort		
Enforcing laws		
Regulations new projects		
Knowledge exchange between municipalities		

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information		
Money		
Collaboration		
Coordination of groundwater levels		
Workforce		

Table 2C.F Coding interview Bunnik

Woudenberg

Drivers	Keywords	Explanation
Climate adaptation	Klimaatverandering bij worden groter	Climate change is resulting in more hectic changes.
Extreme weather	Het zorgen dat het dat er niet teveel water is en dat dat dat dat druk op de riolen ontlast Maar juist die zoomse piekbuien. Die geeft Natuurlijk problemen met water op straat	A driver of the municipality is to protect the area from extreme weather. To make sure that intense summer rainstorms are not too damaging.
Protecting infrastructure		
Intrinsic sustainability goals		
Preventing surface water pollution	Natuurlijk om overstorting en dat soort dingen te voorkomen, overbelasting van het rioolstelsel Menselijke gezondheid.	The municipality wants to avoid sewer overflows, because that means that the polluted sewage water will mix with the surface water. This is threatening to human health
Duty of care		

Barriers	Keywords	Explanation
Lack of citizen participation	Nou sommige omdat ze gewoon helemaal geen vertrouwen in de hele gemeente en de overheid hebben, die zeggen: blijf wel uit mijn tuin en ik denk nergens aan mee. Ja, die ga je ook niet niet overtuigen	There are people that don't have trust in the government, so they do not cooperate with the disconnection proposed by the municipality.
Awareness	We hebben als ze zo een herinrichting gaat doen, een informatieavond Als je altijd en daar vertellen we ook wat We gaan doen, waarom we het doen, Waarom we twee rioolbuizen voor die terugkomen	Because citizens are not aware of the problem, they do not take action. However, with information nights the municipality tries to create more awareness.
Physical aspects	We hebben best wel, nou, 50 tot 70 cm diep onder het maaiveld, zit het grondwater al dus infiltratie kratje of iets? Ja, die staat gewoon vol met water. Dat ja, dat kan je niet bergen.	The municipality has a very high ground level and therefore infiltration is not desirable.
Money/Time		
Preserving existing sewage system	Dat kunnen we alleen doen op plekken waar we het riool gaan vervangen.	The municipality only disconnects the rainwater when they already working on the replacement of sewer systems.
Conflicting interest		
Under prioritising		

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication		
Combined disconnection	Dus vandaar dat wij het afkoppelen, vooral combineren met rioolvervangingsprojecten.	The disconnection is coupled to sewer system replacement.
Money/Time		
Relieving effort	Maar de regenpijp die aan de voorkant van het huis zit. Ja, Dat is vaak een tuintje van 4 m diep of zo. Hier kan je nog wel zeggen van nou, dat doen we dus bij zo'n rioolvervangingsproject, daar proberen we wel te stimuleren dat bewoners ook meedoen en dat bieden wij dan aan door kosteloos op onze aannemer dat in het werk meedoet op- nou kost- op onze kosten, maar voor de bewoners kostenloos, zij moeten toestemming geven om in hun tuin te mogen graven.	They have tried subsidies in the municipality, but that did not work. People did not feel like spending their whole saturday on the disconnection operation. Therefore, the municipality relieves the effort and do it their self. They only need permission.
Enforcing laws		
Regulations new projects		
Knowledge exchange between municipalities	We hadden met Scherpenzeel best wel veel vergelijking, hoge grondwaterstand, dat soort dingen dus ja, de afgelopen ja 12 jaar denk ik 10, 12 jaar zijn we ook beleidsplannen, onderzoeken, Samen gaan doen. Ja, in plaats van ieder ieder zijn eigen onderzoek hebben het samenvoegen en nou of meer body geven of stukje financiële voordeel en je kan elkaar nou eens even kritisch bevragen Het platform Vallei en Eem	The municipality Woudenberg is collaborating very intensively with the municipality of Scherpenzeel on the disconnection of rainwater. There is also another collaboration between all municipalities that once belonged to the waterboard Vallei and Eem. They meet once every two months.

