Utrecht University

Visitor Mobility in and around Utrecht Heuvelrug

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Introduction

National parks are popular destinations among people seeking leisure and recreation activities. Visitors come to parks to enjoy different kinds of sport, peaceful walks or exciting adventures. While visitors receive private benefits from coming to a park, they also create external costs (Santos et al., 2010). For example, visitors' mobility around a park as well as inside it affects the environment in many different ways. Analyzing the ways in which visitors come to a park for recreation and move within it can help improve the park's infrastructure and management. Moreover, it has great implications for sustainability. For instance, Sustainable Development Goals 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), and 13 (Climate Action) are closely related to the topic of mobility. Therefore, looking at visitors' mobility and finding ways to make it more sustainable have valuable implications for a park and its visitors.

In this research, we will be looking at the mobility of people arriving at Utrechtse Heuvelrug National Park for recreation and work. Our key interest is to investigate various modes of transport used in and around the park and externalities generated by different kinds of mobility. Therefore, our research question is: *what are the externalities generated by visitors' mobility and what can be done to transition towards sustainable mobility?*

While our research question concerns the current mobility of visitors and the impacts it has on the environment, we will also use the collected data to think of suggestions about making the visitor's mobility around and within the Utrechtse Heuvelrug more sustainable. We define sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their needs" (Burton, 1987). However, since the scope of the term sustainability is open-ended and contested, we have decided to focus on the environmental impacts and the ways to minimize them in order to address the problem in sufficient depth. Therefore, in this research paper we refer to bikes and public transport as sustainable modes of transportation since they produce less negative externalities than private motorized vehicles which are considered an unsustainable mobility.

We understand that in order to make a shift to a more sustainable mobility we need to look into people's behaviour and rationale behind their mobility choice (Tang, 2012). However, for our report, motivation will only have an explanatory role and will not be researched in depth. Our focus will be on the space allocated to various mobility modes and the possibility for each transport vehicle to visit the Utrechtse Heuvelrug and make recommendations concerning what can be done to facilitate a more environmentally-friendly mobility.

Reader's guide

The report has five main parts: the introduction to the topic, literature review, methods, results & discussion, conclusion, and relevance & integration. The methods part includes an explanation of various tools and methods used to collect the data. The results part presents our findings combined with a discussion of their possible implications. Finally, the last part - relevance & integration - reviews the main outcomes of our research. The aim of this report is to analyze the current mobility of visitors and its impacts on the environment and present suggestions on making mobility more sustainable.

Literature Review

In the literature review part of our research proposal we will be looking at the following subquestions; ‘What are the negative externalities caused by various mobility modes and where are these impacts felt within and around the Heuvelrug?’ and ‘What is the allocation of space in and around the Heuvelrug?’. This part covers existing literature on the subject as well as some data about the Utrechtse Heuvelrug.

Negative externalities of visitors mobility

Modern day transport has evolved to be as efficient and time saving as possible. Due to faster cars, highways and better train connections it is now easier to travel from one place to another. This has increased the usage of such mobility modes. However, transport still generates many negative externalities. Research by Calthrop and Proost (1998) define these externalities and form a red line throughout this research. In the following figure (Figure 1), these externalities can be seen.

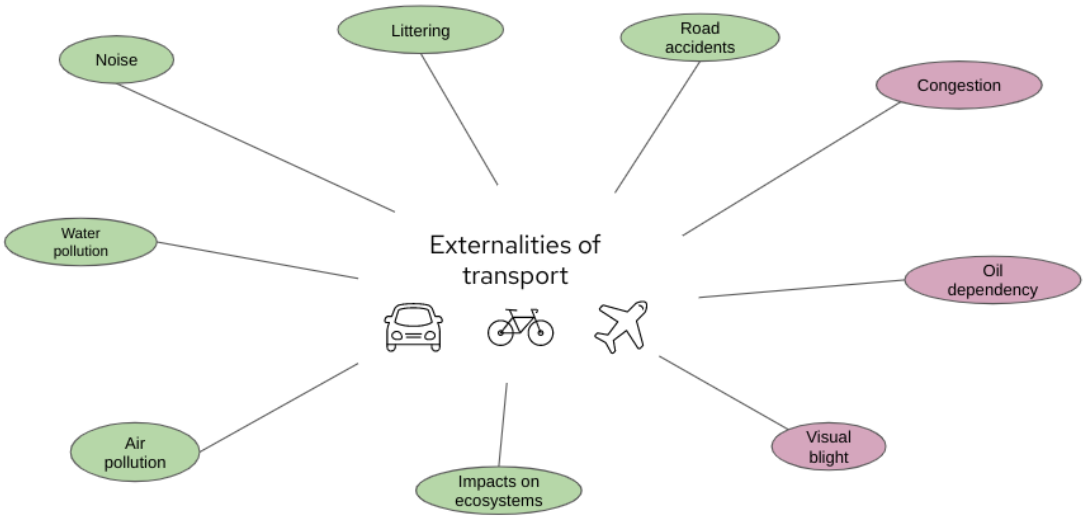

Figure 1: The negative externalities generated by transport (environmental in green and social in purple).

These externalities have many negative effects. For example, habitat quality loss via disturbance is the effect of noise, water pollution, road accidents and local air pollutants. Especially cars, buses and trains generate lots of noise which prevents animals from living undisturbed in their habitats (Reijnen, 1997; Lengagne, 2008). Additionally, these modes of transport produce flows from auto-mobiles, such as motor oil escape and discard, salt-laden run-off from streets, particulate matter, and other air pollutants from exhaust and tire or brake wear (Chatziioannou et al., 2020). This pollutes water systems and disturbs aquatic life (Capolupo, et al., 2020). The dutch hunters association has estimated that around ten thousand animals are involved in road accidents every year in the Netherlands (Jagersvereniging, 2021). This causes many animal deaths, which disrupts ecosystems and biodiversity. Lastly, transport produces emissions, which have adverse impacts on both local and global levels, that add to the greenhouse effect and that are also harmful to animal and human health (Lindsay, et al., 2011). Typical emissions from road transport are: carbon

monoxides, nitrogen oxides and hydrocarbons. These are responsible for 75%, 58%, and 50% of all the respective emanations in the European Union (Chatziioannou et al., 2020). This habitat quality loss via disturbance has negative impacts on biodiversity and ecosystems. Recreation mobility in the park, like cycling, walking, running or horse riding also has negative externalities. For example, erosion of the paths, littering (which happens more when visitors come by car, because they bring more items) or disturbance of other visitors.

There are also social externalities generated by transport that have negative effects. For instance, cars and buses lead to traffic congestion which has many social impacts and also causes even more air pollution (Høyer, 1999). Besides this, countries that import oil are oil dependent due to car and bus transport. These countries are vulnerable to volatile oil prices and oil price shocks (Santos et al., 2010). Another social externality is that roads and parking places are not very pleasing to the eye, especially in a nature park. However, in this research we will not be going much further into these social externalities.
We will only focus on light and noise pollution, littering and congestion.

In the National park, the Utrechtse Heuvelrug, these externalities of transport are felt by the animals that reside around the roads that go through the park and around the parking places. Moreover, people both inside and outside the Utrechtse Heuvelrug are also significantly affected by externalities such as noise and air pollution. For instance, noise pollution can cause health problems such as anxiety and high blood pressure (National Geographic Society, 2019).

The allocation of space in and around the Heuvelrug

The allocation of space in and around the Utrechtse Heuvelrug impacts the choice of the mode of transport for visitors (Garvill, 1999). Therefore, it is important data to gather in order to make the best recommendation for the Utrechtse Heuvelrug, with the purpose to reduce the negative externalities caused by the visitors of the national park. The sub question that will be answered is “What is the allocation of space in and around the Heuvelrug?”. The following data is gathered within and around the national park: walking routes, cycling routes, bus stops and public transport connections.

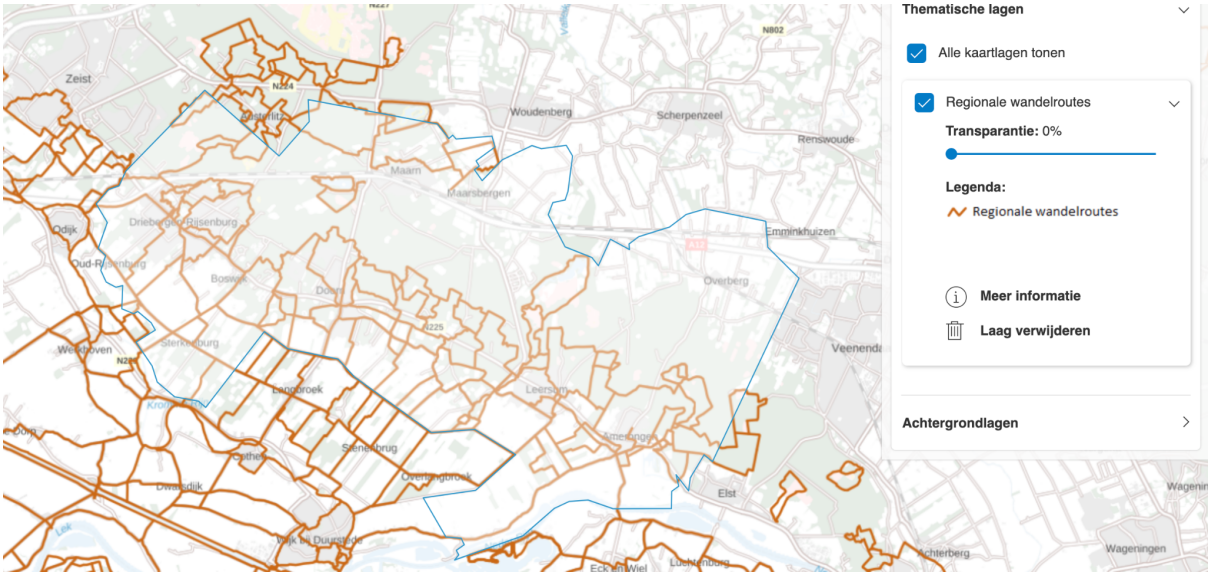

Figure 2: Walking routes within and around the Utrechtse Heuvelrug (Rijksoverheid, 2021)

