

Utrecht University

# Potential for water storage in Utrechtse Heuvelrug

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## Introduction

Water management within the Netherlands has always been of importance; however, it is of an even greater importance now, because of global environmental changes. Periods of extreme drought occur more often in the Netherlands, since the global climate changes by the enhanced greenhouse effect. As of 2018 heavy droughts have taken place, with a maximum drought of about 300 millimetres rain shortage (KNMI, 2020). Periods of drought occur due to a lack of precipitation, which has an outcome of water shortages. Human activity is of importance within a period of drought, since this acts as an external influence on the water retention. The past 3 years the Netherlands, thus also the Utrechtse Heuvelrug, had to deal with severe droughts. In order to protect the Netherlands against the drought the government made hundred million euro available (Rijksoverheid, 2019). For a long time, there was a spraying ban on the Utrechtse Heuvelrug, it was prohibited to use water out of ditches and streams. Since December 2020 this ban was lifted.

Unfortunately, the way in which the Utrechtse Heuvelrug is formed makes the higher laying parts of the hills more dry than its surroundings (Utrechtse Heuvelrug, 2020) . Therefore, water storage is an important topic for the Utrechtse Heuvelrug, because a good freshwater storage system will mitigate the effects of dry periods and decreases the recovery period of the area. You could say that within the area of the Utrechtse Heuvelrug the role of the landscape enhances the effects of drought. Multiple stakeholders, like for example the province of Utrecht, have already set up the so-called “Blauwe agenda”. The Blauwe Agenda strives to tackle problems related to freshwater shortages and flooding on the Utrechtse Heuvelrug. In total 8 different (local) projects are linked to this Agenda.

This research will contribute to the overarching research question: ‘How can we organize our use of several water bodies sustainably along the surroundings of the Utrechtse Heuvelrug?’ By identifying the stakeholders involved in the water shortage problem, the projects they are working on, and the opportunities and obstacles of current projects, an overview will be created of the freshwater storage situation.

It is crucial to understand the opportunities and challenges of freshwater storage in the Utrechtse Heuvelrug in order to know how to use water bodies sustainably. This leads to the research question: **What are the opportunities and obstacles for existing projects regarding freshwater storage in the Utrechtse Heuvelrug?** In this research we will use the following sub questions:

1. What parties are involved with freshwater storage in the Utrechtse Heuvelrug?
2. What freshwater storage solutions are the parties working on?
3. What are the obstacles regarding freshwater storage solutions?
4. What are the opportunities regarding freshwater storage solutions?
5. What societal boundaries do the inhabitants of the Utrechtse Heuvelrug indicate when implementing freshwater storage solutions?

## Literature review

The research will be centred around water management. In order to demonstrate what is already known about this topic, several important studies on water are reviewed in the paragraphs below. These studies are the foundation of our research in the Utrechtse Heuvelrug. Besides, the introduction of the TIS framework has a significant role in the paragraphs below.

### Water in soil

The Earth's surface consists of a layer of soil, which contains water as a main component. Water within a soil is essential to have a healthy layer of soil in which organisms can live. Water flows through the soil given the soil being porous. Hence, micro-organisms and nutrients are transported by water through different layers. The fertile soil has a cycle of the water flow, which is characterised by precipitation, evaporation and drainage. Evaporation is influenced by the global temperature changes, since higher temperatures make water evaporate faster. Consequently, water is withdrawn from soils more quickly (Volchkov et al., 2007). As a result, the natural chemicals within soils are not getting distributed properly, which makes the soil less fertile. This affects plant growth in a negative way, since the chemical components are needed as nutrition. Moreover, water itself is needed for plant growth; plants cannot grow without a sustainable soil water level (Craggs, 2017).

### Water retention

Water retention is the advancement of the water storage potential in an area by the improvement of natural activity. It is important to maintain the livelihood of ecosystems. Thus, this is a process which increases human involvement in the natural process of water

maintenance. The coexistence of nature and human interference is regulated. Therefore, water distribution is in better control and extreme natural events, such as droughts and floods, are less impactful. Changes can firstly be realised by making direct changes to ecosystems. Meaning that water bodies are reconnected and restored to have a better cycle of water. Secondly, the usage and management of water and land is applied in a sustainable method. Specifically, change in agricultural usage of land, the enhancement of growth of forests and pastures, and urban adaptations (European Commission, 2019).

### Droughts

Around the world various problems and subsequent solutions concerning water management are found. Water retention measures are increasingly required for the Netherlands, since soil drought has been occurring more often over the past years. The groundwater levels have declined as of 2018 within short periods of time in the year. However, there are many water bodies in the Netherlands, thus improvement on the water retention is a requirement. Monitoring where water is abstracted, gives an insight where to act upon water shortages (Siepman, 2020). The total economic damage of the extreme drought in the Netherlands in 2018 are estimated on a total damage cost of between 450 and 2080 million euros (Ministerie van Infrastructuur en Waterstaat, 2019).

### Current measures

As the droughts of the years 2018 and 2019 were so impactful, there is a more urgent demand for a solution to water retention shortages in the higher located parts of the Netherlands (Beleidsstafel Droogte, 2019). Currently the Dutch governmental organisation 'Atlas Natuurlijk Kapitaal' has a practice of controlling water levels, which already are being applied in the

Netherlands. To do so the natural surroundings have to be used for water retention. Water is stored within soils as a temporal solution, similarly water is redirected as water levels of open waters rise. Meaning that human intervention is improving the water dispersion. A project where human intervening is visible is the Koopmanspolder. This is an artificially made water body, which is supplied by the main waterbody (Atlas Natuurlijk Kapitaal, n.d.). However, new plans have been made by a cooperation of Dutch governmental organisations. These plans have the aim to prevent the impact of droughts. As a result, the main message from the committee is to work towards a more climate resistant nature. The agricultural sector is advised to have a more sustainable use of water. Thus, watering systems have to be more efficient, so water is not being spilled (Beleidstafel Droogte, 2019).