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information		
Money		
Collaboration		
Coordination of groundwater levels	Waarin de blauwe agenda natuurlijk heel erg opstuurt van dat regenwater terug de grond in en verdroging en alles voorkomen door dat schone water terug te brengen in de grond en dat is in Woudenberg ja eigenlijk niet, want wij hebben eigenlijk een teveel aan water, eerder een teveel aan grondwater als te weinig. Zolang niet heel grootschalig afgekoppeld wordt, geloof ik wel dat dat allemaal prima gaat en dat we dat niet direct gaan merken. Maar ja, Dat is wel een zorg zorger aandachtspuntje vanaf onze kant uit. Ik hou de blauwe agenda wat In de gaten.	If all municipalities in the Utrechtse Heuvelrug were to disconnect and integrate all rainwater, this could lead to problems for the groundwater level. Therefore, that has to be thought out very clearly.
Workforce		

Table 2C.G Coding interview Woudenberg

Amersfoort

Drivers	Keywords	Explanation
Climate adaptation	Natuurlijk zien we dat het klimaat verandert … dus daarom doen we dat zeg maar.	They see that the climate is changing, thus they disconnect the rainwater
Extreme weather	Volgens mij is onze driver toch gewoon om wateroverlast te voorkomen en om het water in de bodem vast te houden, dus ook om verdroging te voorkomen.	The most important driver is to prevent water nuisance and to keep the water in the ground
Protecting infrastructure	Dat je daar dan die waar we nu daar ook wel eens van het wateroverlast in kruipruimtes	There is already water nuisance happening, like flooded basements and they try to prevent that
Intrinsic sustainability goals		

Preventing surface water pollution	Maar dat hebben we weer een probleem met ons grondwaterbeschermingsgebied, want dat mag het niet. Om vanwege de risico's voor de drinkwatervoorziening.	It is important that the surface water does not get polluted because of 'overstorting' of the sewer, because iIn Amersfoort they extract drinkwater from the ground.
Duty of care	Is in principe de Nederlandse wet de waterwet en straks wordt het omgeven en die zegt, van Iedereen moet zijn eigen regenwater op zijn eigen terrein vasthouden, tenzij dat redelijkerwijs niet van iemand kan worden verwacht.	They mention the Dutch 'waterwet' that implies that everyone should hold their rainwater on their own ground.

Barriers	**Keywords**	**Explanation**
Lack of citizen participation		
Awareness		
Physical aspects	Doorlatendheid van de ondergrond, die speelt de rol. Ja uiteindelijk is het doel, het einddoel is gewoon alles, alle regenwater gescheiden en zoveel mogelijk vasthouden daar waar het valt. Voor zover dat kan, want als die niet tot overlast leiden en met grondlaag. Maar het probleem is om in ieder geval in de oude binnenstad dat je daar niet zoveel ruimte hebt om de riolen neer te leggen.	The permeability of the ground plays a role in how much water can be disconnected and infiltrated. It is difficult to disconnect the old city centre because there is limited space in the ground for a water system that collects rainwater.
Money/Time		
Preserving existing sewage system		
Conflicting interest		
Under prioritising		

Overcoming barriers	Keywords	Explanation
Disconnection coach/ Communication	We hebben ook regenwatercoaches die mensen kunnen een verzoek doen om een advies.	In Amersfoort rainwater coaches can be hired to advise citizens on how they can disconnect their garden.
Combined disconncection	Dus je gaat niet op straat openbreken om het regenwater af te koppelen, maar je gaat de straat openbreken omdat er heringericht moet worden, omdat er dingen veranderd moeten worden of omdat die vervangen moeten worden. En dan maak je van de gelegenheid gebruik om dat te doen	In Amersfoort the municipality disconnects the rainwater when the sewage system has to be repaired and is therefore broken open.
Money/Time		
Relieving effort	Dan willen we die Mensen stimuleren door die om in ieder geval de voorkant af te koppelen en dat bieden wij als gemeente aan al om dan Als we toch In de week bezig zijn, ook aan de voorkant door hun tuin genen regenwaterbuis terecht en dan die regenpijp erop te zetten.	When they are working on the sewage system somewhere they simultaneously offer to people that live in that same street to help them with the disconnection of the front of their property.
Enforcing laws		
Regulations new projects	Ja precies, en daar hebben we dan nou, dat komt een land. Dat helpt er aan mee, Omdat soms die ontwikkelaars gezellig, zoals bijvoorbeeld Heijmans en nog wat van die ontwikkelaars die hebben dat ook meegetekend en en die dat maakt gewoon ja, als hij dat nou 5 jaar geleden zou vragen, dan zouden we ook in overleg met zo'n project.	There are regulations that help the municipality with explaining the priority of the disconnecting. It mostly helps with companies.
Knowledge exchange between municipalities	convenant van toekomstbestendige woningbouw. Gemeentes, waterschappen maar ook particuliere partijen als ontwikkelaars	The covenant of futureproof housing construction is made up of municipalities, waterboards, but also companies. They exchange knowledge and ideas.

