

Forest management, mitigating climate change, and conserving biodiversity

Forest Management for Climate Change Mitigation and Preservation of
Biodiversity on the Utrechtse Heuvelrug

Utrecht University, BSc Global Sustainability science

Regional Integration Project

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Bente Schalkx (6697070), Dagmar Hogendorp (7037627), Elize Smits (9659431),
Finnur Ricart Andrason (7061080), Renée Simons (6744958)

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1. Introduction

1.1 Global crises

Global climate change and biodiversity loss are the two defining crises human society is currently facing. Both have been brought about by human activity and must be solved by changes in human behaviour (Edenhofer et al., 2014 / Gosnell, 2021). However, large-scale societal change is a lengthy process and may not suffice to prevent the worst consequences of a changing climate or mass extinction. Therefore, other solutions such as carbon storage, forest management, and nature conservation need to be implemented to safeguard the remaining biodiversity and prevent more carbon from escaping into the atmosphere (Rogelj et al., 2018).

Forests are frequently endorsed as the best solution to climate change due to their ability to capture and store carbon from the atmosphere and therefore decreasing the intensity of the global greenhouse effect. While forests have good potential, there are important risks and trade-offs which need to be considered when examining the role of forests in mitigating climate change (Smith et al., 2014). One such trade-off concerns the ecosystem service of carbon sequestration and biodiversity. High biodiversity in a slow growing forest often does not provide the right circumstances for a large carbon storage capacity (Costanza et al., 2007). Agreements on the role of forests in climate change mitigation thus need to have a delicate compromise between the components of such trade-offs. This is why forest governance, or forest management, is an essential aspect of harnessing forests in combating these two crises.

1.2 Local context

The Utrechtse Heuvelrug (UH) is the second-largest national park in The Netherlands. It extends 134 km² and is mostly covered with forest and wetlands (StatLine, n.d.). Several institutions, organizations, and private owners collaborate to govern this vast area, and among those are Staatsbosbeheer and Utrechts Landschap (Samenwerkingsagenda, 2021). They are responsible for large parts of the forested areas of the UH and are the forest management units focused on in this research paper.

While climate change, biodiversity loss, and the associated networks of complex natural processes are fairly well understood, the management of forests to alter these processes is not, especially for the local context of the UH. A large selection of different methods of managing forests exists (Figure 1) and these methods are more often than not linked to a single purpose. However, when the purpose is to solve two complex existential crises, little is known about the optimal methods or the challenges faced in the governance of implementing them.

1.3 Research scope

The goal of this research paper can be split into three steps. Firstly, the current forest management practices applied by forest managers in the UH will be explored and challenges will be identified. Second, the motives behind applying these methods and their effectiveness will be analysed. And thirdly, the implications of the results and possible suggestions for future research will be provided.

To structure these three main steps, a research question and three sub-questions have been constructed (Table 1). The focus of the research is minimized to the topics of mitigating climate change and maintaining biodiversity as these are two major objectives in forest management and to limit the scope of the research project. The research question is: What challenges do Staatsbosbeheer foresters face in applying forest management in mitigating climate change, specifically with regards to maintaining biodiversity, in the Utrechtse Heuvelrug?

Research Question

What **challenges** do foresters face in applying **forest management** in **mitigating climate change**, specifically with regards to **maintaining biodiversity**, in the Utrechtse Heuvelrug?

Sub-question 1.

Which methods or types of forest management (e.g. afforestation of local species, afforestation of indigenous species, protected areas) are prioritized in the Utrechtse Heuvelrug, and why?

Sub question 2.

Which forest properties (e.g. carbon storage, biodiversity, soil production) are prioritized by foresters in the Utrechtse Heuvelrug, and why (e.g. influence of political climate)?

Sub question 3.

What challenges are foresters in the Utrechtse Heuvelrug facing when it comes to the governance of forest management?

Table 1. Research Question and sub-questions

2. Literature review

Vast research has been conducted on the role of forests in mitigating climate change as well as on how climate change is affecting forests and forest biodiversity. The Netherlands has a long history of managing forest areas. Due to climate change, contemporary forest management is becoming increasingly complex creating more challenges for foresters.

This section will explore the existing literature on the intricate relationships between climate change, forests, biodiversity, current management methods, and stakeholder relations. It will outline the existing knowledge gap before the theoretical framework of the research paper is defined and justified. The text is accompanied by two figures. The concept map (Figure 1) gives a detailed explanation of the intricate nature of natural 'forest management' by foresters, which is a key component of the theoretical framework (Figure 2).

2.1. Mitigation of climate change through forestry

Forestry as a tool in climate change mitigation refers to either the protection of existing forests or afforestation, the creation of new forests. Sometimes a distinction will be made between these two practices as they carry varying implications for other factors involved and must thus be examined separately (Figure 1). However, both practices embrace the function of vegetation as a carbon sink, removing carbon from the atmosphere long-term. A desirable trait as it partially counters the challenges created by anthropogenic emissions of CO₂ and other greenhouse gases (GHGs) (Thomassen et al., 2020). Forests have, therefore, been included as an important tool in climate policies and international agreements. However, it is important to look beyond this carbon assimilation trait of forests and acknowledge the myriad other functions they carry out.

