Exploring positions of key stakeholders towards the application of measures to counter peat oxidation in the province of Groningen

Bachelor Project

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Author: Jort van Galen Last

Student number: S3426769

Supervisors: Drs. Jacco Kuper and Dr. Ir. Terry van Dijk

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Abstract

The Netherlands contains many peat areas, in which peat is oxidizing as a result of low water levels, which are needed to make these areas suitable for agriculture. Peat oxidation is responsible for 4% of the total CO2 emissions in the Netherlands, and it causes land subsidence, which is especially a problem in a low-lying country like the Netherlands. Therefore, measures to counter peat oxidation should be taken, and the Dutch government set money aside to do so. In the existing academic literature, some measures that could theoretically prevent peat oxidation are found. However, research into the feasibility of these measures is lacking. This paper explores the positions of the most relevant stakeholders towards peat oxidation, to identify how the issue can feasibly be tackled in the province of Groningen. This is investigated in the form of interviews with the most important stakeholders. The results show that awareness about the issue is increasing, and that cooperation between different stakeholders is key in developing a strategy to tackle the issue. Moreover, it was found that farmers are currently hesitant to switch to modes of production with higher water levels, because of a lack of knowledge regarding the profitability of these business models. Further findings include ways to stimulate the application of measures to counter peat oxidation, such as by providing subsidies and improving awareness among farmers that raising water levels may also be beneficial for them.

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1. Introduction

The Netherlands contains many peat areas, although a lot of peat has been lost in the past hundreds of years. A part of this peat reduction, about 1/3rd, was caused by the historical excavation and successive burning of peat (Erkens et al., 2016). However, the lion share (2/3rd) was lost due to peat oxidation, caused by lowering water levels to make peat areas suitable for agriculture (ibid). When water levels are lowered in peat areas, the peat comes into contact with air and consequently, it oxidizes. More than 75% of the Dutch peat areas are used for agricultural purposes, so peat oxidation occurs on a large scale in the Netherlands (Van den Akker et al., 2010). Peat oxidation has effects on both the local and the global level.

On the local level, it causes land subsidence in the peat areas themselves, increasing problems regarding water management (Erkens et al., 2016). This is especially a threat in a low-lying country like the Netherlands, with more than a quarter of the country already lying below sea level (ibid). In some places the land subsides by up to 1-2cm per year, causing severe damage to (foundations of) buildings and infrastructure (Brouns et al, 2015). Besides, peat oxidation causes large height and wetness variations on the parcels of farmers, which causes their lands to become less arable. If a part of a plot is too wet, crops may start rotting, while too dry soils can also be problematic (Van den Born et al., 2016).

On the global level, peat oxidation forms a problem because it causes the emissions of large quantities of greenhouse gases, thereby contributing to climate change (Erkens et al., 2016). On average, peat areas in the Netherlands are estimated to emit 22,6 tonnes of CO2/hectare/year, similar to the total CO2 emission of an average Dutch household. In total, this amounts to 7 megatons of CO2 in the Netherlands, which is 4% of the total yearly CO2 emission in the Netherlands (van der Aa et al., 2019). A significant share of these peat lands is located in the province of Groningen.

Figure 1 shows the expected land subsidence in the province of Groningen until the year 2050 (Deltares et al., 2019). In Groningen, land subsidence caused by peat oxidation is amplified by land subsidence resulting from gas extractions. In the figure, the large yellow-orange areas are mainly the result of gas extractions, whereas the effects of peat oxidation are mostly visible in the red-purple areas (with land subsidence up to >60cm).

It has become clear that preventing peat oxidation will reduce problems on the local level and can contribute to reaching climate goals by mitigating the emission of greenhouse gases (Leifeld et al., 2019). The Dutch national