Collaboration with Blue Agenda	Keywords	Explanation
Sharing information		
Money	Ja, Ik denk wel op een of andere manier werken subsidies. Die werken altijd wel ofzo.	Subsidies always are effective
Collaboration	En ook elkaar ondersteunen met de communicatie en promotie is en campagnes en zo. Als daar ook de naam van de Utrechtse Heuvelrug onder staat. Misschien helpt dat, weet je?	To support each other with campaigns and promotion
Coordination of groundwater levels		
Workforce		

Table 2C.H Coding interview Amersfoort

D) Table of drivers, barriers, responses, and municipal collaboration with Blue Agenda

Municipality	Resilience to climate change	Extreme weather		Intrinsic sustainable goals	Protection of infrastructure (such as housing, sewage system)		Preventing surface water pollution	Duty of care (national/ regulations)
		Water scarcity	Excess water		Houses	Sewage system		
Utrechtse Heuvelrug	x	x		x		x		
Soest	x		x		x		x	
Veenendaal	x	x	x	x		x		
Zeist			x				x	x
Bunnik		x	x	x				x
Woudenberg	x		x				x	
Laren	x	x	x		x			
Amersfoort	x	x	x		x		x	x
Wijk bij Duurstede	x		x				x	
Baarn		x					x	
De Bilt	x	x	x	x		x	x	x
Hilversum	x	x	x				x	x
Rhenen	x		x	x		x		
Leusden	x		x		x		x	x

Table 2D.A Occurrence of drivers across municipalities

Municipality	Low citizen participation			Low participation of private sector	Physical aspects			Money & time (for municipality)	Under Prioritising	Preserving existing sewage system
	Low awareness	Lack of money	Low motivation		Soil type	Groundwater level	Urban space			
Utrechtse Heuvelrug	x	x	x	x			x			
Soest	x	x	x				x		x	
Veenendaal	x		x		x	x		x	x	
Zeist	x		x	x				x		x
Bunnik	x	x	x		x				x	x
Woudenberg	x		x			x				x
Laren			x			x	x			
Amersfoort					x	x	x			
Wijk bij Duurstede						x		x		
Baarn		x	x							
De Bilt								x		x
Hilversum						x		x		x
Rhenen										
Leusden	x	x	x			x				

Table 2D.B Occurrence of barriers across municipalities

	Domestic sector				Public sector				Private sector
Municipality	Increase awareness		Relieving effort	Enforcing laws	Regulations for new projects	Money & time	Combined disconnection	Knowledge exchange between municipalities	
	Disconnection coach	Information, (flyers, etc.)							
Utrechtse Heuvelrug	x	x				x	x		x
Soest	x			x		x	x	x	
Veenendaal	x		x		x	x	x		
Zeist			x		x	x	x		
Bunnik							x		
Woudenberg			x				x	x	
Laren	x	x	x	x	x	x	x		
Amersfoort	x		x		x		x	x	
Wijk bij Duurstede		x					x		
Baarn	x	x			x	x	x	x	
De Bilt	x	x			x		x		
Hilversum		x	x		x	x	x	x	x
Rhenen		x				x		x	
Leusden		x			x	x		x	

Table 2D.C Occurrence of responses across municipalities

Municipality	Sharing information	Money	Collaboration	Coordination of groundwater levels	Workforce
Utrechtse Heuvelrug	x				
Soest	x				
Veenendaal	x				x
Zeist		x	x	x	
Bunnik					
Woudenberg				x	
Laren	x	x	x		
Amersfoort		x	x		
Wijk bij Duurstede					
Baarn					
De Bilt					
Hilversum					
Rhenen					
Leusden					

Table 2D.D Occurrence of methods different municipalities would like on how to collaborate with the Blue Agenda

III. Appendix Chapter 3

A) GIS-indicators

Soil Type

Soil type serves as an important indicator for the decoupling of rainwater, as it influences the possible capability of infiltration of water. Various soil types exhibit different grain sizes, with the grain size being a factor of the infiltration rate. Examples of possible soil types with their linked grain sizes are presented in Figure 3A.A. Larger grain sizes correspond with higher potential infiltration rates (Koster, 2024). When decoupling of rainwater is considered, soil type plays an important role which should not be overlooked. Possible infiltration is measured by the k-value. This is a measure of how easily water can move through the soil particles. A high k-value corresponds with a soil type that can present high possible infiltration (Koster, 2024).