The European Space Agency outlines three core roles of forest outside of their importance in the context of climate change. Firstly, forests are vital for species resilience, biodiversity and this role ultimately lays the foundation for all its other functions. Secondly, forests are an important societal resource providing provisioning and cultural ecosystem services. Thirdly, forests provide an array of ecosystem services such as regulating and supporting services, namely carbon sequestration ("Roles of Forests.", n.d. / USDA FS Climate Change Resource Center, n.d.). Failing to recognize the interconnectedness of these diverse roles of forests is at the core of the dangers arising from using forests as a tool for mitigating climate change. It implies a need for policies that include careful trade-offs, grounded in science, developed by policymakers, forest managers, and other actors involved.

2.2 Effect of climate change on forests and biodiversity

A changing climate requires foresters to think ahead and plan a variety of strategies to enhance forest resilience and counteract natural forest challenges. Although the predictions of the effect of climate change are accompanied by uncertainty, it is clear that biodiversity and other ecosystem functions of Dutch forests will be impacted.

One such impact is higher moisture requirements of trees as temperatures rise. Precipitation shortages can cause issues for drought-sensitive species while drought-resistant species flourish, leading to changes in the species composition of forests. In addition, precipitation related droughts increase the risk of wildfires (Best and Boosten, 2021). A warmer climate will also lead to a northward migration of species. The rapid movement of climate limits due to climate change threatens the survival of species that are not able to migrate as quickly (Braakhekke et al., 2014). Furthermore, higher temperatures affect the survival rates of pests and diseases and can extend the growing season for all species leading to the disruption of food webs.

2.3 Biodiversity as a function of forests

Biodiversity is an important part of the functioning of a forest. The loss of biodiversity is caused by area loss, area fragmentation, and environmental pressure as a result of urbanization and agriculture (PBL Planbureau voor de Leefomgeving, n.d.). The increased area occupied by anthropogenic land-uses poses an increasing threat to forest areas such as the UH and brings about social forest challenges.

2.4 Effect of stakeholder relations on forest management

Forest managers function as intermediaries between the forest and the outside world (Meijer et al., 2015). According to an evaluation of Staatsbosbeheer commissioned by the *Ministry of Agriculture, Nature and Food Quality*, forest management is affected by changing societal contexts such as a growing number of stakeholders and their interests complicating decision making processes (ECORYS, 2018).

2.5 Knowledge gap & theoretical framework

By linking anthropogenic activity, climate change, and forest biodiversity it is possible to create a picture where the influences and interconnectedness of these processes are more clearly visible (Figure 2). However, the need for a better understanding of the role of foresters, and the challenges they face, remains (see yellow boxes and arrows in Figure 2). This is the knowledge

gap which has been identified and which will be explored through this research. Stemming from the main research question put forth in the introduction, three sub-research questions have been constructed to guide the research (Table 1).

This research aims to assist foresters on the Utrechtse Heuvelrug in mitigating climate change while conserving biodiversity. Gathered results will be analysed and propositions for future research will be provided.

Although the focus is on the Utrechtse Heuvelrug, some of the findings are expected to be applicable to other forest areas in neighboring regions and in similar climatic zones.