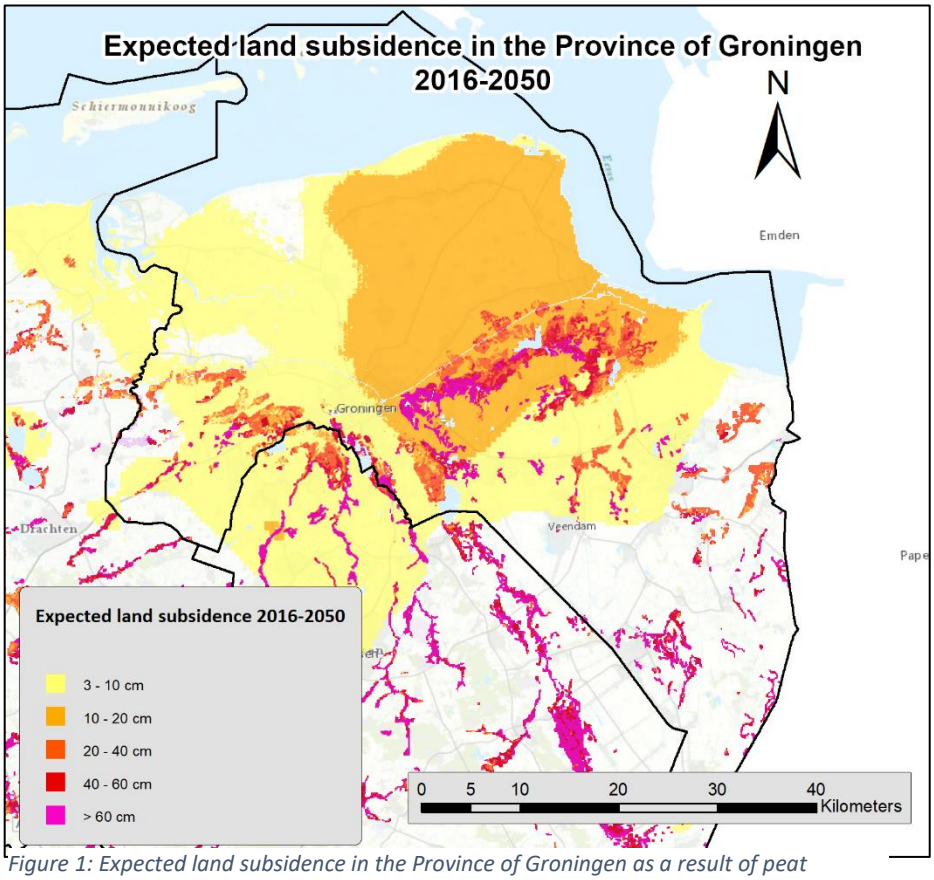

Figure 1: Expected land subsidence in the Province of Groningen as a result of peat oxidation and gas extractions. Map developed by Deltares, Alterra & TNO for "Klimaateffectatlas" (2019). Map edited by the author.

government already set aside 276 million euros for the period 2020-2030, to achieve a 1,0Mton reduction in yearly CO2-emissions in peatlands in the year 2030 (Rijksoverheid, 2019).

Various studies have been conducted into theoretically possible measures to counter peat oxidation (e.g. Tata, 2019; Ferré et al., 2019; Van den Born et al., 2016). Examples of such measures include a land-use change to nature or the application of paludiculture: the cultivation of crops that grow well on land with high water levels, such as cattail and cranberries (ibid). Nonetheless, there is a lack of research about which of these measures would be supported by relevant stakeholders, or under which conditions they would be supported. These stakeholders may all have different interests and positions regarding the issue of peat oxidation, which makes countering peat oxidation a complex issue.

This paper aims to add a new dimension to the existing academic literature, by exploring which measures to counter peat oxidation would be feasible in the province of Groningen. The main research question that follows from this is:

- What measures to counter peat oxidation are feasible in the province of Groningen?

This research question is divided into multiple sub-questions:

- To what extent is there awareness about the issue of peat oxidation among main stakeholders in the province of Groningen?
- What are (according to the literature) common measures to counter peat oxidation?
- What are the positions of relevant stakeholders towards the application of these measures?

First, in the theoretical framework, the current literature on measures to counter peat oxidation, the different possible interests of stakeholders and a possible approach to the issue will be discussed. Then, the methodology that was used will be explained and justified. Subsequently, the results are presented, followed by some concluding remarks.

2. Theoretical framework

2.1 Measures to counter peat oxidation

One of the possible measures to counter peat oxidation is to introduce paludiculture: the cultivation of crops that grow well on wet (peat) lands. By applying this, the peat will not get into contact with air as the soil is kept wet and the water level high, while the area can still be used for agricultural purposes (Tata, 2019; Burger et al., 2019). Paludiculture is still extensively investigated, mainly because there are uncertainties about the (im)practicalities that come with the cultivation of paludicultural crops such as reed, cattail, and cranberries (see Innovatie Programma Veen, 2019; Burger et al., 2019).

Other possibilities include the construction of solar parks on peatlands while keeping the water level in these peatlands high (Burger et al., 2019). This could form a profitable business model for farmers or other entrepreneurs (ibid). Furthermore, it would be possible to change the function of the land to a nature area or water buffer zone (ibid). In nature areas, the water level can be kept high and the area could be used for other (potentially recreational) purposes (Van den Born et al., 2016).

All these measures focus on raising the water level, but Hoogland et al. (2019) found that this may not be effective in countering peat oxidation in every location, because other factors such as soil moisture and soil composition also influence the oxidation of peat. A relatively new measure, based on moistening the soil, is underwater drainage (Hendriks & Van den Akker, 2018; Burger et al., 2019). These underwater drains foster the infiltration of water into peatlands during dry periods (thereby slowing peat oxidation), whereas they prevent the lands from becoming too wet for agriculture in wet

periods (ibid). However, it should be noted that knowledge on this measure is still under development (Burger et al., 2019; Grootjans et al., 2019).

2.2 The different roles and interests of stakeholders

The province is largely responsible for spatial planning in rural areas and partly for water management (Van Dijk et al., 2019), so they are an important stakeholder. The province is also partly responsible for executing the climate mitigation (CO2 reduction) and adaptation goals (Rijksoverheid, 2019), so they could have a strong interest in countering peat oxidation and could be willing to (co-)finance measures.