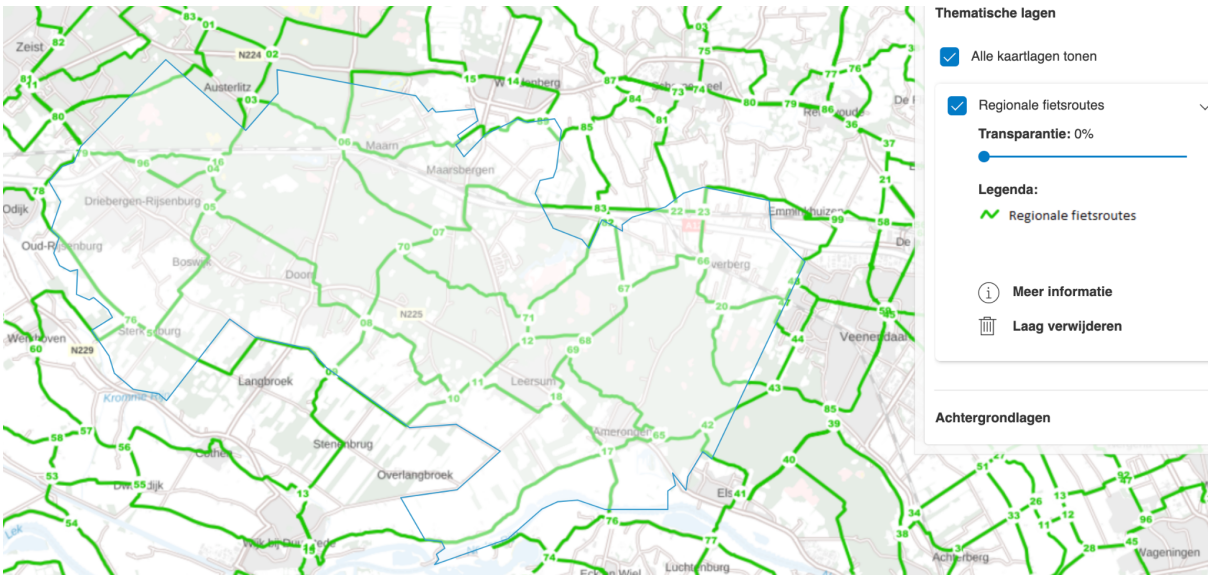

Figure 3: Cycling routes within and around the Utrechtse Heuvelrug (Rijksoverheid, 2021)

Figure 2 provides an overview of the walking routes and figure 3 the cycling routes within and around the national park. There are a lot of routes and all are interconnected, so from every city around the national park there are multiple walking and cycling routes. In total there are 18 walking routes and 3 mountain biking routes prescribed within the National Park (Staatsbosbeheer, 2021), but everyone can make their own route.

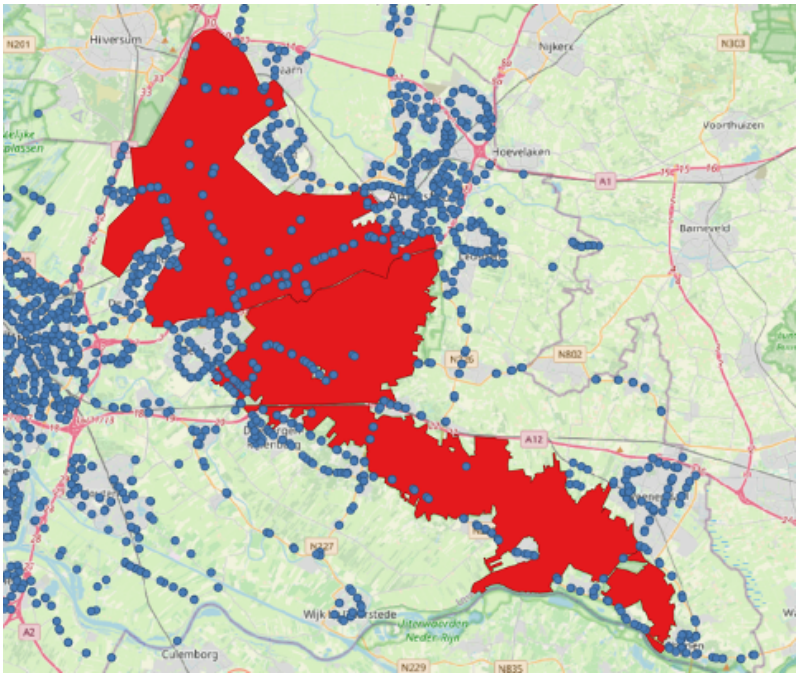

Figure 4: Bus stops around the Utrechtse Heuvelrug (Begemann, 2021) (QGIS team, 2021)

In figure 4 the bus stops around and in Utrechtse Heuvelrug are shown. They also are located nearby some of the walking routes within the national park. This area of the park is influenced by the externalities produced by buses. For example, according to figure 4, a substantial area of the park is impacted by the noise coming from buses.

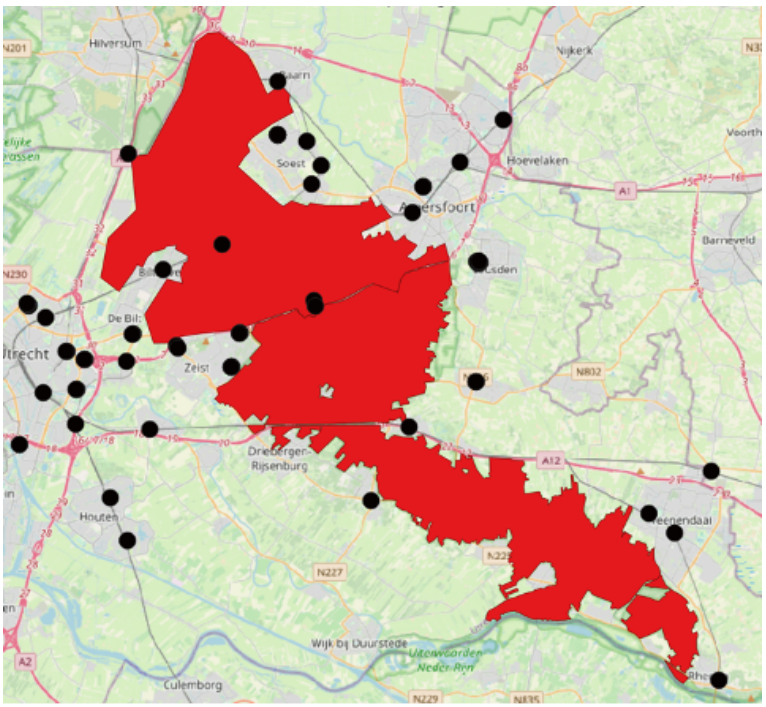

Figure 5: Train connections around the Utrechtse Heuvelrug (Provincie Utrecht, 2021) (QGIS team, 2021)

There are a few train connections around the Utrechtse Heuvelrug (Figure 5). This makes it less attractive for visitors to go by train, however it causes less disturbance for animals. In places around the Utrechtse Heuvelrug there are train connections, which makes it possible to switch from train to bus on these locations.

Methods

In order to answer our research question “what are the externalities generated by visitors’ mobility and what can be done to transition towards sustainable mobility?” in a clear and concise way, we divided our research question into five sub-questions (Figure 6).

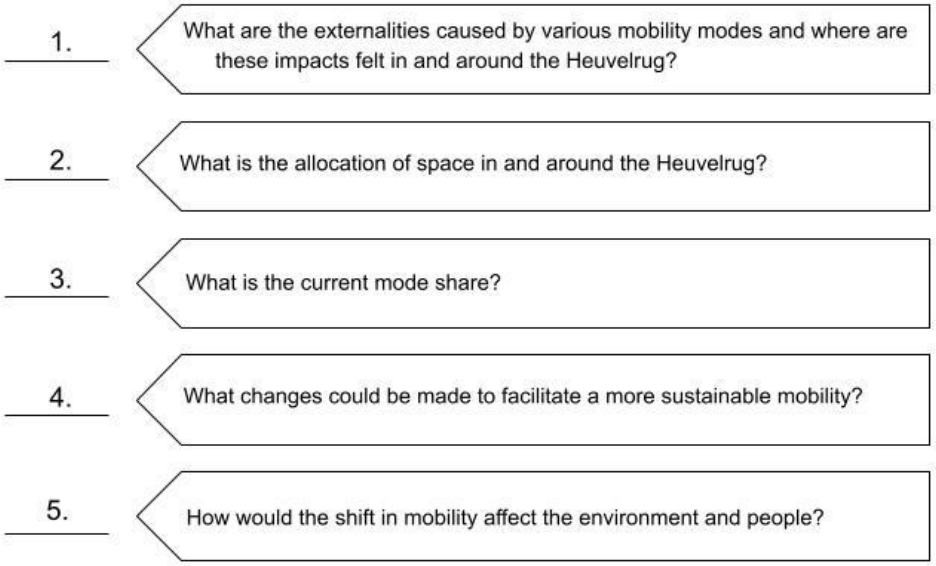

Figure 6: The sub-questions of this research.

To answer these questions, a natural science approach as well as a social approach have been applied. However, it is important to note that the underlying behaviour and motivations of visitors behind their preferred mode of transport are not the main aim of the research, but rather have an explanatory role, since it would go beyond the aim of this research.