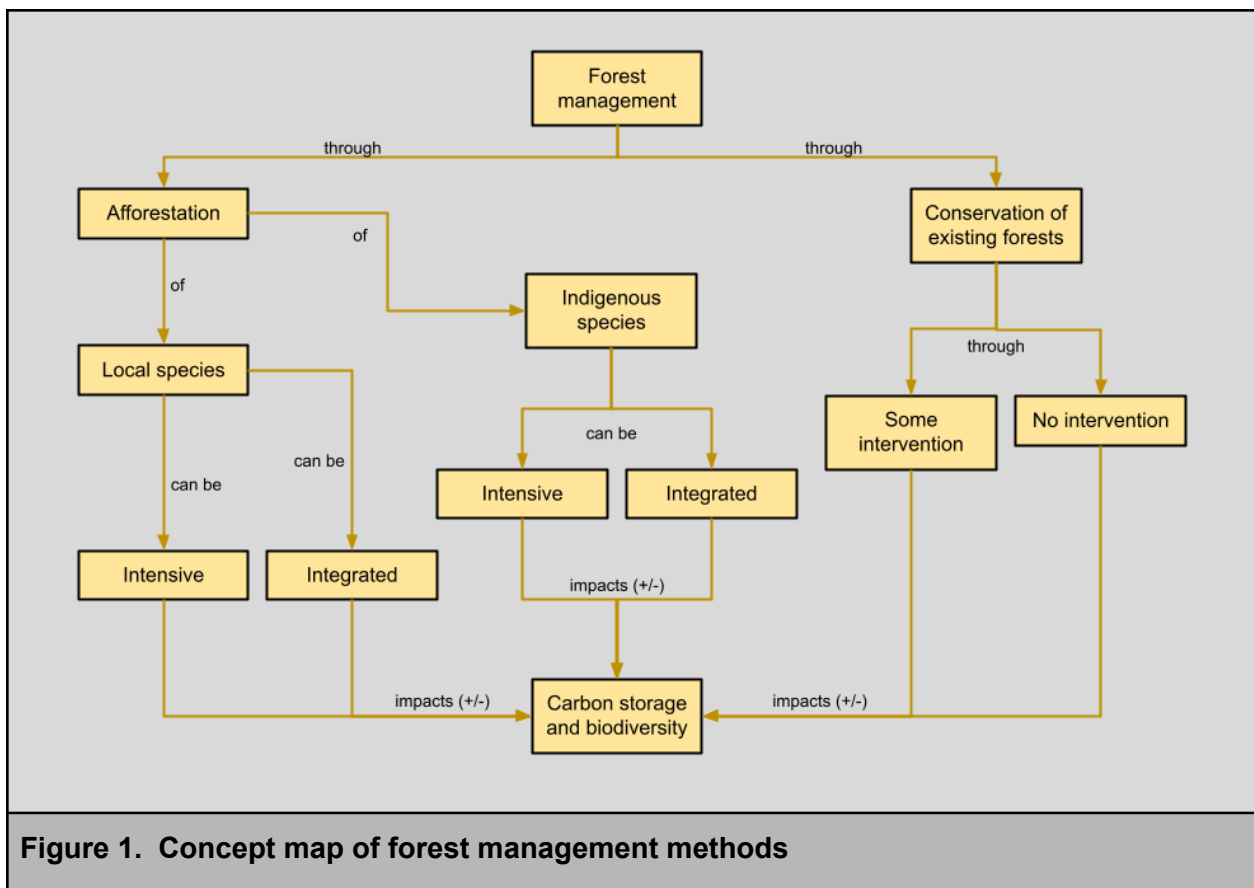


Figure 1. Concept map of forest management methods

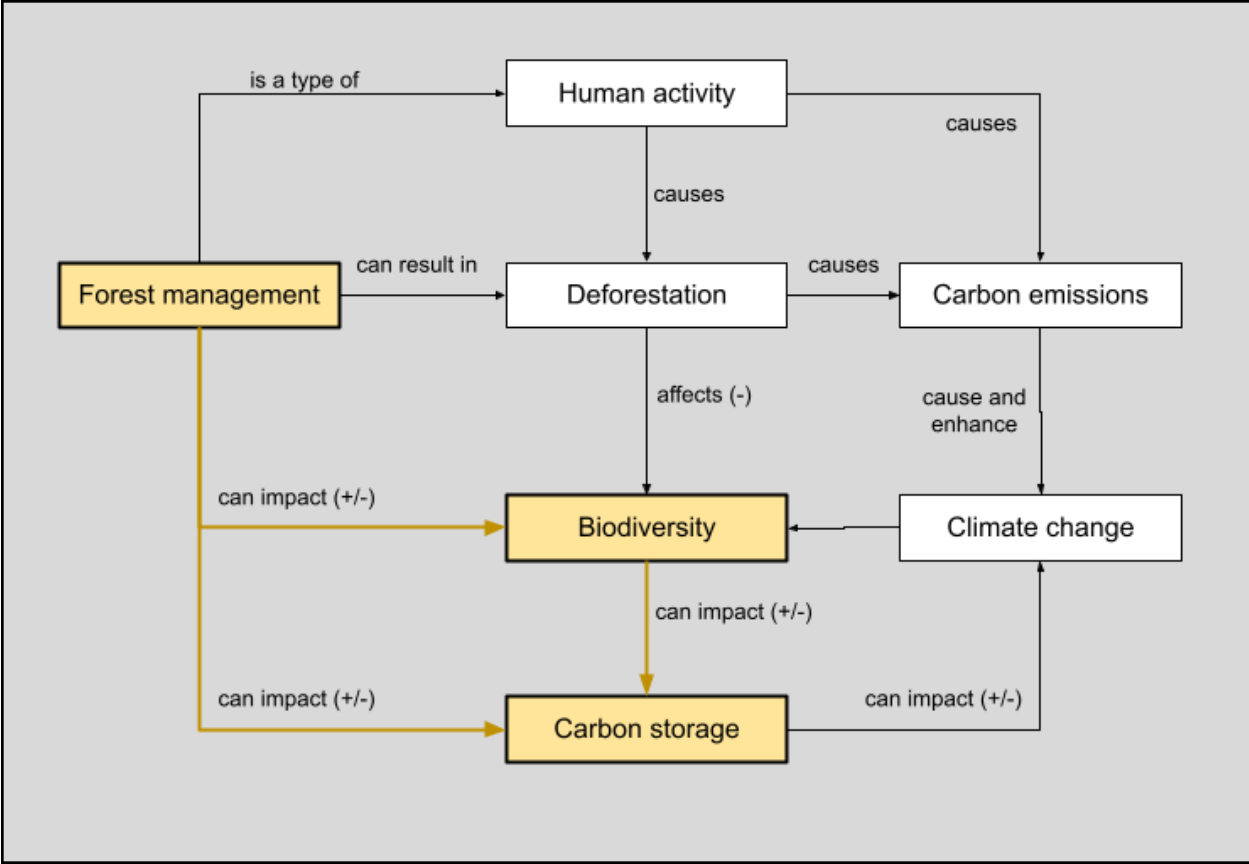


Figure 2. Theoretical framework - Forest management, climate change and biodiversity

3. Methods

3.1 Interviews

There are a number of parties on the Utrechtse Heuvelrug that have a say in the management strategy and the sustainability policies implemented in the area. However, it is not fully apparent to what extent these diverse stakeholders and land owners interact to align their management and what issues arise. To provide a better insight on the challenges that foresters currently face in coming up with more coherent policies to combat climate change, we will conduct 5 interviews with foresters and specialists from organizations such as Staatsbosbeheer and Utrechts Landschap. A qualitative study of the roles and perceptions of foresters on climate change and biodiversity is proposed. Before the target group interviews are conducted, the interview will be pre-tested by peers and the tutor assistant. Semi-structured interviews will be conducted that leave space for the participants to talk about a wide variety of topics and elaborate on their own expertise. Providing all participants with the opportunity to elaborate on their own experiences and expertise will increase the scope of the research and will provide an elaborated overview of the current situation on the Utrechtse Heuvelrug. During the interview the overall structure of the proposed interview questions will be followed with occasionally an added question for clarification. Sub-questions can be used if the participant requires some steering, prompting, and extra structure during the interview.

It is anticipated that the interviews will be conducted in the time period of May 31st, 2021 to the 4th of June, 2021. With permission of the interviewed participant, all interviews will be voice-recorded and are expected to vary in length from 45 minutes to 60 minutes. During the interviews notes will be taken in addition to the voice-recording to provide a clear overview of the structure of the interview. The interviews will take place online through programs such as Microsoft teams or Zoom, or in real life, depending on the preference of the interviewee. In addition, all members of the team will be dressed appropriately and recognizable for the interviewees.

Using purposive theoretical sampling, interviewees will be selected on their function and work experience to ensure validity of the interview (Bryman, 2015). A population sample of 5 foresters will be interviewed to ensure a clear overview of the experience of foresters in combating the loss of biodiversity and climate change on the Utrechtse Heuvelrug. Participants will be recruited by contacting the institutions Staatsbosbeheer and Utrecht Landschap. All participants that agree to be interviewed will be asked to sign an informed consent form prior to

the interview. Complete anonymity will be promised in accordance with the data management plan.