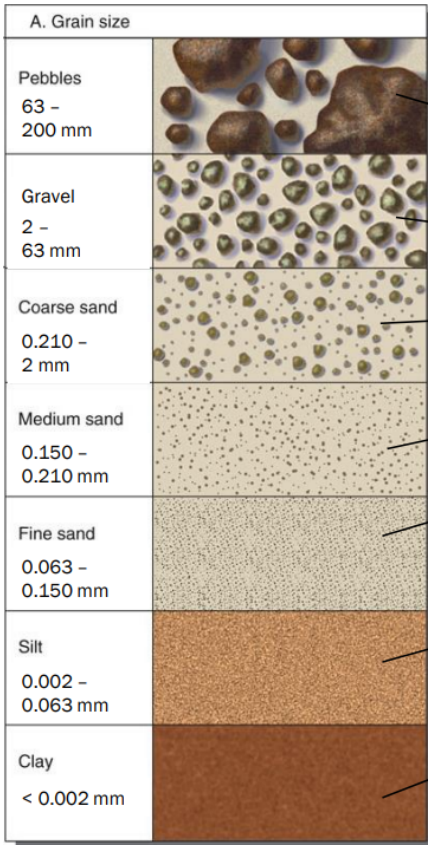


Figure 3A.A Soil grain sizes (Koster, 2024)

Seepage/infiltration

These two indicators go hand in hand, as a high seepage rate corresponds to a low infiltration rate, and vice versa (Yang & Zhang, 2011). Seepage rate explains the rate of groundwater ascending to the earth surface (Cedergren, 1978), while infiltration rate explains the rate of surface water permeating to the ground water (Yang & Zhang, 2011). Both indicator rates are highly connected with the soil type, yet they remain highly variable per urbanised area percentage (Yang & Zhang, 2011). This is why soil type and seepage/infiltration are two individual indicators.

Elevation

The disparity between groundwater levels and elevation is important for the decoupling of rainwater, because when the disparity is inadequate, a greater risk of seepage occurs. The bigger the elevation, the less possibility of back flow of the rainwater (Xu et al., 2024). This is because the rainwater has more time to flow down

due to gravity before reaching the groundwater. Extreme wet periods can be managed better.

Groundwater level

The average highest groundwater level and average lowest groundwater level serve as crucial indicators, because they present two things. The first one is the actual groundwater level which leads to the decision of decoupling rainwater. The second is the visualisation of changes in groundwater levels during different time periods. When the average groundwater level is sufficient for implementing decoupling, but the average highest groundwater level is not, then it can still be decided to not decouple. This is because, due to climate change, extreme hazards occur more often. When there is an extremely wet period, the average highest groundwater (GHG) level may be too high and can cause floods in urbanised areas.

GHG

Gemiddeld hoogste grondwaterstand (Average highest groundwater level), influences the infiltration rate. A lower groundwater level is beneficial for the decoupling of rainwater (NPUH, 2021)

GLG

Gemiddeld laagste grondwaterstand (Average lowest groundwater level), influences the infiltration rate. A lower groundwater level is beneficial for the decoupling of rainwater (NPUH, 2021)

Urbanised area

Decoupling of rainwater has the biggest result in urbanised areas, since it takes some burden off the sewer system, and the groundwater supply can be filled at a better rate to overcome periods of drought. At this point in NPUH, the public environment sewer systems serve as well as disposing of precipitation as domestic wastewater (Langeveld, 2019). Extreme precipitation and extreme drought due to global climate change will result in overloads of the sewers, and water may cause floods. When taking some burden off the sewer system by decoupling rainwater, fewer bad results will occur (Langeveld, 2019). Consequently, the percentage of urbanised areas within municipalities will lead to a crucial factor in the potential results of decoupling.

B) Supporting indicators

The framework for urban infiltration vision consists of two separate components: the heaven-to-surface and surface-and-below, or more specifically the *infiltration potential* and *infiltration capacity* respectively. The latter component has been identified for each municipality in section 2; Figure 3B.A expands on the infiltration potential.