### Functions of TIS framework

The Technological Innovation Systems (TIS) framework will be applied throughout the research proposal and the actual research report. Markard et al., (2015) explain what the TIS framework is and respond to the major criticisms. The approach is used to understand various dynamics of technological systems in innovation, especially in the field of sustainability.

As shown in figure 1, the framework consists of the following seven functions which according to (Bergek et al., 2008) and Green Horizons Scoreboard (n.d.) need to be performed for prosperous responses to environment-related societal challenges.

- The first function is knowledge development and diffusion which includes various theories, inventions and knowledge generation and on the other hand the diffusion of this knowledge.



- Second, entrepreneurial activity/experimentation focusses on experimentation as a necessity of upscaling the innovation.
- The third function is guidance, visions, policies and strategies, this influences the direction of the search and provides focus to the first function.
- Moreover, market formation defines the development of markets, both on creating markets and investigating niches in the market.
- The fifth function is getting legitimacy, this is an important step in the process, whereby the general public has an important role in accepting the method and policy makers in looking for sustainability credentials.
- Furthermore, the mobilisation of resources such as infrastructure, education, jobs and economic capital are vital for TIS.
- The last function is positive externalities which occurs when different efforts of in our case water storage solutions reinforce each other. This is interconnected and strengthens the other function. (Green Horizons Scoreboard, n.d.)

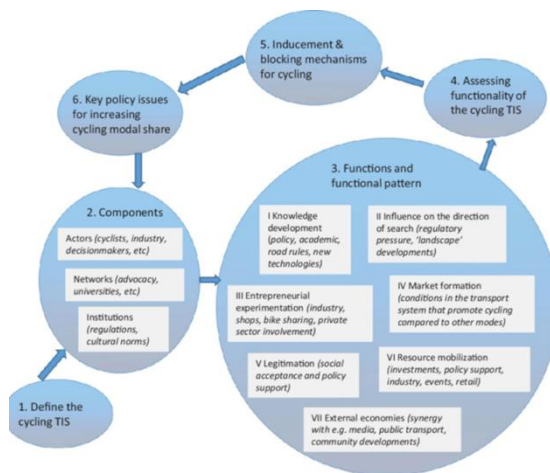


Figure 1: TIS framework (Bakker et al, 2018)

## Methods

The location of the research will be the Utrechtse Heuvelrug, a nature area formed 150.000 years ago during the last ice age (Staatsbosbeheer, n.d.). It stretches from Hilversum in the north to Rhenen in the south. The Heuvelrug is a National Park, whereby a myriad of non-profit organisations collaborates about different challenges within and surrounding the park (Nationaal Park Utrechtse Heuvelrug, 2021). This research consists of two main research methods, namely, interviews and surveys. Both qualitative and quantitative data will be gathered by using these methods. In the end, the main research question will be analysed and visualized by using the TIS framework (see literature review). The TIS framework represents the outline of the analysis and each function will be analysed individually by using the gathered data.

### Interviews

First of all, to answer the first sub-question, the stakeholders must be identified including their associated role within the freshwater storage within the Utrechtse Heuvelrug. This data will be gathered by literature research. An analysis will be made by separating the data in different categories of stakeholders; a table will visualize this clearly. In this way, it is easier to contact these stakeholders with different roles and perspectives. Secondly, a qualitative method is used which is the in-depth interviews with the different stakeholders. These in-depth interviews will be semi-structured, meaning that the outline of the interview is the premade list of questions (see appendix section 2). However, the interview might deviate when something interesting is brought up by the interviewee. The semi-structured method will provide more detailed information than a structured interview.

The preference is to have interviews with all the different perspectives gathered during the research of sub-question one. Using the interviews, sub-question two can be (partly) answered, it is preferred to do interviews with stakeholders involved in local projects like Gemeente Utrechtse Heuvelrug, Icomos and Geopark Heuvelrug. However, literature research will be used as well.

The TIS framework is applied to deduct the technological functionality of the water retention methods used as stated by the interviewees. Since it is likely that it is not possible to interview all stakeholders from all categories, further research must be conducted on different freshwater storage solutions. The interviews will be held either in real life or via an online platform such as Microsoft Teams and Zoom. Preferably two people will be interviewing, one will lead the interview and the other will co-lead and take notes. The interviews will be recorded with the approval of the interviewee. During the interviews, open questions will be asked with no biases and/or steering the interviewee answer. The TIS framework will be used to answer sub-question three and four. The seven functions will be analysed individually by using the interviews and the results of the questionnaires. The current situation, obstacles, and opportunities for each function will be identified and visualized in a table.

## Surveys

To answer sub-question five, another research method is used, namely, a survey during the fieldwork in Utrechtse Heuvelrug. The questions will be designed on collecting data for quantitative research. One way to do this is by designing the survey questions as ratings, this means ordinal data is gathered. The use of scale and ratings is accessible and easy for everyone participating in the survey. Besides, it is easier to analyse the results. The municipalities of Soest

and Doorn will be the specific locations for conducting the surveys with the inhabitants. For each place the same survey will be used, but the data will be separated to make sure an analysis can be made and show the distribution of the willingness throughout the Utrechtse Heuvelrug.

The statistical analysis software called SPSS is used to analyse the surveys and visualize the gathered data. Descriptive statistics, specifically the option 'mean', are used to analyse the ordinal data. The descriptive statistics will create a table for both the towns to show the relevant data. Comparing these data will show whether the distribution of the willingness is evenly distributed throughout the Utrechtse Heuvelrug or not. Besides that, pie charts are used to show clearly the results of certain survey questions. Comparing pie charts from both towns might give relevant findings, such as different height in willingness.

To make the survey valid, the minimum number of respondents is 50 residents for each town. The survey will be tested beforehand by 5 inhabitants to make sure everything is clear, and it does not take too much time. The inhabitants are the target audience of our survey and will stay anonymously.