After conducting the interviews the data analysis phase will begin. The voice-recorded interviews and notes taken during the interviews will be transcribed. This will be done to ease the data analysis and allow for it to be done in a structured manner. The software program NVivo will be used to transcribe the interviews. NVivo uses a coding system that organizes certain themes found in the interviews, subsequently connections between the different interviews can be tracked and missing data will be notified (NVivo, n.d.). Themes such as power relations, carbon storage, biodiversity, adaptation, land-use, and future challenges that relate to the research question and often return in the conversations with the participants will be tracked in the interviews and will establish a further understanding of the perception of foresters on combating climate change and the loss of biodiversity in the UH.

Afterwards, results will be written down and errors and limitations that occurred during the research will be discussed. An overview of difficulties faced in present times and advice on future scenarios will be provided. Data will be further analysed and summarized in structured table overviews (see Appendix 2).

3.2 Data management plan

Our main research method will be conducting interviews with foresters from two institutions. We will take care to conduct the interviews in a transparent fashion with their informed consent. We will also try to minimize the influence of external factors. Therefore, the interviews will be held in private and with the written consent of the interviewed participant. Beforehand, the interview questions will have received ethical clearance from the tutor assistant of Utrecht University. The participant is informed about the purpose and the method used for the project and will be given information about the data analysing and processing of the interview. Thus, the interview will be on a voluntary basis.

Personal data will only be obtained when necessary for a specific purpose and with the consent of the interviewee, and will be stored safely according to the relevant laws in place. In this case the interview participant will be given explicit information about the processing and they will be asked to give permission for the data processing. It is always possible for the participant to stop the interview or withdraw from the project at any time.

Data will be stored in an offline document on a computer of one of the team members, this will ensure no data is accidentally leaked online unknowing to the participants or team members. The team members will treat the information as confidential and will not release any

information outside the necessary data relevant for the study. Once the project has been finished, which will be at the end of June, all stored data will be deleted. This means that from July on no individual will have access to the data and all personal information will cease to exist in our records.