The water boards are responsible for water management, together with other stakeholders, and they are responsible for facilitating a change in water level (Van Dijk et al., 2019), so they are also important in applying measures to counter peat oxidation. Besides, they face increasing costs for water management as the land subsides, because water must be pumped out of deeper lying areas (Van den Born et al., 2016). Thus, they could also have a financial interest in countering peat oxidation.

Farmers are very relevant stakeholders, as they own most land in peat areas and are largely the ones to decide what type of land-use they will practice on their fields. They are also the group experiencing the local effects of peat oxidation, such as land subsidence (Van den Born et al., 2016). For farmers, countering peat oxidation may be a tough consideration. On the one hand, farmers want to stay profitable right now (Rois-Díaz et al., 2017), but they may also see that keeping a sustainable and profitable business model may become harder as land keeps subsiding (Van den Born et al., 2016).

The views of different farmers towards peat oxidation varies, as these are largely based on farmers' personal values and awareness regarding issues like climate change and keeping the "natural" peat landscape (Hyland et al., 2015). Rois-Díaz et al. (2017) found that the tradition in the family or region is a very important factor in deciding what type of farming is practiced, independent of whether this tradition is more focused on sustainability or on more conventional types of farming.

There are different factors influencing farmers' awareness about climate change. Carlton et al., (2015) investigated whether farmers had become more aware of climate change after the drought of 2012 in the US, but found no significant change in climate adaptation attitudes before and after this drought. Niles et al., (2016) found that a lack of knowledge among farmers about issues regarding climate change may partly explain why farmers do not apply measures to counter it. However, even when farmers are willing to adopt measures, there is a discrepancy between the intention to implement more sustainable practices and the actual implementation of these measures (ibid). The actual adoption of measures is strongly related to the perceived ability of farmers to make a significant impact on the global scale (ibid). This suggests that, in many cases, simply educating farmers about climate change will not help. Instead, fostering the feeling that farmers have the capacity to make a significant contribution to counter climate change may result in an actual change of behaviour (ibid).

2.3 Complex issues require stakeholder involvement and area-specific approaches

The large number of stakeholders who all have their own interests, make countering peat oxidation a complex issue, especially since attitudes largely vary between different farmers as well. The uncertainties regarding the effectiveness of some measures in countering peat oxidation further complicate the issue. In tackling such complicated issues, De Roo (2003) argues for an area-based approach, involving all stakeholders. Hereby, cooperation and negotiation are key to balance out the differing interests, to eventually achieve an approach to countering peat oxidation that is acceptable to most parties. For this to work, there should be willingness among all stakeholders to tackle peat oxidation in the first place (see Beunen et al., 2014), whereby awareness about the issue is crucial

(Niles et al., 2016). By applying an area-specific approach, the local circumstances and stakeholders in different places are considered (see also Boer & Zuidema, 2014, in their approach to a more sustainable energy landscape). For countering peat oxidation, this implies that no single set of measures will be applicable in every location.

2.4 Conceptual model

The conceptual model (figure 2) shows the main line of reasoning that is used in this paper, based on the theoretical framework. First, the theoretically possible measures to counter peat oxidation are identified based on literature. Then, by gathering data, the positions of the different stakeholders regarding the issue and the factors that could influence these positions are identified. This is the main focus of this research. Subsequently, cooperation between the stakeholders, taking into account their different positions and local circumstances, will lead to feasible measures to counter peat oxidation.