## Results

### Parties involved

To respond to the first sub question a literature research is performed, the parties involved in the specific projects could not be found, but there is a general list of stakeholders involved in the ‘Blauwe Agenda’. These are the province of Utrecht, National Park Utrechtse Heuvelrug, Vitens, Waterschap Vallei en Veluwe, Hoogheemraadschap De Stichtse Rijnlanden, municipalities, land management organisations, private owners and nature organisations (Nationaal Park Utrechtse Heuvelrug, 2020). Moreover, the projects can only be successful if residents and (recreation) companies are involved (Hoogheemraadschap De Stichtse Rijnlanden, 2020).

### Projects

In order to answer sub question 2, three tables are provided. These tables portrait the current water projects in the Utrechtse Heuvelrug partly initiated by the ‘Blauwe Agenda’ (Blauwe Agenda, 2020).

<b>Broad projects</b>
<p><u>Project A.</u> Knowledge: research and sharing of water system knowledge</p> <p>Project leader: province of Utrecht</p> <ul style="list-style-type: none"> <li>– Determine what knowledge is needed of the complete water system.</li> <li>– Investigate how the system behaves in extreme weather conditions.</li> <li>– Measure the effectiveness of measures to make the system more robust and investigate the possibilities for applying these measures on a larger scale, taking into account the other functions of the Heuvelrug.</li> </ul>
<p><u>Project B.</u> Vision: towards a robust and future-proof water system</p> <p>Project leader: province of Utrecht</p> <ul style="list-style-type: none"> <li>– Develop a vision of the water system, the acute bottlenecks and the medium and long-term goals.</li> </ul>

- Compile an implementation section in the vision that includes the measures, financing and organization to achieve the goals. This project is linked to the provincial environmental vision and the underlying water programme.

**Project C.** Awareness: the importance of clean and sufficient water

Project leader: Nationaal Park Utrechtse Heuvelrug

- Support widely the Blue Agenda and share it with all municipalities, landowners, managers and users.
- Make an inventory of which awareness initiatives are already underway in which water is or can become part of. As the parties involved, the aim is to work together as much as possible in this regard.
- Initial ideas are: to encourage residents of the Heuvelrug to regreen and disconnect their gardens (heuvelrugtuinen, operatie steenbreek), to ensure that entrepreneurs know how to make their business operations and sites inclusive of nature and water (hosting programme), to make residents and visitors aware of the water van de Heuvelrug and the importance of responsible drinking water use (ditch days, drinking water campaigns), making knowledge available to land owners and tenants for a healthy soil and climate-proof water system (soil and climate course).

**Local projects**

**Project 1.** Eem: responsible drinking water, wet nature and cleaner water

Project leader: Vitens

- Based on the responsible expansion of drinking water extraction, the area is being looked at in an integral manner.
- Development options are being investigated for sustainable agriculture, wet nature and a water buffer for the Eem.

**Project 2.** Nonnenland: more robust and better accessible.

Project leader: Staatsbosbeheer

- Create a plan to make the water system of the Nonnenland and Praamgracht more robust.
- Combine water restoration with improvement of the recreational tasks in and around the area.

- Project 3. Op Hees: developing moist hay meadows

Project leader: Natuurmonumenten

- Conduct groundwater measurements to gain more insight into the water system of Op Hees.
- Develop new wet nature that benefits rare plant, insect and butterfly species.

Project 4. Laagte van Pijnenburg: a water exploration

Project leader: Waterschap Vallei & Veluwe

- Make a water exploration with area parties in the Laagte van Pijnenburg.
- Investigate if a better use of water in the short term can be made.
- Develop a water program.

Project 5. Noorderpark-Ruijgenhoek: responsible drinking water, wet nature and cleaner water

Project leader: Vitens

- Investigate the question of whether drinking water production can be expanded without significant adverse effects on surrounding nature.
- Explore the possibilities for nature development, increasing water quality and recreational opportunities in the area.

Project 6. Zeist: streams, pools and swamps in the Stichtse Lustwarande

Project leader: Utrechts Landschap

- Investigate the water system of the Zeisterbos and estates.
- Restore the ponds and, if possible, the cultural-historical streams, and make them future-proof.
- Create pools for the crested newt and restore rare seepage nature by developing wet, lean grasslands.

Project 7. Amerongen: upstream water retention

Project leader: municipality Utrechtse Heuvelrug

- Implement measures to retain and infiltrate rainwater upstream for longer.
- Develop a vision for a climate-proof design of the outlying area of Amerongen.

Project 8. Heuvelrug-Vallei: combating drought effectively together

Project leader: Utrechts Particulier Grondbezit (UPG)

- Inventory is made where priority desiccation locations overlap with land owned by estate owners and site managers.
- Work together on drought control plans that will make the water system more climate-proof.

<b>Other solutions/projects</b>		
Solution/project	Executor	Benefit
Disconnecting downspouts from sewage system	Residents	Precipitation can infiltrate the soil instead of going into the sewage system, which can be overloaded after heavy rainfall. When disconnecting your downspout the precipitation will stay at the location where it precipitated.
Infiltration sewers	Local governments	Infiltration sewers allow water to infiltrate the soil . In that way the water can be distributed throughout a bigger area.
Public green (e.g. lawns)	Local governments/residents	More green increases the infiltration capacity.
Wadi's	Local governments	Wadi's can absorb big amounts of rainwater.
Rain gutters next to the roads	Local governments	Rain gutters can transport rainwater to places where the water can infiltrate the soil.
Removing tiles from the gardens of residents	Residents	Tiles prevent water from infiltrating the soil, so removing these can enhance the infiltration of



		precipitation. Removing tiles can be encouraged by facilitating for example a “Tegeltaxi”, “Operatie steenbreek” and “Tegellichtdag.”
Heuvelrug Tuinen (Heuvelrug Gardens)	Residents	Heuvelrug Tuinen are gardens with more than 60% of green, indigenous plant species and maintained without pesticides. This is beneficial for the rainwater uptake.
Green roof	Residents or other owners of buildings.	Having a green roof increases the isolation of a building, enhances the water balance and biodiversity.
Replace coniferous trees with deciduous trees	Local governments and landowners.	Deciduous trees evaporates less water than coniferous.
Increase the waterlevel in canals and ditches	Landowners and local water authorities.	A higher water level ensures that more water can evaporate and that the desired water level can be maintained, even after much evaporation.