Firstly, for our social science method, we researched literature to answer sub-questions 1, 4, and 5. This literature research has been done in the form of a desk study. We specifically sought for scientific articles about visitors within national parks so that we obtained a broader understanding of the possible externalities that are caused by park visitors to answer sub-question 1. For sub-question 4 and 5 we researched scientific articles about possible sustainable adjustments in visitor mobility and the effect that these adjustments have on the environment, this allowed us to get more insight on this topic prior to the fieldwork days. In addition to the literature research for sub-question 1, we have also conducted a face-to-face structured interview (Bryman, 2012) on different locations (Figure 7) within the Utrechtse Heuvelrug during the fieldwork days. We used a stratified sampling technique, a method that divides the subject amongst different sub-groups, and once divided, randomly samples them. This way of sampling ensures that the resulting sample properly represents every subgroup (Bryman, 2012)

By asking park visitors the same set of questions (Appendix A), we were able to gain insight on the various modes of transport used by the visitors – which answers sub-question 3 – and what externalities they feel in the park. In addition, visitors were also asked for their reason for visiting, e.g. recreational or leisure purposes, as the externalities they feel can strongly be influenced by their reason for visiting. For example, a person walking their dog is

less displeased by a group of picnickers listening to music compared to someone reading a book next to that group.

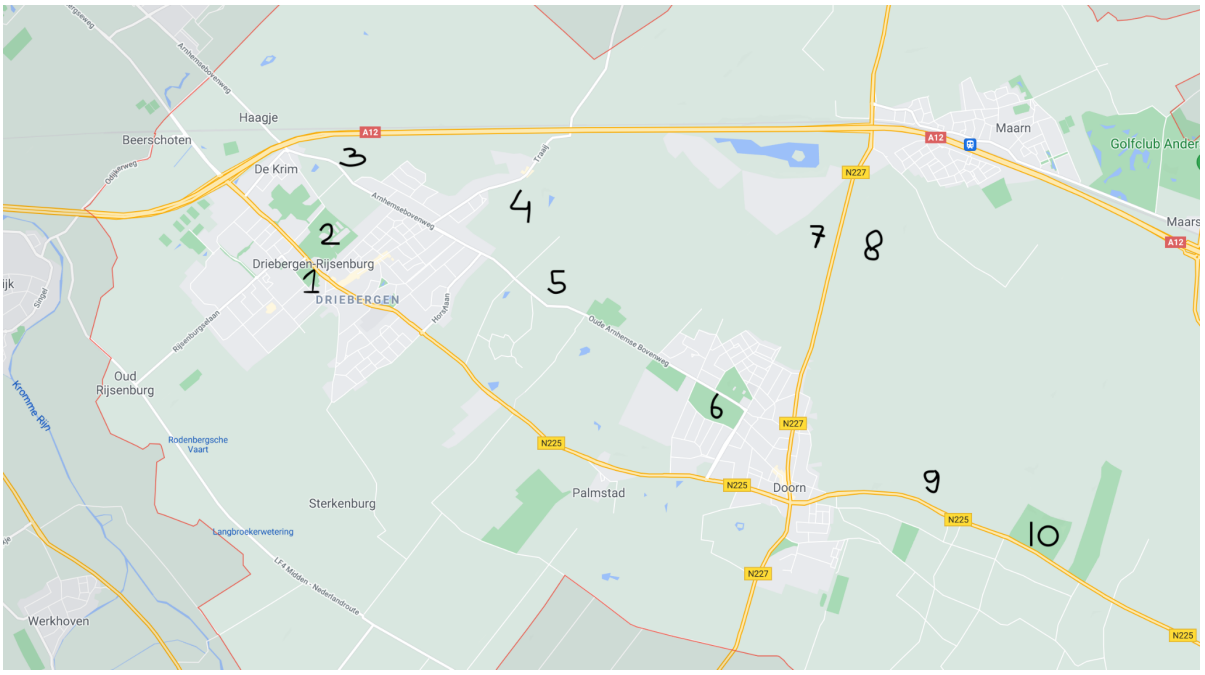

Figure 7: Locations of surveys. 1: Park de Wildebaan, 2: Park Sparrendaal, 3: Grote Boswei, 4: Vennetje het Heihuis, 5: Het grote bos, 6: Ludenbos, 7: Stameren, 8: Het Maarnse bos, 9: Groene entree Kaapse Bossen, 10: Doornse gat.

Secondly, the natural science approach consists of a visual analysis of satellite imagery by using the QGIS program and Google Earth to determine what the space allocation is in the Utrechtse Heuvelrug area. This visual analysis covers sub-question 2. The visual analysis was carried out by looking at the amount of e.g. the walking and cycling routes and bus and train stops, this data was collected mostly through open data sources, including data.overheid and geodata utrecht.

The desk study and most of the meetings were done from home. The survey and mobility flow counts for sub-questions 1 and 3 took place at the Utrechtse Heuvelrug during the fieldwork days in week 22. After the collection of data and literature during the build up of the fieldwork days and during the fieldwork week, as described above, the collected data has been analysed through several processes.

For the first sub-question, a structured interview was taken amongst visitors of the park to collect data on the externalities felt by the park's visitors and link that with their reasons to come to the park. This provided insight in which externalities stand out and who experiences them the most, showing us which areas can be improved upon.
The visual analysis, made in QGIS using open data sources, highlights certain areas that could be lacking in certain facilities, like bus stops, parking spaces for bikes, cars, and/or (school/tourist) buses even though those areas would be needing those facilities based on for example the business of that area. If these facilities are missing, they could affect the choices people make for their transport mode, so changing this could improve the sustainability of the park through making more sustainable options available in all areas. The GIS map presents certain externalities, like light, air, and water pollution, and highlights where these are more and less concentrated. If these externalities are concentrated too much in certain areas, recommendations to adjust this can be made.

The data collected for the mode share is essential to evaluate the impacts of the externalities, because it is weighted against the amount of people that feel the externalities. By using the open data, we could generalise the data for more parts of the park and show the true impact of the externalities.

This research aims to display areas of improvement for the park in the scope of sustainable mobility and management of externalities. Expecting to find lacking facilities in public transport and bike parking spots and clustering of externalities in certain areas, recommendations will be made to address this and minimize the impact. The purpose of this is to increase the sustainability of the national park by increasing sustainable connectivity and management of externalities and to better the experience of the visitors of the park in the long run.

Results and Discussion

Visitor mobility mode

In the survey, people were asked to report all transport modes ever used to get to the park, as seen in figure 8. The car is the most favored mode of transport, yet it does show that people go by bike, foot, and public transport. Contrary to this, the mode of transport at the moment of taking the survey shows less people using the bike, going by foot, or public transport.

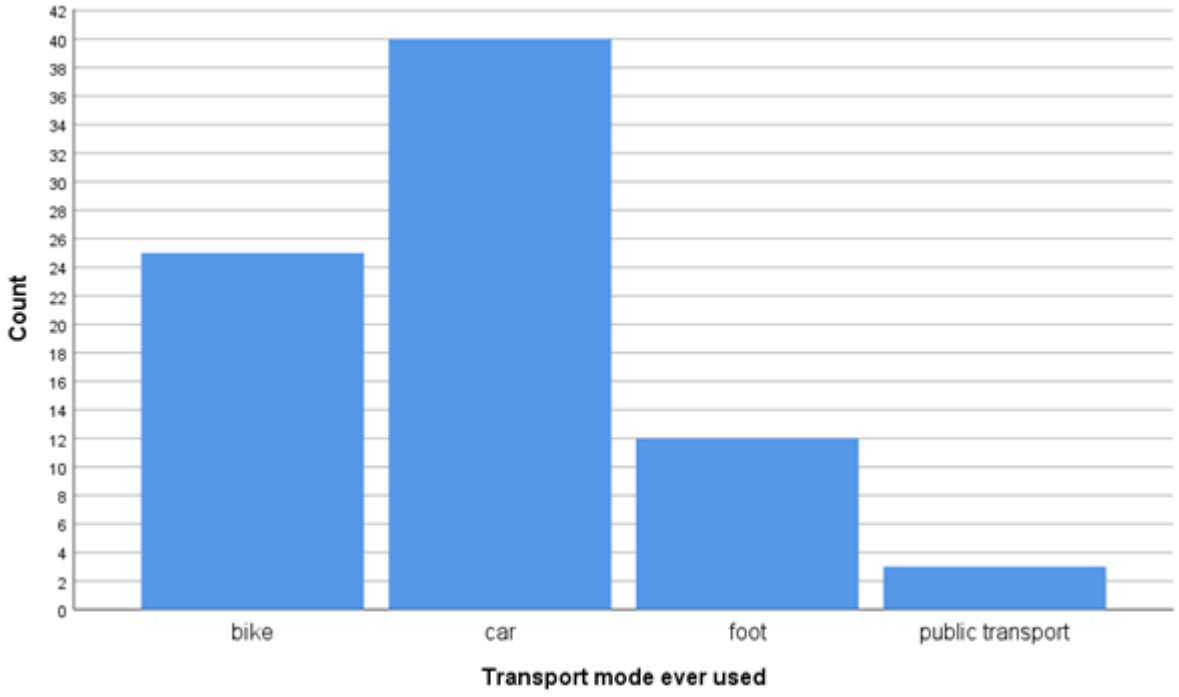

Figure 8: the number of different transport mode ever used to get to the park

When plotting the transport mode against the distance (Figure 9), motorized vehicles (including cars, campers, motorbikes, etc - for 98%, this refers to car usage) are dominantly represented throughout the data and cover the largest range of distances travelled – from 0 up to 105 kilometers. The bike is almost solely used within the 30 km range and by foot only in distances less than 10 km. Outliers here are at 130 km by bike and 70 km by foot, this can be explained by misinterpretation of the question – answering their mode of transport inside the park instead of toward the park – or as stand-alone data points. Public transport is only mentioned in one occasion, therefore nothing concrete can be said about the range in which people consider using public transport.