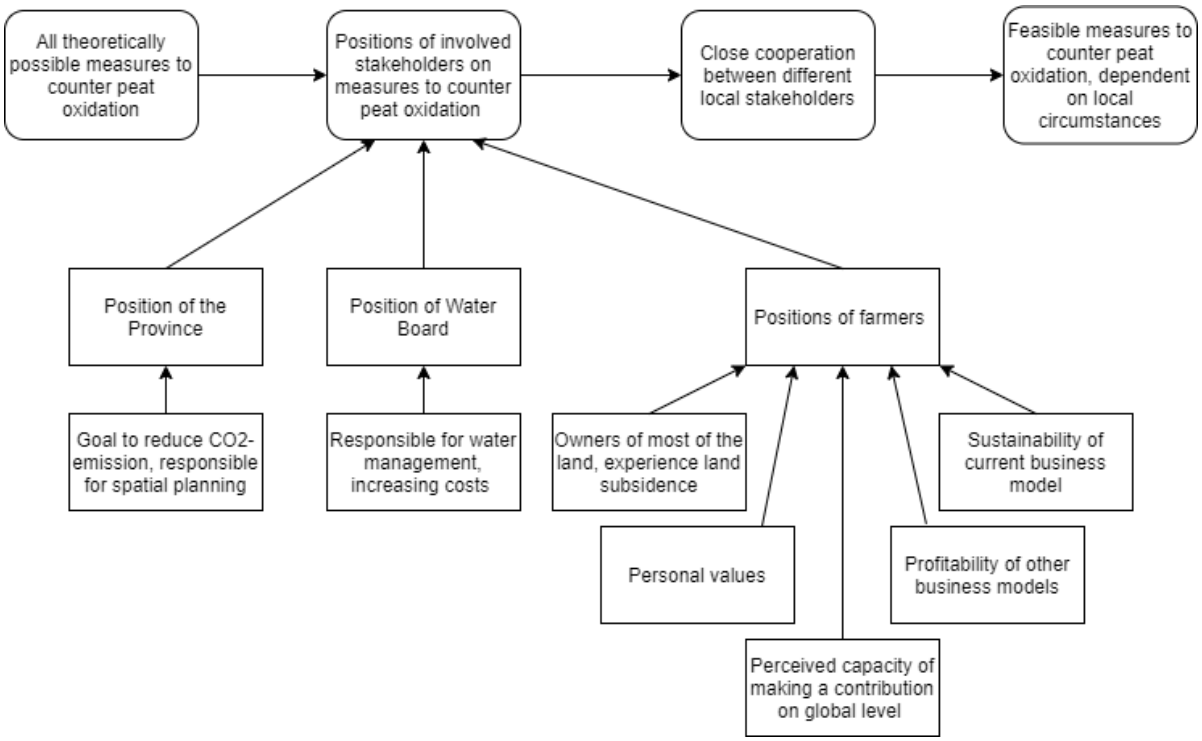

Figure 2: Conceptual framework, based on literature used in the theoretical framework.

2.5 Hypotheses

As this study mainly has an explorative character, no explicit hypotheses are formulated. However, some expectations can be established. Based on literature on the implementation of other climate-mitigation and -adaptation measures relating to agriculture, it is expected that many farmers probably have two roles regarding the issue: they earn their money by cultivating crops on their farmland, but they are also likely to live in the areas most affected by the land subsidence. Thus, it can be expected that they have at least some interest in mitigating the effects of peat oxidation, although this should be combined with a profitable business model (Rois-Díaz et al., 2017). Furthermore, the positions of different farmers are expected to vary as they are influenced by many different factors. Besides, it is expected that the complexity of the issue and the large number of stakeholders involved will require an area-specific approach involving all stakeholders (De Roo, 2003; De Boer & Zuidema, 2014).

3. Methodology

This research aims to identify the positions and deeper reasoning behind opinions of stakeholders. A quantitative research method would not be fitting to this research goal (Punch, 2014). Thus, to be able to capture the complexity of the issue, semi-structured interviews were conducted among the most relevant stakeholders.

3.1 Approaching respondents and the format of the interviews

An employee from the water board Hunze en Aa's and one from the province of Groningen, both with knowledge regarding peat oxidation, were approached through the internet and through the personal network of the researcher.

Initially, the plan was also to conduct interviews with multiple farmers who own land in peat areas, by going out into the field. However, this could not be done due to the outbreak of the corona virus. This required a change in research design: instead of going to farmers themselves, the interests of farmers were represented by conducting interviews with two people that have been actively engaged in issues in the agricultural sector for many years, including peat oxidation, and thus have a lot of knowledge about the different interests of farmers. They were found through the internet.

Due to the corona crisis, the semi-structured interviews had to be conducted through the phone. The interviews were led by questions asked by the interviewer, but the interviewees were also given the space to go off the exact topic of the question. This flexibility allowed interviewees to reveal new perspectives/insights that may not have been discovered if 'structured interviews' would have been performed (Punch, 2014). Unstructured interviews would also not be appropriate for this research, as this would have resulted in messy data whereby the connection between findings of the different interviews would be lacking (ibid). Furthermore, this would have made it hard to compare the answers of the different respondents.

The interviewees were asked questions regarding their view (and the view of the group they represented) on peat oxidation, their awareness about measures to counter peat oxidation and their willingness to implement these measures. The interview guide that formed the backbone of the interviews can be found in Appendix 1. It is important to note that large parts of the interviews did not only pertain to these questions, as the interviewees were given space to bring up other things that they deemed important or relevant.

3.2 Reflecting on validity, reliability and reproducibility

It should be noted that qualitative methods have their limits, mostly regarding external validity (Punch, 2014). The results from this research may be very context-specific and can thus not be generalized to other cases (Longhurst, 2016). Because of the small sample size (N=4), statistical analyses would not be useful. However, qualitative methods can reveal new insights that could also be true in other cases, and thus form the basis for further (possibly quantitative) research. Regarding the internal validity of this research, the findings of this research only reflect a part of the reality that was studied. Understanding the *full* reality would require an innumerable amount of interviews with all stakeholders regarding peat oxidation, which is not feasible (Punch, 2014).

The same questions were asked to all interviewees as a basis, which makes the data of the different interviews inter-comparable and partly reproducible if another researcher were to use the same interview guide. However, the results of the research also depend on the amount of flexibility the researcher allows during the interviews. As mentioned earlier, during this research, the researcher allowed a considerable amount of flexibility to reveal parts of the story that might have gone unnoticed otherwise. Regarding the reliability over time, it is likely that findings would differ if the

interviews would be performed again in a few years, because knowledge on (countering) peat oxidation is rapidly evolving.