## 1. Knowledge Development and Diffusion

Over the last years, the focus within water management has shifted. The current problem is simple, but complex. As a result of climate change, there is precipitation surplus during winter, with most precipitation being directly drained away, while during summer there is a precipitation shortage. Consequently, the Heuvelrug suffers from the droughts caused by this imbalance in water (E.Harkema, personal communication, May 25, 2021). The focus point of water policies have always been aimed at preventing local or regional floods, but it currently focuses also strongly on drought management (E.Harkema, personal communication, May 25, 2021). The transition in tackling droughts has slowly but steady become a larger point of attention within de national and regional policies. In 2002, the province of Utrecht considered multiple drought prevention measures for the Heuvelrug, including reducing the water pressure during longer periods of droughts and deduce the amount of groundwater extraction (Grijpstra et al, 2002). Preventing further harm of future droughts is of great importance. Already existing water management techniques, such as giving precipitation time to infiltrate, are the most useful to tackle this (E. Harkema, personal communication, May 25, 2021).

The summers of 2018 and 2019 were extremely hot and dry, causing several problems in and around the Utrechtse Heuvelrug. Several parties therefore decided in 2020 to collaborate on making the Heuvelrug region more adapted to droughts and floods (K. Te Velde, personal communication, May 25, 2021). The 'Blauwe Agenda' contains various goals for future water management, with the main goal being 'creating a robust watersystem' (Blauwe Agenda, 2020). There is however one challenge within this goal: the implementation of the 'Blauwe Agenda'.

While it aims on collaboration in water problems between different and within sectors, the specific execution of it is still uncertain.

## 2. Entrepreneurial experimentation

When looking on local scale regarding tackling the water related problems, it is important to involve every landowner. Not only the municipality needs to take action, but also the private landowners and farmers are responsible. Ideally, every landowner should manage to hold the rain water on the land where it precipitates (A. Ter Schure, personal communication, 2021). The municipality feels and takes the responsibility for making the private properties climate adaptive. There are several ways in which they try to get people moving, for example with subsidies for disconnecting the downspouts from the sewers, making your garden more green and for purchasing a green roof. The results of the questionnaire showed that a subsidy would increase the willingness to buy a green roof with +/- 25%. Another way to motivate people is to provide services. The aim of these services is to make it easier for people to be climate adaptive (A. Ter Schure, personal communication, 2021). The results of our questionnaire showed that +/- 50% of the respondents would use the “tegeltaxi”, a free tile pick up service.

## 3. Guidance and visions

The main viewpoint, guidance and strategies describes the entrepreneurial activity of the interviewees. Therefore, various viewpoints lead to main tasks which are prioritized in the Utrechtse Heuvelrug in several ways. Firstly, one of the interviewees carries out a coordinative task within a network of stakeholders, which involves: *“fourteen municipalities, and the water Authority, and the Province and the safety region.”* The interviewee states about their strategy that it is an execution program for their network, which is being carried out by: sharing good

examples, central subsidy schemes, requesting subsidies and by building up communication networks for inhabitants for universal use (K. Te Velde, personal communication, May 25, 2021).

The interest group for the Utrechtse Heuvelrug, also takes up an entrepreneurial task, as their spokesman says: *“what we do, is trying to get a very large area [which involves the Utrechtse Heuvelrug] UNESCO qualified, and that UNESCO is named Geopark.”* This is according to the organisation done to properly address the story about the Utrechtse Heuvelrug, since inhabitants and visitors can then better comprehend the value of the area. With the story the interviewee means the ecological and historical value. The outcome of this strategy of the interest group can influence the sustainable usage of the area (M. Hofstra, personal communication, 2021).

One of the interviewees has a similar vision which addresses the historical story. The emphasis of the interviewee’s vision is put on using the historical knowledge about an area, as there can be learned a lot from previous expertise. Secondly, it is mentioned that major topics, such as water management, have to be made into feasible problems. This is done for the next reason according to the respondent: *“... to have a goal to aim for, to comprehend as a human.”* Therefore, water balances need to be made to see who is accountable for major use of water (D. Six, personal communication, 2021).

Moreover, another interviewee, which is a policy officer for Water and Climate adaptation, also mentions their vision on involvement as an innovative project to increase awareness as follows: *“Besides we are making climate-squares, as it is al climate adaptation, we want to involve inhabitants.”* The climate-squares are designed as the entrepreneurial idea (A. Ter Schure, personal communication, 2021).

#### 4. Market formation

A remarkable aspect of the market of water storage is that the focus shifted from discharging water to holding water (K. Te Velde, personal communication, May 25, 2021). Ter Schure mentioned the following: “The subject of climate adaptation is becoming increasingly important. In 2018, the ministry said that all governments must have adapted their land in a climate-adaptive way by 2050. We had to have the policy ready for this by 2020.” (A. Ter Schure, personal communication, 2021). Besides, all interviewees mentioned the urgency of collaboration amongst businesses, governmental institutions and residents (appendix section 4). The participation of the residents often slows down the process of adapting. Other obstacles are the construction costs of new sewers and subsidies being too administrative (A. Ter Schure, personal communication, 2021). Ter Schure mentions current initiatives as potential solutions: “For the sewers, they have now said we are going to pull a kind of "re-lining", a synthetic stocking through the sewers so that you no longer have to pull them out of the ground.” and “A colleague of mine said that you can shift the work to a company, that we simply hire a company to process subsidy schemes.”.