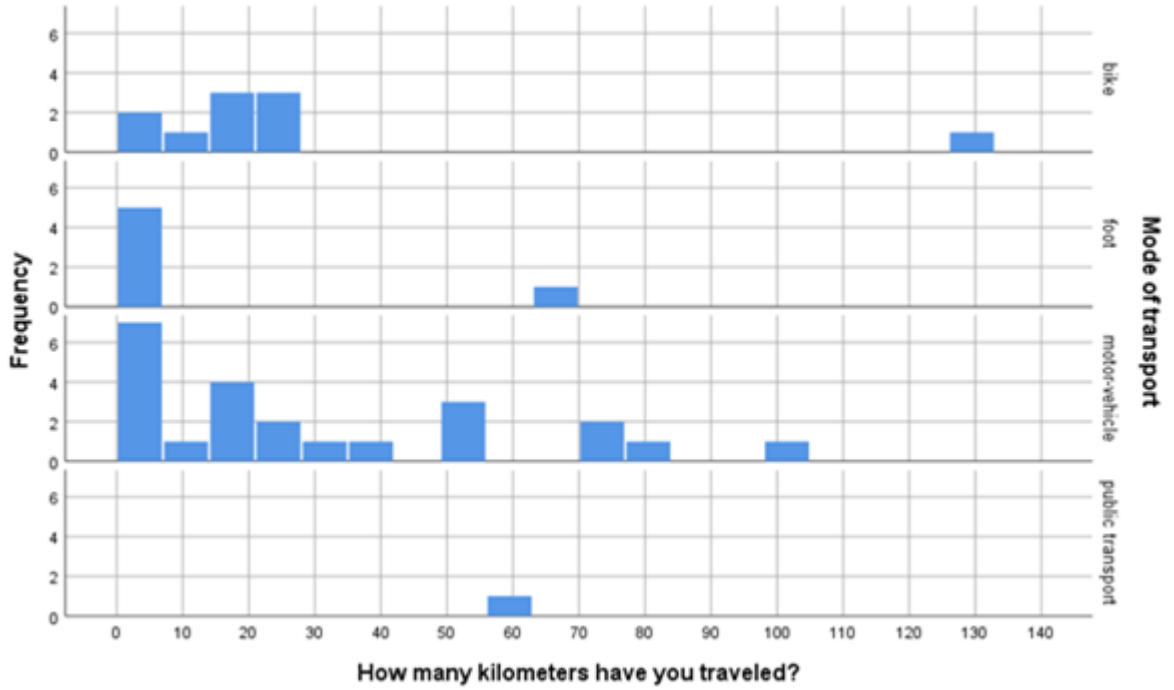

Figure 9: The mode of transport set out against the amount of kilometers traveled

Additionally, figure 9 demonstrates the overall distances traveled – thereby showing that the largest portion travels less than 20 kilometers to the park (65%). Research (Schaap, 2015) shows that people are willing to travel 10 kilometers on a normal bike and up to 30 kilometers on e-bike for leisure activities. See ‘solutions’ for possible incentives for people to come more often by bike.

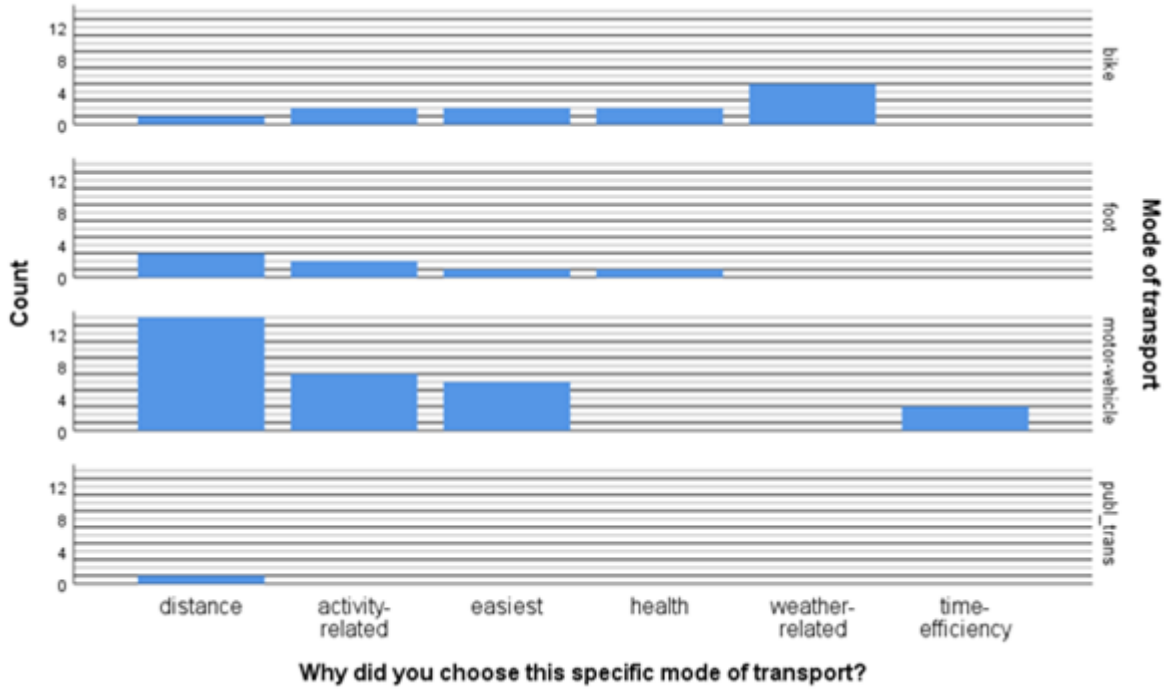

Figure 10: mode of transport set out against the reasoning behind the choice of transport

In figure 10, the mode of transport chosen is set out across its motivation. Standing out is that motorized vehicles are chosen very often due to the distance traveled. Convenience or the activity planned are great motivations for choosing the car. Distance is also presented as motivation to go by foot, however as seen in the previous graph, this is only with distances less than 10 kilometers. The choice to travel by bike seems very weather dependent. Once again, public transport is only mentioned once, therefore it is not possible to say anything regarding the motivation behind the choice of public transport. The reason why people chose public transport over the car was in all 3 instances due to not having a car at that moment in time.

Negative externalities

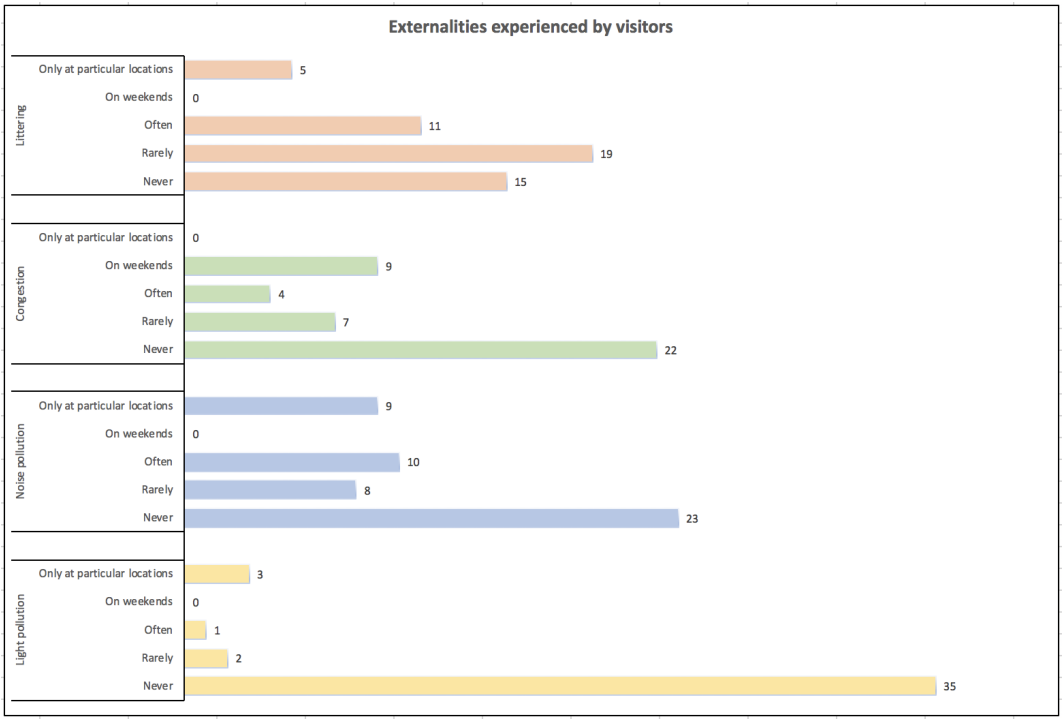

figure 11: externalities experienced by visitors.

Figure 11 shows how often visitors experience externalities such as littering, congestion, noise, and light pollution. There is an unequal number of responses between categories due to some people not being able to answer the question. Nevertheless, according to the figure noise pollution and littering are felt the most, whereas congestion is either prominent on the weekends or not experienced at all. The least experienced externality according to the visitors is light pollution which is understandable considering most of them come to the park during daytime.