Precipitation enters the urban hydraulic system through three types of land cover: *Green infrastructure, impermeable grey infrastructure* and *semi-impermeable grey infrastructure*.

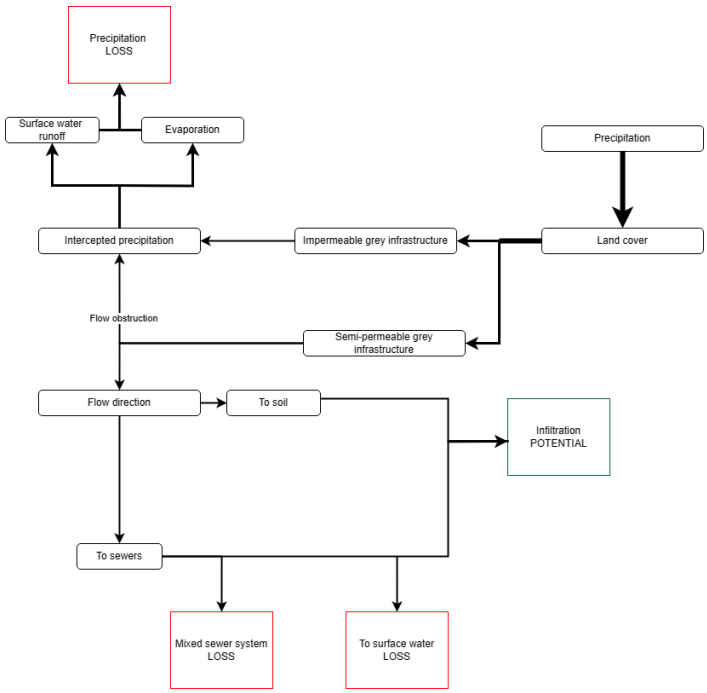


Figure 3B.A Heaven-to-surface precipitation flow; no intervention

As for impermeable grey infrastructure, two types can be identified: imporous infrastructure and semi-porous infrastructure covering an area with a shallow groundwater table. Both types result in no net gain in groundwater recharge (Gill, 2006), and as such, **disconnected sewer systems will not contribute to water infiltration either**.

Nonetheless, precipitation entering impermeable grey infrastructure is not designated to either evaporative losses or surface water runoff; there are strategies to mitigate these losses.

- *Precipitation routing* may be analysed using gradient variations and slope friction, offering insights in physically obstructing infrastructure. Digital elevation models (DEMs) and land use charts may be used to identify such obstructions. Then, **re-routing** of precipitation to (semi-)permeable grey infrastructure (i.e. to disconnected sewers) or green infrastructure may be considered as a way to increase water infiltration (Wang et al., 1998).
- *Water retention* at a higher gradient mitigates the hazard of seepage at the lowest gradient, which is particularly necessary during extreme precipitation events (Carter, 2018). Moreover, during peak precipitation, water retention at a higher gradient

allows for a higher infiltration yields and reduces sewer overflow.

- *Disconnection of sewer systems to groundwater* achieves two particular goals: groundwater recharge and reduced pressure on water purification firms. Although the potential gain from such sewer systems are substantial, figure 3B.B illustrates that the previously mentioned parameters may decrease the potential substantially.