3.3 Ethical considerations

Before the interviews were conducted, interviewees were informed about their rights (e.g., interviewees can decide to withdraw from the research at any time before publication) and they were asked if they agreed with the interview being recorded. The researcher also clearly stated his role as an independent observer, trying to reveal the opinions and positions of stakeholders and the reasoning behind that, without judging these opinions or conveying any messages from third parties. Interviewees were also asked whether they would like to receive (a summary of) the final research, in order to allow them to fully know how their contribution has been used. Finally, the names of all interviewees were anonymised and information that could lead readers to personal information has been removed or anonymised.

Different stakeholders often have opposing opinions regarding policies and measures, which can sometimes create tensions between them (see for example Beunen et al., 2014). If this research would only focus on getting an overview of which stakeholders would be willing to execute certain measures and which would not be, this could increase tensions between stakeholders (if, for example, only one stakeholder would not be supportive of taking certain measures to counter peat oxidation). However, by conducting in-depth interviews, this research also tries to understand the reasoning behind the positions and opinions of stakeholders, and under which conditions they would be willing to take measures. Thus, this research could actually reduce tensions between the different stakeholders by improving understanding among them of each other's positions on the topic. In this way, the research could help facilitating a meaningful dialogue between stakeholders and take away (possibly false) assumptions made by the different stakeholders about other stakeholders.

3.4 Analysis of the interviews and answering the research questions

Four interviews have been performed, an overview of the respondents and the dates of the interviews can be found in Table 1.

Table 1: Overview of respondents and dates of interview

Respondent	**Date of interview**
Employee from water board Hunze & Aa's	31-03-2020
Employee from province of Groningen	02-04-2020
Farmer, also chairman of ecology/nature-oriented farmers organisation	30-04-2020
Representative from LTO Noord (Agriculture and Horticulture Organisation)	26-05-2020

After the interviews had been conducted, the recordings were transcribed into text, after which they were analyzed using codes. These codes allowed for easier interpretation of the data and were used to search for patterns in the interviews. As this research is mainly explorative in nature, it used inductive coding to analyze the data. This means that the data was analyzed using codes that were developed on the basis of the qualitative data itself, instead of using a predefined set of codes (Punch, 2014). The main code groups that were used were "stakeholders", "causes of peat oxidation", "effects of peat oxidation" and "measures against peat oxidation". These groups all included several codes (e.g., for "stakeholders" this were "province", "water board", "farmers", etc.) which resulted in a clear overview of the results of the different interviews.

4. Results

In the following sections, the findings of the interviews are presented and discussed in relation to the literature. This is done based on six main themes, some of which are divided into sub-themes.

4.1 The heterogenous water and peat systems of Groningen

Currently, no measures specifically against peat oxidation are being applied in the province of Groningen. All interviewees noted that other provinces such as Friesland and Noord- and Zuid-Holland are ahead of Groningen in applying measures to counter peat oxidation. In some of these provinces pilots are being done, for example with underwater drainage, whereas others already have full policy instruments in place that compensate farmers if they apply modes of production whereby peat is preserved.

However, the types of peat areas and related water systems in Groningen differ substantially from those in the other provinces. Besides, within the province of Groningen there are also large differences between the types of peat landscapes and between the thickness of the peat layers. Figure 3 illustrates this heterogeneity in peatlands in the province of Groningen.