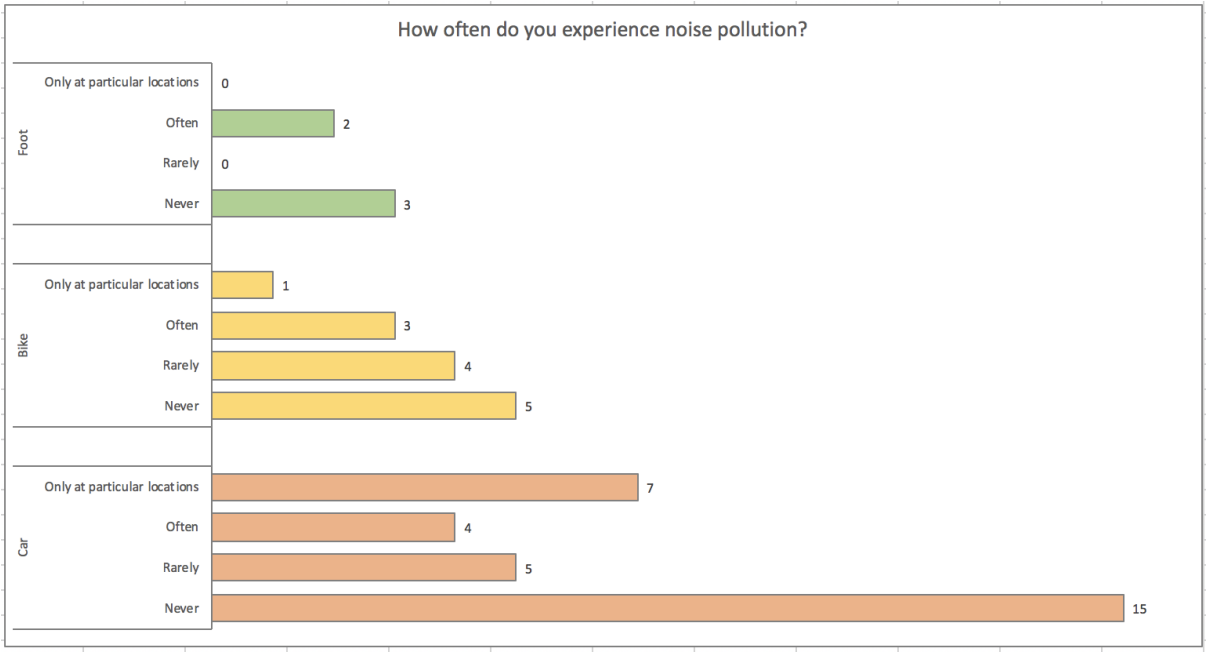

figure 12: perception of noise pollution.

According to figure 12, which shows how often visitors experience noise pollution based on the mode of transport they use, there is a difference in perceptions of noise pollution between people who use cars and those who came by bike or foot. Although there is an unequal number of people in the three categories, we see that people who went by car were much more likely to say that they never experience noise pollution.

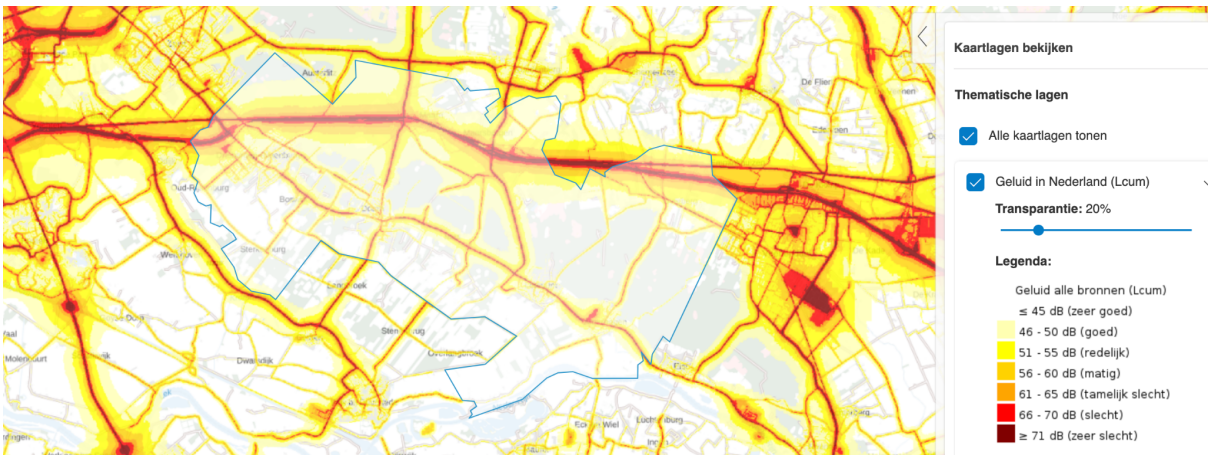

Figure 13: Noise within and around the Utrechtse Heuvelrug (Rijksoverheid, 2021)

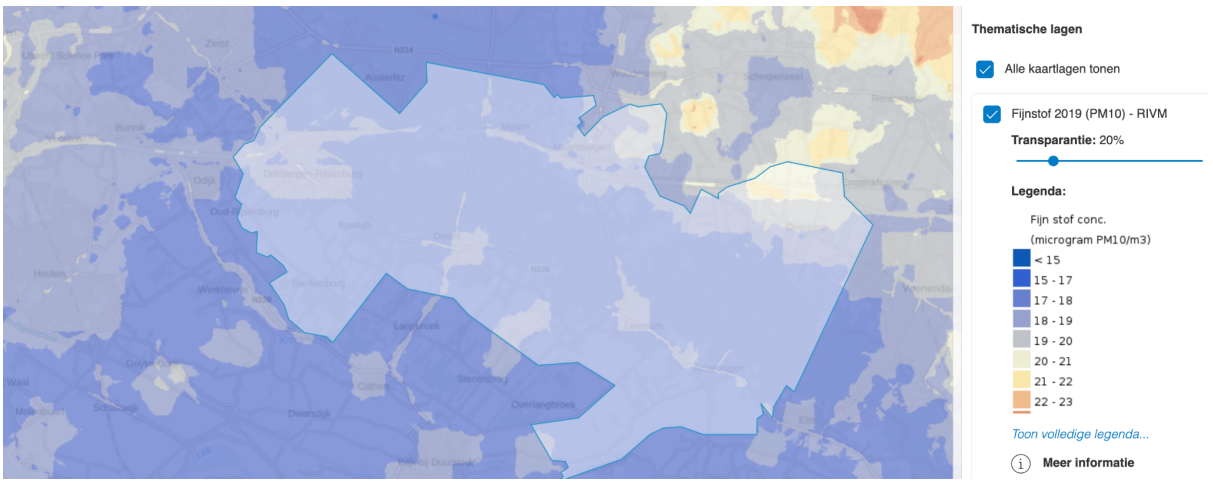

Figure 14: Particulate matter concentration within and around the national park (Rijksoverheid, 2021).

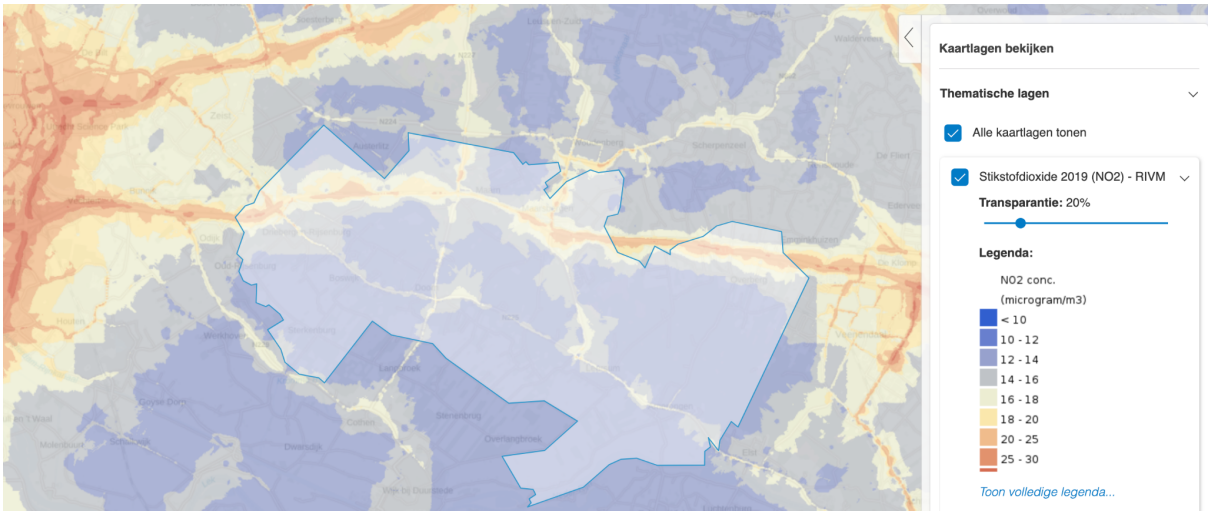

Figure 15: Nitrogen concentration within and around the national park (Rijksoverheid, 2021).

The noise, particulate matter concentration, and nitrogen concentration within and around the national park (figure 13, 14 and 15) are some of the most important negative externalities and are caused by the following modes of transport: buses, trains, and especially motorized vehicles such as cars. The A12, a highway in the Netherlands running from the Hague, through Gouda, Utrecht and Arnhem and towards the border with Germany at Bee (ANWB, 2020), is the main cause for the experienced negative externalities such as noise pollution, particulate matter concentration and nitrogen concentration. In figure 13 it can be seen best, as the red highway through the Utrechtse Heuvelrug, which means the accumulation of sound is bad or very bad in this area. Figure 14 also shows that the particulate matter concentration is 19/20 microgram PM10/m3 in this area, which is a significant amount for a natural park. In the rest of the national park the particulate matter concentration is around 17 microgram PM10/m3. Lastly, in figure 15, the A12 also causes a higher nitrogen concentration than in the rest of the national park. Namely, a nitrogen concentration between 20 and 30 microgram/ m3, while the rest of the national park has a nitrogen concentration between 10 and 18 microgram/ m3.

From the surveys, information can be subtracted whether the statements about the highway being the highest cause of the noise pollution, particulate matter concentration and nitrogen concentration are true. In the survey the question was asked ‘How often do you experience noise pollution?’. About the particulate matter concentration and nitrogen concentration nothing was asked, as this is only relevant if you live in this area and most of the people were coming to the national park only for the day. At locations closer to the highway (A12)(figure 7) people were experiencing more noise pollution than surveys taken at more distance. I.e. at location 3 (Grote Boswei) 3 out of 4 people were experiencing noise from the highway. And at location 4 (Vennetje het Heihuis) 2 people (3 people not) were experiencing noise from the highway. This is relatively more than at the other locations, so the surveys strengthen the statement that the A12 causes the most noise pollution.