#### 5. Legitimacy

To investigate the legitimacy of the general public regarding accepting new solutions to tackle certain sustainability problems, a questionnaire has been used to research the willingness and opinion of the residents in the Utrechtse Heuvelrug.

The first relevant findings from the survey are the difference in willingness by the residents regarding the addition of a subsidy. As aforementioned, the results of the questionnaire

showed that a subsidy would increase the overall willingness to buy a green roof by +/- 25%. This is an increase of around 26 residents over a total of 105 residents.

Another survey question indicates the willingness of getting a subsidy for a 'Heuvelrugtuin'. In Soest the willingness increased by 15 %, whereas in Doorn the willingness decreased by 9 %. In total the willingness increased by +/- 3% when a subsidy is offered for getting a 'Heuvelrugtuin'. This is approximately an increase of 3 residents among a total of 105 residents.

## 6. Resource mobilization

Because the water shortages and floods on the Utrechtse Heuvelrug is a big and overarching problem, it is resource intensive to solve it. There are several partnerships in the region regarding the water problem, like for example 'De Blauwe Agenda'. Local water authorities, local governments, landowners and nature organisations work together in order to make the Utrechtse Heuvelrug climate adaptive and mitigate the effects of the water problems. For the activities there has to be enough money, but this is not always the case. The municipality of Utrechtse Heuvelrug, for example, had to put a big project on pause because of problems with funding (Ter Schure, 2021). Koen te Velde mentions that the residents of the area are the key to success; when some enthusiastic residents start to take action, others will follow. Residents will rather follow the good example of other residents than the example of the government. Te Velde proposes that the government should (financially) help those citizens' initiatives, instead of investing all the budget in their own projects (personal communication, May 25, 2021).

## 7. Positive Externalities

The water storage solutions can provide various positive externalities. Firstly, the opportunity for the so-called 'underwater drainage', whereby excessed water is pumped back into the

agricultural land. This does not only benefit the groundwater levels of the area, but also helps countering subsidence and climate change. As groundwater levels decrease, the ground above sinks consequently. If the soil consists mainly out of peat, oxidation will occur and large amounts of CO<sub>2</sub> will be emitted. The underwater drainage has potential to tackle these problems.

Another positive externality is the initiative of Heuvelrug gardens (Heuvelrugtuinen), whereby residences of the Heuvelrug are stimulated to make at least 60% of their garden is green (Heuvelrugtuinen, 2021). This is not only an effective measure to increase the amount of infiltration (Eisinga, 2021), but is also beneficial for biodiversity (K. Te Velde, personal communication, May 25, 2021).

## General overview of TIS framework

Function	Current situation	Obstacles	Opportunities
1. Knowledge Development and Diffusion	A shift from preventing floods to preventing droughts	Uncertainty within data of future droughts	<ul style="list-style-type: none"> <li>- Collaboration on multiple levels benefits implementations of possible measurements</li> <li>- Larger audience for raising awareness</li> </ul>
2. Entrepreneurial experimentation	Government takes the lead in climate adaptation	More participation from residents is needed.	Subsidies and services increase the willingness of residents to participate
3. Guidance and visions	Emphasis on cooperation and awareness among residents.	Feasibility of water problems and implementing historical knowledge	Involvement of inhabitants and cooperation towards sustainable land-usage
4. Market formation	Governmentally driven. Since 2018 new approach for all governments.	Resident participations slows down the process. Sewer replacement is expensive. Subsidies too administrative.	<ul style="list-style-type: none"> <li>- 'Re-lining': different method instead of sewer replacement</li> <li>- Administrative work is done by external parties</li> </ul>
5. Legitimacy	Sustainable initiatives like green roofs and a 'Heuvelrugtuin'	Societal boundaries such as costs	Subsidy offered by municipality
6. Resource mobilization	Partnerships like the Blauwe Agenda Projects from the government without much involvement from the residents	Too little involvement of residents	Enthusiastic residents can set the tone and give a good example to other residents.
7. Positive externalities	Also tackling subsidence -Beneficial for biodiversity	- Only investigating the ecological benefits	- Awareness created of interdisciplinary problem



## Discussion

### Interpretation of the results

The results show a transition in the working method of water management, namely the inclusion of drought prevention within water policies. This finding was expected due to other literature, since droughts have caused major damage in recent years (Ministerie van Infrastructuur en Waterstaat, 2019). However, uncertainty within this data relies within the various future scenarios that the Heuvelrug faces. Flexible adaptation to future droughts is important for all stakeholders (E. Harkema, personal communication, May 25, 2021). Meaning that this includes the market of water storage in the Utrechtse Heuvelrug, which is considered to be in the pre-commercial stage and starting to enter the up-scaling stage. It can be concluded that the market is still governmentally driven, but with the aim of collaborations, like moving administrative work to external parties, an assumption is that this will most likely shift to a combination (Planko et al., 2016).

Motivating people to make their properties more climate adaptive is made attractive by providing subsidies. The results show that the willingness of people to take a green roof increases with approximately 25% when they can get a subsidy, which can be seen as a substantial increase in the willingness. Thus, it can be argued that private costs constitute a societal boundary that can be reduced by providing a subsidy. Increasing the number of subsidized projects can be a good step towards a more climate adaptive Utrechtse Heuvelrug; however, the (local) governments have to alter their budgets. In addition, the system to processing of those subsidies has to become easier. However, an ambivalence in the results is the decrease in willingness when

a subsidy is offered for a 'Heuvelrugtuin' in Doorn. A reason might be a misinterpretation within the survey, which caused an error in the data.

Correspondingly, it can be more financially attractive to provide services. In particular services which increase residential participation with the aim to facilitate climate adaptation. In case of the "tegeltaxi", approximately 50% of the respondents of the survey would make use out of the survey, which indicates that there is interest in these kinds of services.