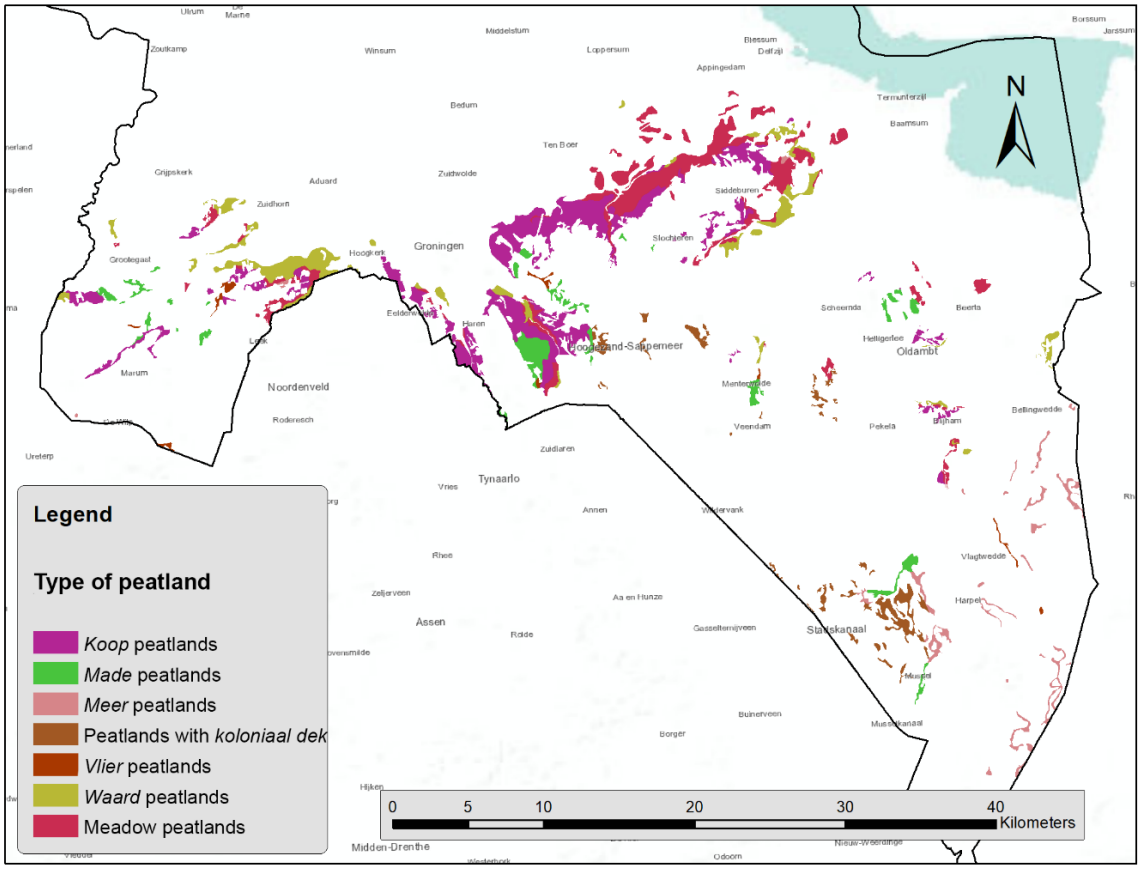

Figure 3: Map showing the heterogeneity of peatlands in the province of Groningen. Edited by the author, based on "Bodemkaart van Nederland" developed by Alterra (2019). The Dutch parts of the names of peatland types are put in italics.

Friesland, Noord-, and Zuid-Holland mainly have peat meadow systems, which have relatively homogeneous peat distributions within a certain *peilvak* (a demarcated area where the same ground water level is maintained by the water board). These peat meadow areas also exist in some parts of the province of Groningen: they can be found near the Zuidlaardermeer and in the “Lageland” area East from the city of Groningen (see figure 3). In these areas, similar measures could be applied as are applied in the other provinces.

However, as was mentioned by the civil servants from the province and the water board, in the South-Eastern part of Groningen, the peat lies on top of the Pleistocene sandy dune structure, causing large differences in the thickness of peat layers, and large differences in height once the peat has oxidized. Also, when the peat has disappeared in these places, sandy soils will remain that are less capable of retaining water, increasing the chance of drought-related problems for farmers. These more heterogeneous peat soils require a different approach than the one used in peat meadow areas.

All interviewees noted that it may be impossible to save all the peat in Groningen from oxidizing, because in certain parts the peat areas are very thin or capricious. Thus, it makes sense to make a sort of cost-benefit analysis to find out where the peat is most worth saving. Besides, it was noted that many of the thick peat layers in the province of Groningen are located in the lowest-lying parts of the province, creating increased flood risks as the peat is oxidizing. This can be seen in Figure 4, which shows the location of peatlands in Groningen on top of the altitude map. Most peatlands are located in the blue zones, which are the lowest parts of the province, lying at depths up to 3 meters below sea level.