As can be seen in figure 12, most of the visitors who come to the park by car say that they never experience noise pollution. According to Wells and Xenias (2015), cars can be seen as a “personal security pod” or a protective cocoon i. e. a personal space which serves as a protection from the outside world. Modern vehicle manufacturers strive to create a cocooning space by introducing “cocooning” technologies which isolate a driver from the world and externalities. For example, many brands of cars advertise their cars with messages like: *“Our interior designers have skilfully evolved the car’s cabin to produce a stylish yet cocooning space. Incredible attention to detail has gone into making the cabin as quiet and refined as possible”* (Bentley Continental GT) and “*Inside it’s like being cocooned in your own convivial private sanctuary”* (Rolls Royce Ghost). Arguably, the experience of cocooning makes people bond with their cars more and it makes the externalities such as noise pollution less noticeable. However, more research into this topic is necessary.

Environmental and health effects

Lastly, we look at the sub question 5: “how would the shift in mobility affect the environment and people?”. As was discussed in the literature review, some transport modes, most notably private cars, have a significant impact on the environment by generating negative externalities such as air pollution, noise, and water pollution. As can be seen from our research, most visitors of Utrecht Heuvelrug use cars as their main mode of transportation (figure 8) due to a variety of reasons. Although the negative externalities are not always felt by visitors, they do cause significant harm to the national park. Therefore, a shift in visitors’ mobility is essential for sustainability and health of the park. This shift can be achieved by promoting soft mobility which includes different forms of non-motorized transportation (NMT) (Rosa, 2010) such as cycling, walking, and using small-wheeled transport (e.g. skateboards and skeelers). Soft mobility is regarded as sustainable mobility since it produces zero emissions. Therefore, by encouraging visitors to use NMT, the park would significantly reduce local pollution as well as greenhouse gas emissions. Moreover, it would decrease levels of air and noise pollution, traffic congestion, and road accidents. As can be seen in figures 12 and 14, externalities such as noise pollution and nitrogen concentration are mostly felt around highways (e.g. A12) which disrupt wildlife and visitors. Therefore, discouraging visitors to come by car would decrease the effects of the externalities in the areas of the park which are located near the roads.

Since visitors come to Utrecht Heuvelrug mostly for recreation purposes (67,9%), it is important to minimize negative externalities, especially noise pollution, so that people can enjoy their visit. According to WHO (2017), noise from transport creates the highest negative health impact. Hence, switching to soft mobility would create health benefits for people living

in or visiting Utrecht Heuvelrug. Furthermore, it would result in healthier lifestyles for visitors since soft mobility uses only human energy. Physical activity has significant benefits both for physical and mental health. It helps prevent diseases such as cancer, diabetes, and cardiovascular diseases (*Physical Activity*, 2020). Therefore, it is in the interest of visitors to switch from unsustainable mobility to soft mobility both for environmental and health reasons.

Solutions

In the survey participants were asked if they could think of ideas to make visitors use motorized vehicles less often when traveling to the Utrechtse Heuvelrug. Their answers have been mapped into a word cloud (Figure 16). The word cloud shows what visitors think could be a way to reduce the number of people who come to the park by car. The most common suggestions were to improve public transport, reduce the number of parking spots for private cars, and create more and better secured parking spaces for bikes. Other ideas include making better bike paths, renting bikes, and promoting public transport.

Figure 16: word cloud of how visitors think the park can reduce the choice of visitors to go by car.

The first main solution focuses on public transport. In the survey, we asked the respondents if they considered the Utrechtse Heuvelrug to be easily accessible by public transport. As seen in figure 17, many people said they did not know how accessible the park was by public transport (42,00%) or that they thought it was not accessible enough (36,00%). They added remarks about it being too long of a walking distance, that it takes more time, or that it was not an option due to their personal circumstances or planned activities, such as wheelchair accessibility or taking bikes with them. The group that said it was not accessible pointed out that the connection was not regular and frequent enough and the connections were not well organized. Only a relatively small portion said the connections were good enough (22%).

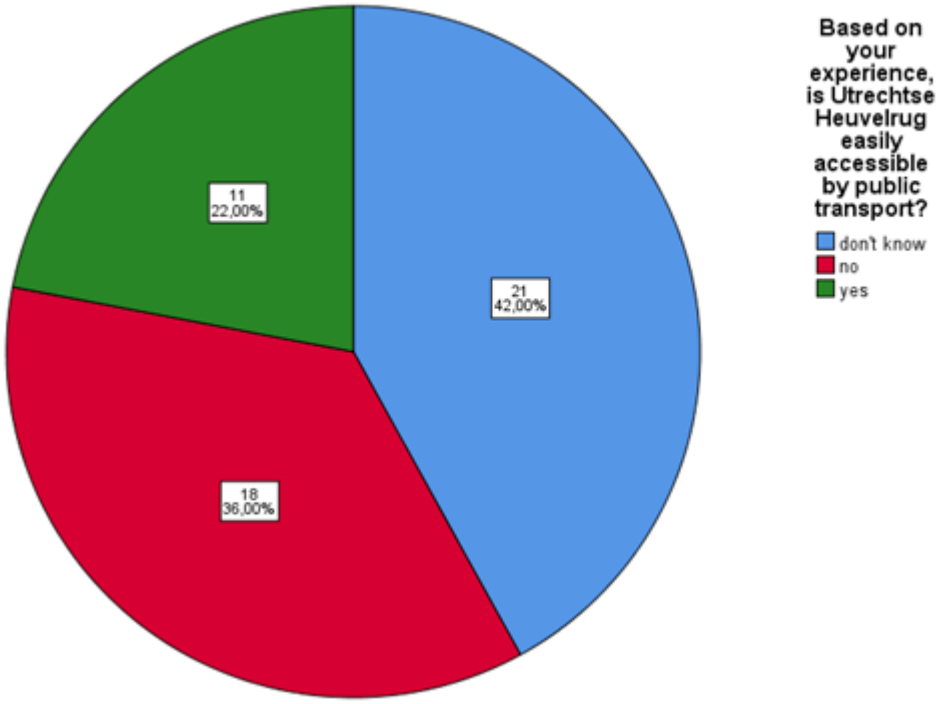

Figure 17: pie chart of how easily the Utrechtse Heuvelrug is accessible by public transport.

According to Google Maps, to go from Utrecht Centraal to Utrecht Heuvelrug (for example, Zanderij Maarn) on a regular afternoon, it takes about 1 hour 10 minutes to go by bike, 1 hour 10 minutes by public transport, and only around 25 minutes by car. As can be seen in figure 18, there are three possible routes one of which makes a big loop by going through Amersfoort which makes the journey quite long and inefficient. The fastest and most convenient route would be the one that is highlighted blue in the figure. However, the time between the buses in this route is approximately 30 minutes which means that the route can take 30 minutes longer than expected due to the waiting time.

figure 18: how long it takes to travel to Zanderij Maarn by public transport.

Besides public transport taking a long time, another reason that influences a person to take a car over public transport is the walking distance. The walking distance is the distance between the bus/train stop and the final destination of the traveler. After research, the consultancy firm Groep Planning has concluded that within a range of 300 meters, public transport is used 3,5 times more compared to the general range of 700 meters (Desmedt et al., 2020). Figure 19 shows the bus-stops in the Utrechtse Heuvelrug with a 300 meter radius added to them. It is clear that if visitors desire to go in the heart of the park, they would have to walk way further than 300 meters. Surely, the walking distance differs per person and their reason for visiting, however for this research it has been decided to follow the 300 meters range. Therefore, one of the solutions for less motorized vehicle use by visitors would be to improve on the public transport system; either by more bus stops, more frequent busses, or better connections from the train station.

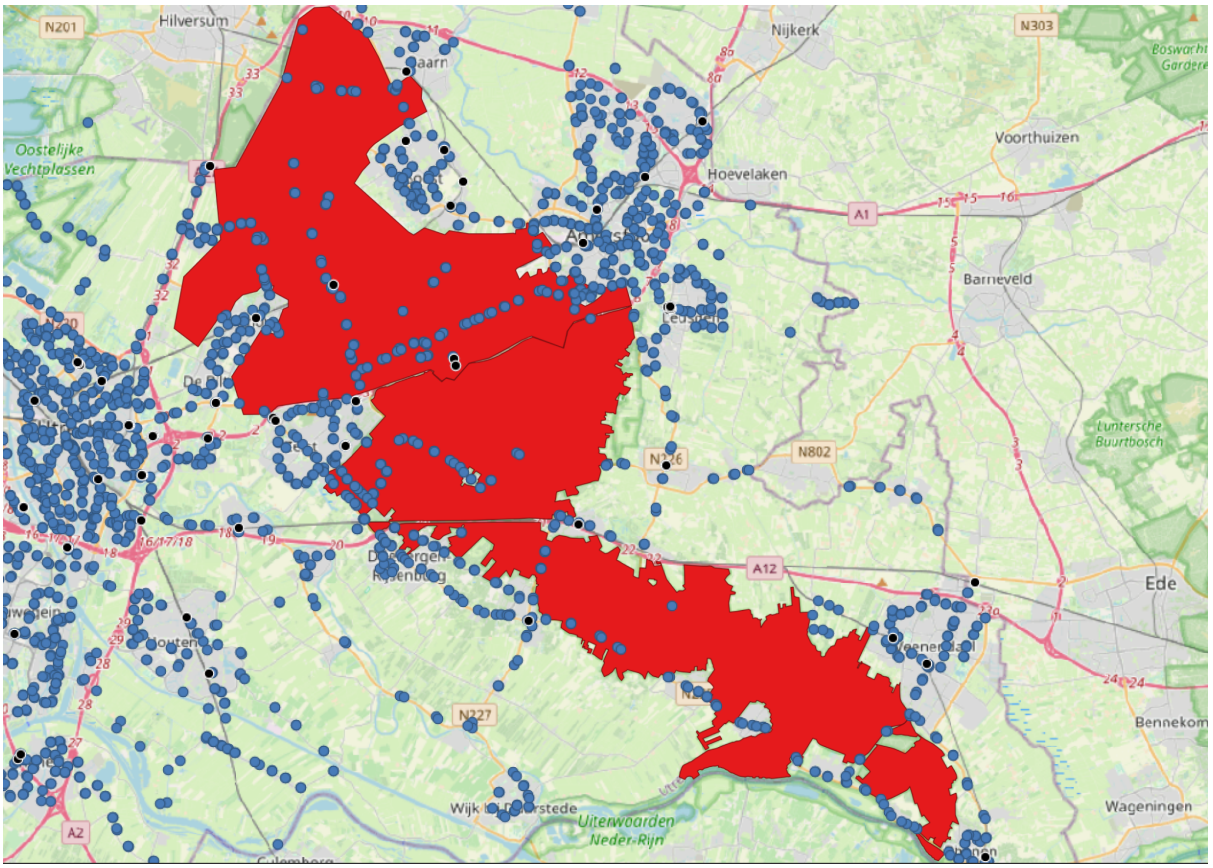

Figure 19: map of public transport connections with a 300 meter radius surrounding them. Includes bus stops (blue) and train stations (black).