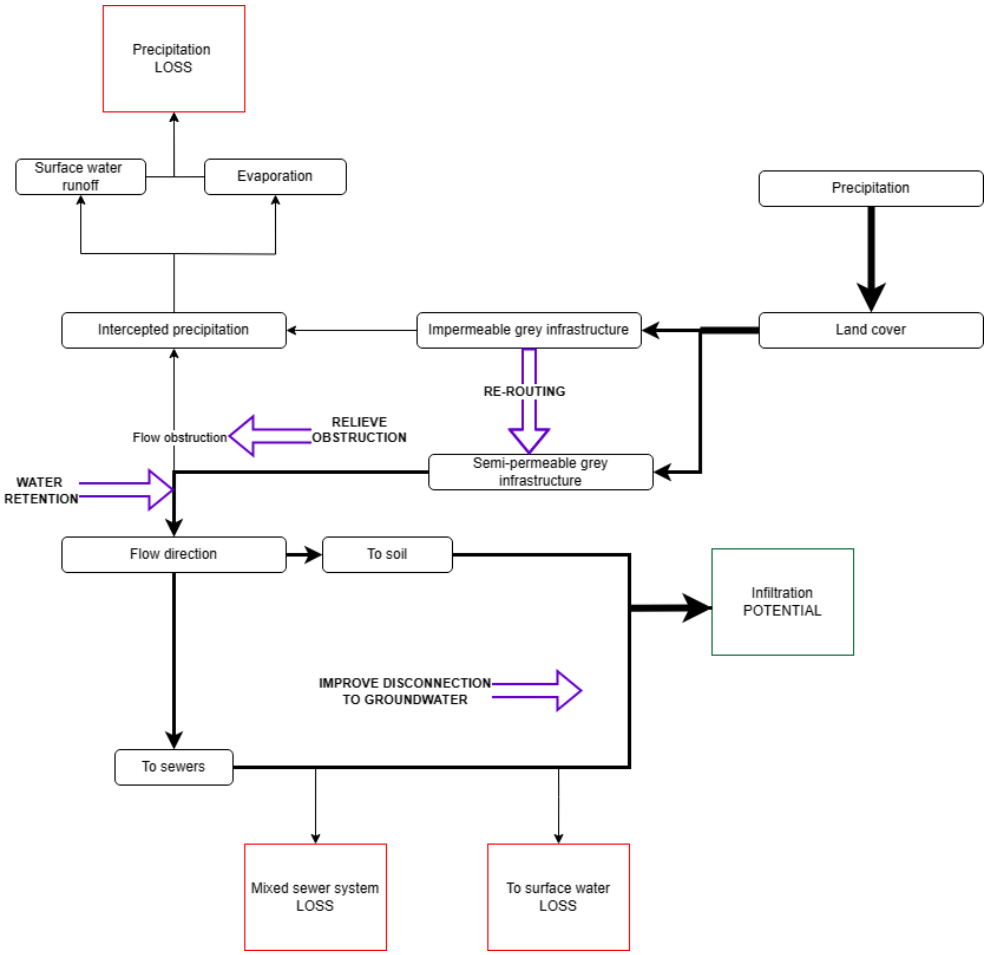


Figure 3B.B

Under changing climate conditions and increasing uncertainty about extreme droughts and storms, resilient and adaptive urban water management is needed to ensure environmental- and socio-economic security (Sebestyén et al., 2023). Considering the refined interlinkages between natural properties, disturbance of one parameter may result in a detrimental and irreversible cascade of environmental degradation; as such, natural infiltration to groundwater is highly susceptible to future prospects of soil degradation (Oral et al., 2020). To gain insight into the properties at risk, the following section aims to analyse the perceived value of urban green spaces, and the stress-factors that urbanisation and climate change pose.

Two encompassing properties have been identified: vegetation properties and top-soil properties. The threats of urbanisation on urban water infiltration that are posed include; *Soil bulk density* and *soil erosion*

- *Soil bulk density* is affected by the physical pressure applied by gray infrastructure. Generic soil type classifications are based on the average particle size of the soil composition, which under natural circumstances provides an indication of the *infiltration rate*; however, by compressing the soil layer with substantial force, the infiltration rate may be reduced by as much as 70%, regardless of soil type (Gregory et al., 2006). This adds a critical note to the estimated urban infiltration potential across the Utrechtse Heuvelrug.
- *Soil erodibility* can be defined as the extent to which a soil site is susceptible to erosion, which in turn negatively reduces the infiltration rate of the soil (Wang et al., 2013). Given the prospects of seasonal droughts and extreme precipitation events, soil resilience is an increasingly important factor to maintain, as soil erosion occurs under these conditions (KNMI, 2023; Wang et al., 2015). Within the context of urban water management, healthy soils contribute to the resilience against extreme precipitation events.

As for the vegetation properties, Shi et al (2022) have identified two main contributing factors of vegetation types that may impact the threats of soil compression and soil erosion.

- The *root orientation* of different plant species may act as a nature-based solution to increased soil bulk densities under urban areas. High-density root networks increase soil aeration and capillary porosity of the soil, allowing water to infiltrate at an increased rate.
- Vegetation provides natural *organic matter*, both above the surface as below. Above-surface organic matter may substantially reduce soil erosion as it reduces the impact of incoming precipitation, as well as increasing retaining precipitation water from the soil surface, allowing for more homogenous exposure of the precipitation volume to the soil. As for the below-surface organic matter, root residues provide necessary carbon resources to the soil, resulting in transforming soil structure and increased formation of soil aggregates, all of which contribute to an increase in infiltration rate (Shi et al., 2022).

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