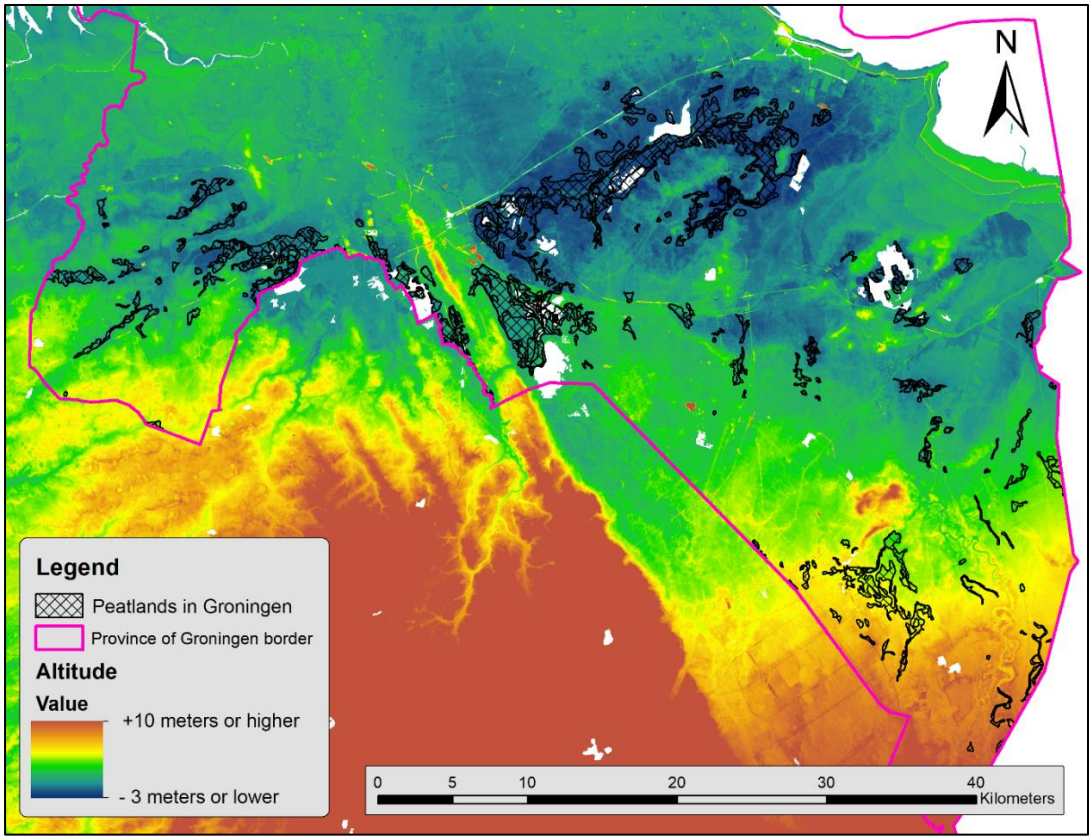

Figure 4: Peatlands of Groningen on top of altitude map. Created by the author, based on "Bodemkaart van Nederland" (Alterra, 2019) and "AHN3" (Actueel Hoogtebestand Nederland, 2019).

The water board and the province of Groningen are currently closely cooperating to find focus areas, where the peat is most worth saving. In doing so, they also want to involve other stakeholders, such as landowners (mostly farmers) and other societal parties.

4.2 Increasing awareness about peat oxidation

All interviewees noted that the awareness about peat oxidation and climate change has increased throughout the last years among stakeholders, which has led to a discussion about the fundamentals of Dutch water management.

A common catchphrase from the Dutch water boards is “water level follows function” (*peil volgt functie)*, implying that the water level is there to facilitate the function of the land. For illustration, this means that if a plot is used for the cultivation of potatoes, the water level in that plot is lowered to the level that works best for potatoes. The current policy on water levels in peat areas is called “water level indexation” *(peilindexatie)*, whereby the water level is further lowered periodically, to stay the same relative to the subsiding surface. This would in turn cause further peat oxidation and land subsidence, after which the water level must be lowered even further (Van den Born et al., 2016).

That is why there is a general discussion going on about whether “water level follows function” is a sustainable way of operating in peat areas. This is a tough discussion, because the opposite, “function follows water level”, would imply that many farmers must substantially change their land use and business model to fit to a higher water level. The employee from the water board said the following about this discussion:

> *“We would like to start a dialogue with the [people in] the area, to look at possible land-use forms in a non-traditional way, and also to see if the traditional draining standards that we [water boards] have to adhere to can be called into question.”*

From the interviews with the farmers’ representatives, it became clear that farmers have also become increasingly aware that the land is subsiding, and that their current agricultural practices may be impossible to sustain on the long term as peat is disappearing and their lands are becoming increasingly wet or dry.

Furthermore, they noted that awareness of climate-related issues especially increased after the droughts of 2018 and 2019, even though views between farmers still largely differ (see also Hofstee, 2020). This notion contrasts research by Carlton et al. (2015), who did not find a significant relationship between adaptation attitudes from farmers before and after the drought of 2012 in the US. This difference could be caused by differing attitudes in different geographical contexts (US vs Western Europe) and by the fact that one dry year can be seen as coincidence, whereas multiple consecutive years of drought may indicate a pattern.

4.3 If there is awareness about the issue, why is no action being taken?

Even though the farmers’ representatives noticed that awareness about issues surrounding climate change and peat oxidation is increasing, most farmers are still rather hesitant in changing their business models to more sustainable modes of production.

The cultivation of cattail or cranberries, or applying paludiculture, would theoretically allow for a combination of crop cultivation with a higher water level (Tata, 2019; Burger et al., 2019). However, this would require a huge change of farmers’ business models. The interviewed farmer noted that many farmers with land in peat areas currently use their land for cattle breeding or dairy farming, which is a completely different branch of farming that requires different knowledge and different tools (machinery, storage units, etc), compared to paludiculture. Such a change is not considered feasible by many farmers or does not even cross their minds.

He also noted that even if the idea to switch to other modes of production pops up into the minds of farmers, they are faced with large uncertainties regarding the profitability of these modes of production, whereas they require a certain confidence that such business models are profitable. This is in line with findings by Rois-Díaz et al. (2017), who found that confidence in profitability is a key factor in determining farmers willingness to switch to more sustainable modes of production. When the farmer was asked about the reasons that farmers are currently not applying any modes of production that would help countering peat oxidation, the following came up:

"Then there would have to be a serious economic perspective in it. And if you look at the current ground prices, I do not believe that the cultivation of for example cattail is economically viable. As a government, you would have to create very good preconditions, to make such modes of production interesting to farmers or other entrepreneurs".