A returning topic in the results is the demand for cooperation in water management. The interviewees emphasize the seek for cooperation between policy makers. More demand for cooperation is in line with the cooperative approach of Dutch governmental organisations; however, the interviewees mainly point out another topic, which is the need for awareness among inhabitants (Ministerie van Algemene Zaken, 2019). On the contrary, direct measures can be taken to ensure a more sustainable use of water. This has to be done as stated in previous literature and by an interviewee: 'By making a water balance to visualize the major withdrawals and input of water' (Six, 2021). Unsustainable use of water can then be assigned to stakeholders.

About the situation at the Utrechtse Heuvelrug is that there already are multiple partnerships between different kind of organisations. A benefit of the partnerships is that it helps to divide tasks and distribute the workload more efficiently. In that way the depletion of resources is also more efficient. If the organisation would be the only ones taking action, the approach would be very expensive. A good way to reduce costs is to involve the residents of the area, because each resident then makes his own piece of land more climate adaptive. There are several ways to motivate the residents, but according to Koen te Velde seeing other residents making their land climate adaptive is the best way to motivate residents (personal

communication, May 25, 2021). For this scenario you need to have some enthusiastic residents who can give the good example. This observation of Te Velde can be a basis of new policy.

Besides, the results showed two possible positive external effects of implementing water storage policies. Firstly, the countering of subsidence helping also prevent CO2 emissions and secondly, the positive contribution a green garden has on biodiversity. However, these externalities have also some drawbacks. Firstly, these findings focus mainly as ecological positive externalities, whereas also other type of positive externalities -such as economic or social benefits- could have been included. Furthermore, the underwater drainage could raise questions, as the technique is relatively new and an examination of the long-term effects of are still uninvestigated.

### Limitations

Reflecting on the research, several limitations can be identified. The major limitation is time that we had for this research: the duration of the project was only 2 months. For this reason, there was not enough time to conduct more interviews with different stakeholders, this would have given a larger spectrum of viewpoint and insights in the different projects of the Heuvelrug. Moreover, due to this time constraint, the questionnaire could not be more extensive, because conducting and analysing more questions takes a significant amount of time. An example for a more extensive questionnaire would have included the living situation of the residents. This is an important aspect for their contribution to water solutions, since in an apartment less water solutions can be implemented than in a garden.

Another limitation of the research is the narrow focus on the opportunities and obstacles in the current projects, with the result that other important features are left out, such as the social and economic impact of the implemented solutions.

Furthermore, the research is primarily on the regional level of the Utrechtse Heuvelrug, national and international influences are excluded. Since the Heuvelrug is a rare case, with the combination of height, various landscapes in a small park, water extraction and the absence of large rivers, the solutions analysed in this report are to a small extent applicable in a larger context.

The final limitation is that the projects of the 'Blauwe Agenda' are recently implemented, therefore, just the current situation is known, the long-lasting effects of the methods are unknown and there is not a clear future vision.

#### Recommendations further research

For future research it is recommended to make a water balance to test which stakeholders withdraw the most water. Consequently, required awareness around the topic can be raised. Moreover, direct measures can be taken to those which impact the area the most. Thus, unsustainable water storage is allocated to the highest profitable stakeholder. Direct solutions can be provided to these stakeholders. The effectiveness of services for stakeholders, such as residents, needs to be tested after implementation. Durability of the measures is recommended to test with a longitudinal study.

Correspondingly, the ways in which awareness can be raised the most effectively among residents has to be researched. Therefore, possible changes in social valuation of water in the Utrechtse Heuvelrug need to be documented.

## Conclusion

The focus of this research was to find the answer to the following question: **‘What are the opportunities and obstacles for existing projects regarding freshwater storage in the Utrechtse Heuvelrug?’**. To answer the research question, both qualitative and quantitative data has been gathered. The five sub-questions form an outline of the conclusion and will lead to the final conclusion.

To answer the first sub question we mainly looked at the most important stakeholders in the ‘Blauwe Agenda’, which is the most important and overarching plan to assess the water problem. The parties working on the ‘Blauwe Agenda’ are local governments, local water authorities, landowners, and nature organisations. Arguably, the most important stakeholders in the water problem are the residents of the area. These projects can only be successful with the help of locals, that is why many solutions are focussed on the residents.

The ‘Blauwe Agenda’ stakeholders are working on eight main projects to address the problem of water storage. These projects focus on investigating the current situation and developing an approach. In addition, municipalities already have their own policies and solutions. These solutions are focussed on the drainage and the storage of precipitation by increasing the infiltration capacity of the area. Greening residential areas and reducing the number of stones and concrete are the main goals of the solutions.

The results indicate that subquestions 3 en 4 are interdependent. The main obstacle is the lack of awareness among residents of the Utrechtse Heuvelrug, as a result, more awareness is required. Consequently, cooperation is achievable among the different stakeholders. However, social involvement slows down the process.

The questionnaire investigated whether the attitude of the residents of the Utrechtse Heuvelrug towards solutions changes when they will be financially compensated, for example with a subsidy. The results show that the willingness to invest in solutions increases when a subsidy is available. However, in most current cases no subsidy is available. In conclusion, the private costs of solutions is the most important societal boundary for residents.

All in all, the greatest difficulty and potential in terms of freshwater storage in the Utrechtse Heuvelrug is the need of collaboration among all stakeholders. The most promising project that contributes to this goal is the 'Blauwe Agenda'.

## Relevance and integration possibilities

This research will give an insight in the point of view of stakeholders to provide an array of possibilities and constraints regarding freshwater management at the Utrechtse Heuvelrug. Different viewpoints are of importance to indicate what sustainability issues are of importance within the region. Consequently, suitable solutions can be provided for the problems within the area. An inventorisation of the prospects for the area can be made. This inventorisation is partially formed by professionals who work on the water management in the region and partially by the inhabitants. The willingness of inhabitants to make adaptations for the sake of improved water management of the area is provided by the surveys. Pitfalls and preferences of various stakeholders within the area can be properly set out, thereby stakeholders can find consensual and sustainable solutions for water problems within the Utrechtse Heuvelrug.