Furthermore, the second main solution focuses on the parking spots for private cars in the Utrechtse Heuvelrug area. This solution logically follows when trying to reduce motorized vehicle usage; if it becomes more difficult to park your vehicle near the park, visitors would not be incentivized to use a motorized vehicle as their main mode of transport. In addition, reducing parking spaces will also help with cutting down emissions (Stecker, 2011). Some might argue that reducing parking spaces is not a feasible solution, however during the corona-crisis the Utrechtse Heuvelrug already closed down the parking spots in

order to limit and prevent visitors to come by car (Nationaal Park Utrechtse Heuvelrug, 2020).

Lastly, another solution for reducing motorized vehicle use by visitors would be to install secured parking places for bikes. In the survey, participants were asked if they thought there were enough parking places for bikes (Figure 20). This question shows that most people think there are enough bicycle parking places or they don't really know and have never thought about it. Only about a quarter of the visitors that were surveyed thought that there were not enough bicycle parking places. However, interpretation of the participant is an important factor for this question, as some participants did not only think of designated bike parking spots, but also parking possibilities against a tree for example. Therefore the data obtained through this question might not be 100% reliable.

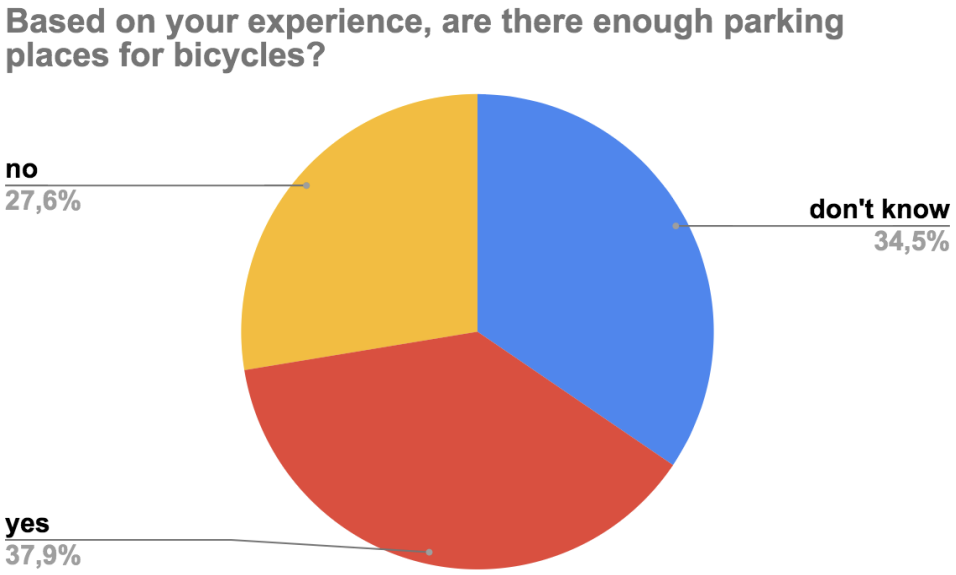

Figure 20: pie chart of visitor's experience on bicycle parking places.

Then, the participants were asked questions to inform a potential explanation why people prefer the car over the bike by looking if parking the bike is an issue. As portrayed in the graph of figure 21, quite a few participants say that there are not enough parking spaces for bikes (42,5%), especially people that live rather close to the park itself. The amount of parking spots, therefore, could be a limiting factor for people to go by bike.

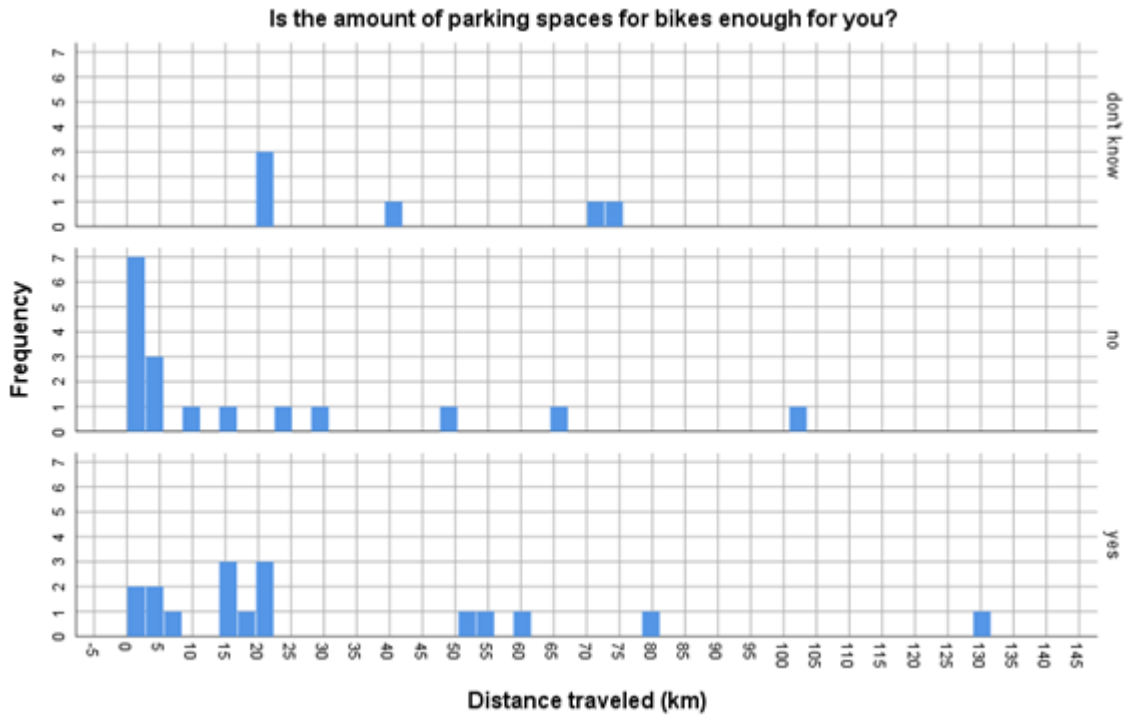

Figure 21: the opinion on the amount of parking spaces set out against the distance traveled.

But when looking at the potential change when offering secured parking spots, many participants say that it would not change their transport mode (Figure 22). Only 5 participants said they would come more often by bike, explaining that they have either an expensive race bike or an e-bike: “Definitely, we have e-bikes.”. But because secured storage spaces are not available throughout the entire park, people that would only come when they can store their bike in a secure spot are not represented in the available data and therefore this gives a skewed view of reality.

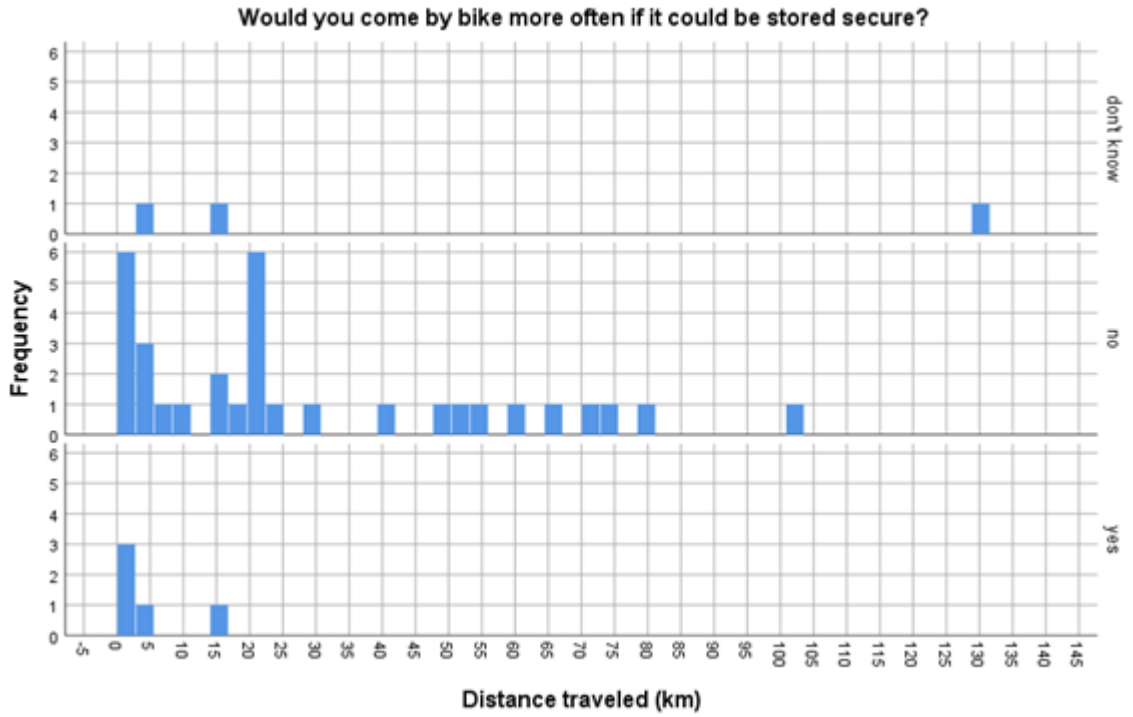

Figure 22: traveling by bike if it is stored secure set out against the distance travel

There were also limitations to our survey. Firstly, there was not a lot of variety in the age of the surveyed people. We did not ask for people's age, but most of the people we surveyed seemed to be older than fifty. This makes our sample not representative of the usual visitor demographic of the Utrechtse Heuvelrug. We should have taken this into account when selecting visitors to survey and we should have added the question of age to the survey to see if there is a relationship between certain answers and the age of the surveyed visitors. Secondly, some of the questions we asked were too broad. This resulted in very long answers and a lot of work in categorizing these answers. It did, however, make room for creative suggestions about, for example, how we can make the park more sustainable. Thirdly, we should have done our surveys in more different locations. This way we could have given a better and more detailed answer to our subquestion about the allocation of space in the park. With more survey-answers in other locations about the externalities we could have mapped where the externalities are felt in a more detailed way. Lastly, the data did not cover enough modes of transport. We did not survey anyone that came to the park by mountain bike or horse. As these modes of transport bring externalities with them (as mentioned in the literature review: erosion of the paths and disturbance of other visitors), it would have been interesting to see how they experience the externalities they bring with their mode of transport.