4. Results

Five interviews have been conducted, with participants of various functions within their organization. Four of the interviewees were part of Staatsbosbeheer; three forest rangers, of which two are team leader, and one ecologist. The other interviewee works as a policy officer for planning and policy at Utrechts Landschap. The names of the participants will not be provided due to privacy concerns. All interviews have been transcribed and have been analysed by distinguishing different topics. The topics we have chosen are: function duties of interviewee; power relations between stakeholders; forest challenges natural; and forest challenges social. For each topic there are subtopics in which the main idea is explained and some quotes are provided. In this chapter, we will compare the interviewees perception on the different topics and look for patterns in the data. All data is available in the appendix.

4.1 Functions and duties of foresters

First off, participants were asked to describe their own occupation and to describe what they think could be improved about their job.

The occupation of the foresters includes the management, ecological and public side of the area, as well as authority up to a certain budget. One of the used management strategies is the thinning of old trees, in order to allow other vegetation to increase in size. However, while being occupied with the tasks, one interviewee runs into difficulties when it comes to time management. The participant believes that too much time has to be spent on the policy side, including writing work plans and having consultations with the province. This makes it difficult for the participant to go into the field to check on the state of the forest.

The ecologist performs advisory work for those with management functions. Their main focus is biodiversity and the relation to implemented management. The participant is also in contact with the province and other land managers. Personally, the interviewee feels that the function is too broad and distract from what they describe as real ecological tasks.

The policy officer participates and defends the interest of nature in policy processes of municipalities, provinces and water boards. The participant believes that improvement can be made by making a more explicit division of tasks, so that economical interests are taken into account in other workplaces and Utrechts Landschap can focus on defending the interest of nature.

4.2 Power relations between stakeholders

Next, the interviewees have been asked to clarify which stakeholders are present in the area and what the relationship between the different stakeholders are. In addition, they were asked to further explain challenges concerning the different stakeholders.

The stakeholders mentioned by the interviewees were: Utrechts Landschap, Natuurmonumenten, Staatsbosbeheer and private estates that own land at the Utrechtse Heuvelrug. All parties have to follow national and international laws, however, some parties are dependent on other factors in their decision-making. The second participant elaborated more on the relationship between all stakeholders. The National government functions as the overall decision maker regarding European nature policy, with the province providing the financial side and the provincial regulations on nature policy. The neighboring land holders all have an equal power balance among each other and Staatsbosbeheer has team leaders who finalize decisions with the advice of the ecologist.

Although there are a lot of parties involved in the management of the area, it does make the decision making process take less long as the government does not have to be included in the discussions about the management. However, almost all interviewees mentioned that the amount of stakeholders and different interests make it hard to reach one solution and stick to the same work plan.

In addition, the fourth interviewee is concerned about the reliability on the government:

"(...) You see that the radical right-wing flank is rising and it's growing in the Netherlands too, and it's often not the side that has the time to think ahead. Often, if you look at climate policy, it's always about thinking long term."

The participant also described that when the Water Board (Waterschap) decides to make the land dry for the farmers, Staatsbosbeheer will *'draw the short straw'* while wanting the forest to be wet to be able to sprout in the summer.

When analysing the given answers, it comes forward that there are many stakeholders that all have a say in the policy making and management of the Utrechtse Heuvelrug. As Staatsbosbeheer receives funding from the government, the decision making process is dependent on the political climate of the country, making it sometimes hard to think of long term solutions. Likewise, Natuurmonumenten has to adapt their management to the preferences of its members. The amount of different opinions and interests make the implementation of new or adapted forestry strategies a long process.

4.3 Forest challenges: natural

In maintaining biodiversity on the Utrechtse Heuvelrug there are many aspects to consider. This section concerns the greatest challenges the interviewees are currently encountering and will likely encounter in the future regarding natural forest challenges.

Various challenges have been mentioned that influence the management strategies on the Utrechtse Heuvelrug. All interviewees remarked that currently desiccation is one of the largest challenges on the UH. Interviewee 3 noted that due to three extremely dry years, and the increased need for drinking water and water for agriculture, desiccation becomes an increasingly severe problem. An increased frequency in droughts results in species extinction for certain tree types whereas other species thrive. On the UH this is especially problematic as in the past large surfaces have been planted using monoculture tree plantations, according to the first interviewee. Moreover, interviewee 3 mentioned that drought related issues often result in tipping points where a chain reaction is set in motion:

“It is often the case that if one tree dies, it has consequences for the other. Beech trees often do that, if they lose their mate, you get more sunlight that falls directly on the bark of the tree and beeches can’t stand that, you get a kind of sunburn effect.”