Our research subject has several interfaces with the subjects of project groups 3B and 3C. Both 3B and 3C are investigating the water cycle of the Utrechtse Heuvelrug and the drought problem which is associated with this cycle. Project group 3B is trying to measure the groundwater levels of the Utrechtse Heuvelrug. The measurements are used to map the area and to create a better understanding of the relation between the soil types, vegetation covers and the groundwater level. This knowledge can be used to assess the drought problem. But also, project group 3C is investigating the drought problem of the Utrechtse Heuvelrug, but then in relation to the farmers of the area. The main thing our project group (3A) and project groups 3B and 3C have common is our interest in solving the drought problem. Our research stands out in the fact that we try to create a clear overview of opportunities and obstacles of current water storage projects.

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## Appendix

### 1. Mail Format

Geachte ...,

Momenteel voer ik met medestudenten van de Universiteit Utrecht een opdracht uit waarbij wij in het gebied van de Utrechtse Heuvelrug de wateropslag in kaart willen brengen. Dit betreft de studie Global Sustainability Science, waarbij wij de toekomst en de aansluitende plannen van het waterbeheer in het natuurgebied willen inventariseren.

Om verder onderzoek te doen zijn wij op zoek naar betrokkenen die ons meer kunnen vertellen over hun aandeel met betrekking tot de wateropslag. Uw expertise heeft onze interesse getrokken en wij zouden graag meer te weten willen komen over uw vakgebied. Hiervoor zouden wij graag met u of een woordvoerder een gesprek aan willen gaan. Mocht u hiermee instemmen, gelieven wij fysiek af te spreken conform de corona-maatregelen. Echter zou dit ook via een online medium kunnen.

Graag horen wij van u,

Met vriendelijke groet,

## 2. Interview questions

- Wat is uw rol met betrekking tot de water opslagprobleem in de Utrechtse Heuvelrug?
  - Hoe lang bent u hierbij al betrokken?
  - In hoeverre wordt hier aandacht aan besteed binnen uw organisatie?
- Heeft u door de jaren heen opmerkelijke veranderingen meegemaakt m.b.t. de water opslag? Zo ja, wat voor een veranderingen precies?
  - Wat is de oorzaak hiervan?
  - Wat is het gevolg hiervan?
  - Hoe waren verschillende partijen hierbij betrokken?
- Wat zijn de grootste valkuilen in de huidige aanpak (*specifiek per organisatie*) van de droogte in de Utrechtse Heuvelrug?/Waar loopt u nu tegen aan m.b.t. de wateropslag?
  - Hoe is dit ontstaan?
  - Hoe wordt hier aangewerkt?
  - Wat is er al verbeterd?
  - Waar liggen de mogelijkheden om het probleem dat u zojuist benoemde op te lossen?
- Wat denkt u dat er in de toekomst nog meer zal veranderen in de Utrechtse Heuvelrug?
  - Kunt u een beeld schetsen wat op korte termijn op de Utrechtse Heuvelrug prioriteit moet hebben?
    - Hoe kan dit worden gerealiseerd?
  - Kunt u een beeld schetsen wat op lange termijn op de Utrechtse Heuvelrug prioriteit moet hebben?
- Bent u bekend met projecten/plannen om deze veranderingen tegen te gaan, zo ja welke?

- Hoe denkt u draagvlak te krijgen met uw plan(nen) voor de Heuvelrug?
- Wat is in uw optiek het belang van de inwoners van de Utrechtse Heuvelrug in de watergerelateerde kwesties?

### 3. Survey questions

Google form Soest <https://forms.gle/AdWeWsCH9jePodJs8>

Google form Doorn <https://forms.gle/HXP6GRKRizQLKxRi9>

1. De Utrechtse heuvelrug kampt met een waterprobleem
  1. Helemaal oneens
  2. Gedeeltelijk oneens
  3. Neutraal
  4. Gedeeltelijk eens
  5. Helemaal eens
2. Stelling: Watermanagement komt genoeg aan bod in de politiek.
  1. Helemaal oneens
  2. Gedeeltelijk oneens
  3. Neutraal
  4. Gedeeltelijk eens
  5. Helemaal eens
3. Ik heb ..(vul in).. te maken met de gevolgen van het waterprobleem.
  - Nooit
  - Af en toe
  - Vaak
  - Altijd



4.



Om gemeentes meer regenwaterproof te maken, worden oude rioolbuizen grootschalig vernieuwd. Dit betekent dat minimaal 2 weken de straat erbij ligt zoals op de foto. Op een schaal van 1-5, in hoeverre bent u voorstander van dit project? (1 is geen voorstander, 5 helemaal voorstander)

1. Helemaal niet
1. Gedeeltelijk niet
2. Neutraal
3. Gedeeltelijk wel
4. Helemaal wel

5.



Op deze foto ziet u een lokaal project in Amerongen waar een wadi (waterberging) wordt aangelegd om water op te vangen. In hoeverre, op schaal van 1-5, bent u voorstander van dit project?