Conclusion

Going back to our research question which is “What are the externalities generated by visitor mobility in Utrecht Heuvelrug and what can be done to transition towards sustainable mobility?”, we identified that the negative externalities generated by visitor mobility in the Utrechtse Heuvelrug are mostly noise and light pollution, littering, and congestion.
From the surveys the conclusion can be made that the negative externalities such as noise pollution and littering are felt the most among the visitors. Noise pollution is mostly generated by motorized vehicles such as cars which are used the most by visitors. Noise pollution is mostly felt near the A12.

There are different reasons behind visitors' choice of transport such as convenience, distance and weather. As has been found from the survey, people are most likely to use cars in general. Below 20 kilometers people choose the bike or go by foot, when it is suitable for the weather and the activity, but above 20 kilometers the distance becomes too large for many to travel by bike. In order to transition towards more sustainable mobility, it is important to look into the motivations behind visitor’s choice of transport. However, it was not the main aim of our research. Therefore, further research into the rationale behind mobility choice is necessary for a successful transition from environmentally harmful modes of transport to sustainable ones.

The results provide the following recommendation to the national park. Firstly, public transport should be improved regarding frequency and bus-train connections. This way, the park will be easier accessible by public transport and it will become more attractive for visitors to go by public transport instead of less sustainable transport modes. Secondly, parking spots should be reduced in order to limit and prevent visitors from coming by car. Thirdly and lastly, secured bike places should be installed to encourage visitors to come by bike.

To conclude, analyzing the current visitors’ mobility in and around Utrecht Heuvelrug allowed us to investigate externalities generated by it and understand what should be done in order to achieve a more sustainable Utrecht Heuvelrug. A transition towards sustainable mobility is essential and can be achieved by following the recommendations mentioned in the report.

Relevance & Integration

In this section, we explain the relevance and importance of our findings. Firstly, the results helped us better understand the current mobility mode of people arriving to the park for recreation and leisure, the impacts it has on the environment, and how they are felt around and within Utrechtse Heuvelrug. Based on the gathered data, the most common transport mode among visitors is a car and the negative externalities that are felt the most by visitors are noise pollution and littering. Since motorized vehicles are the mode of transport which generates the most externalities and disturbs many visitors by producing noise, we concluded that for the park to become more sustainable a modal shift is necessary. It can be achieved by improving public transport, and changing the allocation of parking spots.

However, in order to be able to make additional recommendations for the Utrechtse Heuvelrug and its visitors, an interdisciplinary approach is necessary. For instance, besides natural sciences which tell us about the externalities generated by different transport modes, we need to involve social and behavioral studies to understand the motivations and preferences of people. There is a clear connection between our subtopic, which is called “visitor mobility”, and the subtopic 2F “mobility preferences of Heuvelrug users” which focuses more on the social and psychological aspects of the problem. Moreover, our topic is closely related to the subtopic 5C “Sustainable Mobility in the Region”. In order for the Utrechtse Heuvelrug to achieve climate-neutrality by 2035, visitors’ mobility should be closely investigated. Combining the findings of different groups would allow us to have a greater picture of the mobility in and around Heuvelrug as well as envision more sustainable mobility and ways to achieve it.

There is also a broader and more global relevance of the topic to a sustainable future. In order to achieve targets 11.2, 11.6, and 11.a of the Sustainable Development Goal 11 and mitigate Climate Change we have to ensure less polluting and harmful modes of transportation. While visitors’ choice of transport to a National Park such as Utrechtse Heuvelrug may seem insignificant, it cannot be ignored. Even a small contribution to sustainability matters. By making recreation and leisure activities less environmentally harmful, we can move towards a sustainable future.

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Appendix A

Survey

Introduction to the survey

Hello, my name is …
We are students at Utrecht University, and we are conducting a study on mobility of visitors of the Utrechtse Heuvelrug. Our research is intended to understand the reason to use current mobility modes within and around the park and negative externalities generated by them. Our final aim is to give suggestions on how to change the allocation of space within the national park to make visitors' mobility more sustainable.

Would you agree to participate in our survey? (If they agree to participate, continue reading)
Thank you for agreeing to participate in our survey.

The survey consists of -- brief questions and will take around 10 minutes. All data collected in the survey is confidential and will be used anonymously.

- Do you have any questions about this?
- Do you give permission to record and use your answers for our research?

Thank you in advance for your time and effort and let's start with the interview!

Survey questions

What do we need to know, and in what order?	**What question will be asked to the participant?**	**What answer does this question produce?**
Understand the important/relevant (relevant to sustainable mobility) differences among the people in our sample. The distance the respondent had to travel to come from the Utrechtse Heuvelrug. Gives insight on their preferred mode of transport.	**How many kilometers did you travel to come to the Utrechtse Heuvelrug?**	Open question Bar chart and divide in categories
Gain insight on space allocation. Come with 4 people by car: only takes up 1 parking space. Come with 4 people by bike: takes up 4 bicycle parking spots	**With how many people did you come to visit Utrechtse Heuvelrug?**	Open question

Gain insight on visitor's reasons to visit Utrechtse Heuvelrug and understand why they use certain modes of transportation?	**What are the reasons you come to the Utrechtse Heuvelrug?** Work / recreation	Open question
Understand how often the respondent visits the park. If the respondent is a frequent visitor they might have their typical mode of transport, whereas if they are a first-time visitor from far away they most likely went by car.	**How often do you visit the park?**	Open question Bar chart? Divide categories
With what mode of transport the respondent came to the park.	**Which mode of transport have you used to arrive at the park?**	Bar chart
Respondent might name impacts	**Why did you choose this specific mode of transport?**	Open question Reasons for choice
Gain insight on respondent's usual mode of transport	**Which modes of transport have you ever used to come to the Utrechtse Heuvelrug?**	Bar chart
Gain insight on respondent's reasons for using a certain mode of transport depending on certain conditions. Weather could impact the respondent	**In which circumstances do you choose which mode of transport?**	Open question Reasons for choice

to use a car instead of a bike.		
Gain insight on respondent's reasons for using a certain mode of transport depending on their activity	**Does your choice of transport differ depending on the type of activity you're coming here to do? If so, how does it differ?**	Open question Reasons for choice
What externalities does the respondent feel and where?	**Where and how often do you experience noise pollution?**	Open question
What externalities does the respondent feel and where?	**Where and how often do you experience congestion?**	Open question
What externalities does the respondent feel and where?	**Where and how often do you experience light pollution?**	Open question
What externalities does the respondent feel and where?	**Where and how often do you experience littering?**	Open question
What externalities does the respondent feel and where?	**Do you experience any other negative externalities? Where do you experience these?**	Open question Pie chart if lots of same answers
How often people experience problems with public transport and whether it prevents them from choosing this mode of transport.	**Based on your experience, is Utrechtse Heuvelrug easily accessible by public transport?**	Yes, No Pie chart
How often people experience a shortage of parking places for bicycles and whether it prevents them from choosing this mode of transport.	**Based on your experience, are there enough parking places for bicycles?**	Yes, No Pie chart
Gain insight on visitors' willingness to change their preferred mode of transport (if it is not by bike already) to bicycle if their bicycles	**Would you come by bike more often if there were secured parking places for bicycles?**	Yes, No Pie chart

were secured.		
What would visitors themselves suggest in order to make car usage less frequent?	**How can the national park reduce the choice of visitors to come by car?**	Open question Different solutions
What would visitors themselves suggest in order to make visitor mobility in Utrechtse Heuvelrug more sustainable?	**How can we change visitors' mode of transport to become more sustainable?**	Open question Different solutions Bar chart?

Appendix B

Data Management Plan

The primary objective of this study is: to find out how we can make the Utrechtse Heuvelrug more sustainable. To go about this, we will be surveying visitors of the Utrechtse Heuvelrug to collect data. The data will give us a better view on the mode share in the park, externalities of transport and the allocation of space. To collect this data, we will use google forms and then we will transfer the data to an excel file.

subjects	volume	data capture tool	format	file type	storage space
human	< 100	google forms	-	quantitative	0 GB
human	< 100	excel	.xlsx	quantitative	0-10 GB

Personal data will not be collected, but the data will still only be accessible by the group members and the supervisor.

The data and documentation will be stored in online documents that all the group members can access on teams in files.

Question	yes	no	N/A
Do you use a certified Data Capture Tool or Electronic Lab Notebook?		x	
Have you built in skips and validation checks?		x	
Do you perform repeated measurements?		x	
Are your devices calibrated?		x	
Are your data (partially) checked by others (4 eyes principle)?	x		
Are your data fully up to date?	x		
Do you lock your raw data (frozen dataset)		x	
Do you keep a logging (audit trail) of all changes?		x	
Do you have a policy for handling missing data?		x	
Do you have a policy for handling outliers?	x		