Thereafter, interviewee 3 mentioned that increasing the amount of water that enters the Utrechtse Heuvelrug is near to impossible since there is no water flowing through the area. The only river present is near the flanks of the hill ridge and this water flows off immediately since the area has the shape of a mountain. Therefore it is essential to ensure that the rainwater that falls is retained as long as possible and not discharged quickly via the streams. According to interviewee 2, the process of humidification could counteract the negative influences resulting from droughts. The participant described the process as creating a buffer to physically retain water to hold it for longer instead of the water immediately running off through waterways. However, the interviewee also mentioned that applying a solution as humidification is challenging due to the excessive amount of stakeholders that are involved in applying such solutions on the UH.

Subsequently, all participants mentioned that the Utrechtse Heuvelrug experiences negative impacts of high nitrogen deposition resulting from intensive agriculture. This excessive nitrogen deposition results in a drastic decline in biodiversity both on land and in water since it results in eutrophication in water and in acidification of the soil. Interviewee 5 describes the situation as follows:

“This nitrogen deposits in our forests and causes all kinds of minerals from the soil to leach out. This makes the soil acidic. The system cannot repair itself at the moment. Because

that nitrogen has accumulated over the years and therefore the mineral leaching has become more and more intense.”

Lastly, interviewee 1 mentioned that due to climate change and increased interconnectedness over the world, the number of invasive species entering the UH has increased and will remain increasing in the future. Interviewee 3 noted the introduction of species such as the Japanese Knotweed and the giant hogweed in recent years. The participant mentioned the importance of mapping the occurrence of these invasive species and keeping track of where control is necessary to avoid overgrowth of the invasive species and avoid damage to native species. In conclusion, it is essential to make the right decisions on maintaining enough native species but also introducing invasive species that are drought resistant, according to interviewee 3.

There can be concluded that overall the largest challenges currently faced by the foresters of the Utrechtse Heuvelrug are desiccation, acidification, and the negative impacts caused by the deposition of nitrogen. Implementing solutions into the current managing system is a huge challenge due to the excessive amount of stakeholders. Moreover, the introduction of invasive species due to climate change and an increase in interconnectedness worldwide, results, if not controlled, in overgrowth and damage to native species that were already present on the UH.

4.4 Forest challenges: social

In this section the interviewees have been asked to clarify on the influences that visitors have on the maintenance of biodiversity on the UH, on the resulting impacts of COVID-19, and on how citizen awareness in the area is perceived.

All participants observed an increase in the number of visitors on the UH since the introduction of COVID-19. This increase has resulted in negative impacts on biodiversity as many recreationists do not stick to the rules present on the UH. One forest ranger describes a phenomenon in which roe deers are scared off by dogs that are not on the leash, resulting in roe deers running to death or drowning. The participant views the current visitor awareness on these negative impacts, resulting from diverging from the rules, as insufficient. Although visitors are addressed when they cross boundaries or do not stick to the rules present, little attention is given to overall visitor awareness.

The policy officer mentions that Utrechts Landschap applies zoning for recreation to safeguard the presence of areas where quietness can be ensured for the benefit of nature. However, due to this increase in recreation resulting from COVID-19, the breeding season is

heavily disturbed which can consequently affect the population of different species in the coming years. The interviewee is of the opinion that the campaigns currently running on the UH are creating awareness, however many participants still do not stick to the rules. It was also noted that due to COVID-19 a different type of recreationist is present on the UH who are often less aware of the rules. Interviewee 5 mentioned a 60 percent increase in violations from previous years, this new group of visitors urgently had to be educated which takes a lot of time and effort.

Interviewee 2 and 4 both are of the opinion that current awareness campaigns are sufficient but it is challenging to actually improve visitors behaviour. Since the team at the Utrechtse Heuvelrug only has two to three enforcers, it is necessary to prioritize certain areas and close others. But all things considered, according to interviewee 4 the enforcement has proven to be effective and it seems that the forest animals are getting used to the visitors. Interviewee 4 describes the situation as follows:

“You see now for the first time in a year that the roe deer are less bothered by people. If people are walking by, the roe deer just keep on looking. In the past it was really the first one to flee.”

In conclusion, COVID-19 has caused a significant increase in the number of visitors to the Utrechtse Heuvelrug. This has been associated with a greater pressure on nature, such as people going off the paths and dogs scaring off roe deers. To take care of this situation, campaigns have been released, warning signs have been spread through the area and the most vulnerable areas have been closed. Nowadays, the effort seems to be effective and the forest is getting more used to the flow of people.

4.5 Forest management, mitigating climate change, and conserving biodiversity

Eventually, the interviewees were asked about the management strategy that they believe would work the best for the Utrechtse Heuvelrug, concerning climate change and biodiversity.

The first interviewee would like the management strategy to focus on creating different layers in a forest and mixing different species in the area. Working in layers improves the resilience of the forest, as a fallen tree can be replaced faster by a tree that had been growing just a couple of meters down than by one that still has to sprout. The mixing is for making a forest resistant to external factors, so that if one tree falls out, others can fill the blank spot. The management has mostly a focus on the future, so species are adapted to future conditions.