1. Helemaal niet
  2. Gedeeltelijk niet
  3. Neutraal
  4. Gedeeltelijk wel
  5. Helemaal wel
6. Heeft u een groen dak?



- Ja

- Nee
7. Overweegt u een groen dak te nemen?
- Ja
  - Nee
8. Hoeveel procent van uw tuin is groen?
- 0-20%
  - 20-40%
  - 40-60%
  - 60-80%
  - 80-100%
9. 'Een Heuvelrugtuin is minstens 60% groen, er wordt gifvrij getuinierd, het biedt beschutting voor vogels en insecten en je vindt er planten die passen in de omgeving van het Nationaal Park.' In hoeverre, op schaal van 1-5, is uw tuin een Heuvelrugtuin?
1. Helemaal niet
  2. Gedeeltelijk niet
  3. Neutraal
  4. Gedeeltelijk wel
  5. Helemaal wel
10. Staat u ervoor open om een Heuvelrugtuin te hebben?
- Ja
  - Nee
  - Misschien

11. Stel u krijgt een subsidie voor het nemen van een groen dak, bent u dan meer bereid om dit wel te nemen? (Vul 'niet van toepassing' als u er al voor open stond of er al één heeft)

- Ja
- Nee
- Niet van toepassing

12. Stel u krijgt een subsidie voor het nemen van een Heuvelrugtuin, bent u dan meer bereid om dit wel te nemen? (Vul 'niet van toepassing' als u er al voor open stond of er al één heeft)

- Ja
- Nee
- Niet van toepassing

13. Tegeltaxi: Ophaalservice voor gewipte tegels. De gemeente biedt maandelijks de optie aan om uw tegels gratis op te laten halen. Zou dit uw bereidheid voor het nemen van een Heuvelrugtuin vergroten?

- Ja
- Nee
- Misschien

14. Een regenton is om water op te slaan. Bent u bereid een regenton aan te schaffen?

Een regenton kunt u aanschaffen vanaf €30.

- Ik heb al een regenton

- Ja
- Nee

#### 4. Quotes from interviews

From Ter Schure (2021)

“De overheid heeft gezegd:

“iedereen staat voor dezelfde opgave, zoek vooral de samenwerking. Het is een vrij nieuwe opgave waar we allemaal voor staan, dus doe het vooral regionaal.”

Alle gemeenten zijn verdeeld over de beheergebieden van de waterschappen. Daarin zijn allemaal samenwerkingsverbanden in ontstaan en bij ons is dat het Netwerk Water en Klimaat en die werkt samen met alle gemeenten die behoren tot het beheergebied van het hoogheemraadschap Stichtse Rijnlanden.....Dus we hebben met Staatsbosbeheer, Utrechts Landschap, terrein beheer, de tuin branche, want mensen moeten ook aan de slag in de tuin, met de GGD vanwege de hitteproblematiek”

“Inwoners willen bij ons altijd actief participeren en daar wordt heel veel waarde aangehecht dat de bewoners daar mee eens zijn.”

From Te Velde (2021)

“Dat bracht mij wel bij dat belangrijk is om dat samen met bewoners te doen en dit breed aan te pakken en uiteindelijk zorgde dat ervoor dat ik vanuit het waterbeheer meer naar klimaatadaptie ben gaan werken.”

From Hofstra

“Laat ik zeggen, als wij nou de enige roepende zouden zijn en de waterschappen en de provincies enzo enzo zal het geen bal interesseren dan kan je niet vooruit. Dus het is een beetje samenspel.”

## 5. Planning and task division

Task	Who	Milestone	Week	Deadline
<ul style="list-style-type: none"> <li>▪ Introduction</li> <li>▪ Research Questions + Aim</li> <li>▪ Methods</li> <li>▪ Relevance</li> </ul>	<p>Freek Namara &amp; Freek</p> <p>Elieke &amp; Ruben Casper</p>	Everybody finished first concept part	18	<p><b>Monday 3 May 17:00</b></p> <p><b>First Draft Research Proposal</b></p>
<p>Introduction Literature Review Methods Relevance Planning + Task Division Reference List</p>	<ul style="list-style-type: none"> <li>▪ Freek</li> <li>▪ Namara and Casper</li> <li>▪ Elieke</li> <li>▪ Freek</li> <li>▪ Ruben</li> <li>▪ Everyone</li> </ul>	Introduction, literature review, methods relevance are finished	19	<p><b>Wednesday 12 May 17:00</b></p> <p><b>Second Draft Research Proposal</b></p>
<p>Introduction Literature Review Methods Relevance Planning + Task Division Reference List</p>	<ul style="list-style-type: none"> <li>▪ Freek</li> <li>▪ Namara and Casper</li> <li>▪ Elieke</li> <li>▪ Freek</li> <li>▪ Ruben</li> <li>▪ Everyone</li> </ul>	Proposal done	20	<p><b>Friday 21 May 17:00</b></p> <p><b>Research Proposal Final Version</b></p>
Interviews done	Division depends on how many interviews	Interviews done	21	<b>Friday 28<sup>th</sup> of May</b>
Fieldwork: survey	Two towns: 3 people – in one town 2 people – in other town	Survey done	22	<b>Monday 31<sup>st</sup> May - 4<sup>th</sup> of June</b>
Data gathering	Everyone	Data fieldwork uploaded	22	<p><b>Friday 4 June 17:00</b></p> <p><b>Data Fieldwork uploaded</b></p>



Survey and interview coded	Survey – 2 people Interview -3 people	All coded and analysed	23	<b>Friday 11<sup>th</sup> of June</b>
Research draft: each part is partly finished	Everyone- specific division will follow	As much as possible finished for the research draft. At least for every part something.	24	<b>Monday 14 June 17:00 Research Draft</b>
Read and final check	Everyone One person has the task to hand it in.	Research report finished	25	<b>Final version Research Report 17:00</b>

## 6. Data management plan

The research is focused on the obstacles and opportunities of the water management projects in the Utrechtse Heuvelrug, highlighting the social science perspective. We will collect mainly qualitative data from interviews and both quantitative and qualitative data is generated through surveys.

The surveys are on a voluntary basis and are anonymous, no identification (name, gender, age) will be asked and collected for the research. Due to the anonymous character of the survey, it impossible for the participant to withdraw or make changes after completion. Furthermore, the data used from the interviews will be sent to the interviewees prior to the publication of the research for approval. If the interviewees would like to make changes or withdraw there is the opportunity to do so. Data and definitive project documentation will be stored on centrally provisioned Utrecht University and can be published online.