The ecologist of Staatsbosbeheer focussed more on bringing heat resistant species into the area, so that the forest is kept vital and the forest floor is managed. Which is also beneficial

for the wood production, therefore more hardwood species and other species from southern Europe are planted.

Subsequently, the policy officer believes the best management strategy is to keep the forests biodiverse, with various species that are adapted to climate change. Moreover, the participant mentions the urgency for solving the desiccation crisis currently pressuring biodiversity on the UH.

"I think it will take a lot of lobbying to achieve a structural rise in water levels. It's not just about making your forest more diverse with the right species, it's also about working on the hydrological situation, but you can never do that alone and it's really difficult."

The fourth interviewee mentioned a management strategy which works with small-scale ecosystems, layering and a focus on increasing the number of species. Working with small-scale ecosystems automatically brings in more species, but also improves the variation in a forest as it stimulates other species to thrive. This strategy is also related to moving away from bulk cutting, which has actually been stopped nowadays. By maintaining layered tree crowns, the temperature in the forest remains relatively stable, which is beneficial for the plant and animal species.

The fifth interviewee also votes for a mixed forest with management on small-scale, adapted to climate change. In addition, the management strategy should consider the nitrogen problem on both national and local level.

Overall, the interviewees have a comparable view on the best management strategy. According to most, the focus has to be set on biodiversity and layering the tree crowns. This strategy is used to make the forests more resistant to external factors and drought.

5. Discussion

This research has given us many insights into the future possibilities of forest management and the synergies and trade-offs it entails. By talking to experts in the field of forestry, a lot has been learned about the forest management system and how it should be adapted to the changing climate resulting in longer periods of drought, and the expected arrival of more tourism and recreation on the Utrechtse Heuvelrug in the future.

In the research, we aimed to address the challenges of forest management in mitigating climate change with regards to maintaining biodiversity on the Utrechtse Heuvelrug.

The results show that the current forest management system is currently in transition; on its way to more sustainable management that can accommodate the nature reserve and its visitors in the longer term, but there is still a long way to go. Nature and forest management is a complex system because a lot of stakeholders and organizations have to adapt in order to make the change successfully. Therefore, regional, national, and even international management levels have to work together to make a positive change towards sustainable forest management, according to the respondents.

In order to come up with conclusive results for the main research question, we introduced 3 sub-questions. The first sub-question looks into the prioritized methods of forest management. This question has a certain relevance since we first had to investigate what the preferences were from stakeholders to manage the nature reserve. In this way, we could come up with a new forest management system in the way they would think it is the most applicable. The second sub-question is about which forest properties (e.g. biodiversity, soil retention, etc.) are prioritized by foresters and why. It is imperative that these priorities of foresters are respected and, above all, listened to. After all, they are connoisseurs of the area and know how best to enforce it in order to move towards sustainable forest management. The third sub-question relates to the challenges for foresters in the governance of forest management. In our research, we need to understand the barriers first, in furtherance of making changes to encounter these challenges in the future.

Our findings are consistent with the literature review we did beforehand. As discussed in both the introduction and the literature review, many researchers frequently endorse forests as the best solution to climate change due to their ability to capture and store carbon from the atmosphere (e.g. Smith et al., 2014 & Costanza et al., 2007). However, what the interviewees emphasized was the importance of conserving existing forests rather than being too keen on planting new ones. Furthermore, afforestation should not be viewed as a silver bullet as there are many natural and social factors such as biodiversity conservation, drought resistance,

invasive species, cooperation, and power relations, which make this a difficult method to solve an isolated problem. The issue must be regarded more as a part of a larger whole, a larger ecological and climatic crisis.

There have been a number of obstacles and challenges during the conduct of our research, which might make our research less reliable. Some interviews were conducted on the location of the Utrechtse Heuvelrug where other interviews were conducted online. By interviewing on location, the respondent might have more of an affinity with the interviewer and might give a different answer to the question than if it was asked in an online setting. In addition, of the 5 interviews, 4 interviews were conducted with Staatsbosbeheer foresters. By interviewing too many employees of the same organization, one risks gathering too many of the same answers. It would be preferred if more employees of Utrechts Landschap, Natuurmonumenten, and other involved stakeholder organizations were interviewed, as they too manage the Utrechtse Heuvelrug. In addition, there has been no contact with the province, we only interviewed a single level of power, which makes our research less inclusive. Furthermore, we only interviewed 5 people; with so many stakeholders and organizations involved in the management of the Utrechtse Heuvelrug, the research could maybe be extended to become more comprehensive.

6. Conclusion

Forests are key players in the mitigation of climate change and those who manage them have some level of influence on various scales in the development of forest and climate change management policies. Along these lines, foresters' views on the discussed topics, i.e. function duties of interviewee, power relations between stakeholders, forest challenges natural, and forest challenges social, are equally important.

Three sub-questions have been developed to help answer the research question (Table 1). The first sub-question, regarding the types of forest management prioritized by foresters on the Utrechtse Heuvelrug, can be linked to the topics 'function duties of interviewee' and 'forest challenges natural'. A number of different forest management strategies is used, including: the thinning of old trees (interviewee 1), humidification (suggested by interviewee 2, deprecated by interviewee 3), and the afforestation of native species while also introducing drought resistant invasive species (interviewee 3) (Figure 1). From these results can be concluded that there is no real prioritization of methods present or preferred, as different areas require a variety of management strategies. In addition, this is in line with the small-scale management strategy, which is implemented to stimulate species variety within a small area.

The second sub-question, concerning prioritized forest properties, is mainly addressed by the topics 'forest challenges natural' and 'forest challenges social'. The interviewees describe the visibility of processes such as acidification, eutrophication due to nitrogen deposition, and desiccation on the UH. These processes influence biodiversity and soil conditions. The loss of which is increased by recreationists. Therefore, biodiversity and soil quality (mainly nitrogen deposition) are currently the most important properties. In order to improve the condition of nature, the forest management strategies mentioned at the first sub-question are implemented.

The third sub-question is addressed by the topics 'function duties of interviewee' and 'power relations between stakeholders' and discusses the challenges foresters face in the governance of forest management. The most frequently discussed issue is the amount of stakeholders. Most stakeholders have differing interests and it can thus be challenging to reach a consensus. This has a direct influence on the state of the forest, as it takes a long time to adapt the forestry management to challenges faced, such as biodiversity loss and nitrogen deposition. The governance also has a direct influence on the guidelines and management of the Utrechtse Heuvelrug. As the sitting party decides on the environmental goals on a national level, as well as within organizations like Staatsbosbeheer, it is never fully secured that a management plan will prolong for many years.

The Utrechtse Heuvelrug is a fragmented area in terms of nature management strategies and involved stakeholders. Foresters, like our interviewees, are at the bottom of the so-called power-food chain and thus only influence forest management in an indirect manner. Even though they have a front row seat to the effect of climate change on biodiversity in the UH, their efforts to mitigate climate change are restricted by them not having any official power to make legal decisions. All in all, complex stakeholder relations are the largest challenge in applying the necessary forest management strategies to mitigate climate change and preserve biodiversity.

By analyzing the synergies and trade-offs in forest management on the Utrechtse Heuvelrug, the challenges created by stakeholder power relations and the too small influence of those who actually work in nature have been emphasized. Suggestions for future research include a more in-depth analysis of present power structures. In addition, considering foresters in comparison to other stakeholders have high levels of knowledge about the management of natural areas such as the Utrechtse Heuvelrug, further research is needed to increase the influence of foresters in policy development. Expanded forester influence will lead to better functioning forest management policies.

Forests can have an important executive function in the mitigation of climate change, it is strongly advised to use them and their foresters to their maximum capacity.

7. Relevance and integration possibilities

As previously mentioned, the research in question is relevant from both a social and natural science perspective. In the upcoming years, the world is going to face increasingly complex sustainability issues. The aforementioned will in a like manner have an effect on the natural area of the Utrechtse Heuvelrug. Sustainable forest management is therefore important for the future. Forests provide important materials for sustaining the earth as we know it. If managed properly, forests can be used as a tool for mitigating and combating climate change.

The results of climate change, e.g. temperature increase, resulting droughts, increasing risks of wildfires, etc., will lead to detrimental forest biodiversity loss (Braakhekke et al., 2014). Eventually, the Netherlands will have to cope with environmental changes such as increasing sea levels, which will result in major social and ecological impacts. However, forests and other natural areas are capable of damage control and, for example, have a high water retention capacity, which can be helpful in decreasing flooding danger and thus lessen the negative natural and social influences caused by climate change (Richert et al., 2011).

With the assistance of healthy and thriving ecosystems, we can postpone the most detrimental effects of climate change and create more time to find better, long-term, solutions for future climate change-related issues. It is of grave importance to do research on how well-integrated, interdisciplinary forest management can combat climate change while preserving biodiversity.

The natural area of the Utrechtse Heuvelrug is located in a highly-populated area, which is estimated to become increasingly crowded over time. With more inhabitants, visitors, and consequently an increase in human presence on the UH, it is a challenge to sustain a healthy forest area. Establishing the right ways of dealing with these managerial challenges is essential for the UH foresters, in order to adjust the forest management rules in favor of nature conservation.

These growing anthropogenic impacts on natural areas with regards to climate change, have not been researched properly on the UH yet. Research about which management methods and stakeholder decision making processes are the most effective, most realistic, and which challenges will be faced by foresters in the implementation of these management adjustments, are useful for prospective climate change challenges. Performing this research on forest management in the Utrechtse Heuvelrug area, and how to improve or adjust this over time to foresee future sustainability problems in the coming future is crucial.

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