Besides the insecurities regarding the profitability of these new business models, both the farmer and the representative from the LTO noted that also the (im)practicalities of these new modes of production are not very well-known. For illustration, the farmer noted that cattail cultivation caused a decrease in water quality in a pilot in Noord-Holland, and the representative from the LTO commented that the cultivation of cattail had struggled with geese eating the crops in another pilot project (see Innovatie Programma Veen, 2019).

4.4 How to start action?

4.4.1 Cooperation is key

All interviewees clearly stated that close cooperation between the most important stakeholders is absolute key in developing a plan of action for the peat areas in Groningen, and all parties said that they were very willing to cooperate. The representative from the province stated:

*"We want to make a plan of approach together with the LTO, to make sure that the plan is supported"… "what we, as governmental party, clearly do **not** want, is to put down a plan of action saying "and this is how we are going to do it", whereby the agrarians are not involved."*

The water board also wants to start the dialogue with the farmers. As a start, they already had an information evening and had planned on doing workshops together with farmers, which have not happened yet because of the outbreak of the corona virus:

"In some sort of workshops, we would like to look at alternatives together with farmers, and ask them: what is your opinion on this? Do you see opportunities in this? Which alternatives are feasible, affordable and realizable?"

The approach to find a strategy to counter peat oxidation by closely cooperating with all stakeholders is in line with approaches suggested by literature (e.g. De Roo, 2003) for tackling complex issues.

4.4.2 The importance of a good research base that all stakeholders agree on

The representative from the LTO also stated that cooperation is key, and that enough money should go into the process of developing a good strategy to tackle the issue. An important starting point for good cooperation would be to agree on the facts surrounding peat oxidation. Thus, he emphasized that it is very important that enough resources are put into a solid research base, regarding thickness of peat layers, but also into the exact causality between factors such as water level and soil moisture on the one hand, and peat oxidation on the other hand.

The provinces and water boards in Groningen and Drenthe are currently in the process of developing an important part of this research base: the thickness of peat layers has been measured in the area of water board Hunze en Aa's, and is currently being mapped in the area of Noorderzijlvest. The representative from the LTO said this was a good start, but would like to see more transparency into what exactly will be done with such maps:

"In what way will focus areas be defined based on these peat thickness maps? Will the peat thickness maps be combined with measurements regarding the ground water level and soil moisture to more clearly find out what the exact causality is between the two, and what effect potential measures would have? "

He stated that more transparency from the governments about how data is used to come to certain measures or focus areas would improve the trust between the farmers and the governments.

The representative from the LTO emphasized that peat oxidation and land subsidence are complex issues influenced by many different factors, thereby pointing to research by Hoogland et al. (2019). They conclude that, even though water levels are certainly an important factor, raising the water level is not an efficient measure to counter peat oxidation in every location, as the efficiency also depends on soil composition (ibid). This reinforces the need for solid research into the exact causality.

The civil servant from the province also noted that there are processes by which peat is oxidizing without being in direct contact with air, and that there are large research gaps into the ways that clay-on-peat areas function and how the exact relationship between ground water level, soil moisture and peat oxidation is in such areas. Thus, province and water board clearly agree with the importance of a good research base and acknowledge that there are still a lot of question marks. They also mentioned that in the Dutch climate agreement (Rijksoverheid, 2019), money has been put aside for such research and that the provinces of Groningen and Drenthe are now trying to get finance for research to answer these questions.

To further improve the research base on peat oxidation, the representative of the LTO also pointed to the initiative *Boeren Meten Water*, which is a cooperation between water boards and farmers, whereby many different parameters in the soil (water levels, moist levels, presence of certain minerals) are being monitored. This information could then be combined with information about land subsidence and thickness of peat layers, which could also help giving insight into the exact causality between various parameters and peat oxidation.

4.4.3 The difference between theory and practice

The representative from the LTO noted that the standards that governments use regarding land subsidence caused by peat oxidation are often a lot higher than the actual land subsidence as can be found on websites like *bodemdalingskaart.nl*. The interviewed farmer also had about 20% of his land on peat areas, but didn't dare to say whether the soil was subsiding there because of peat oxidation, as there is also a bubble of natural gas under his plots that is being pumped out. Both interviewees did not in any way want to marginalize the problem, but the representative from the LTO stressed the importance of being realistic about the size of the problem.

He thereby also points out that governmental agencies tend to look too much at the theoretical side of the story, whereas the part that counts for the farmer is the practical side. He illustrated this by giving a (fictional) example:

> *"A civil servant reads about paludiculture as a possible solution to peat oxidation in the newspaper, and then instantly goes to farmers saying that there are feasible alternatives, whereas these have not been proven yet or the practicalities have not been explored yet".*

4.5 How to stimulate the application of measures?

4.5.1 Subsidies as a stimulant

The interviewed farmer noted that subsidies could form an important stimulus for farmers to switch to more sustainable modes of production. Regarding these subsidies, the civil servant from the province said that

"In principle, we would be willing to provide such subsidies, but of course we would have to make sure that we have the [financial] resources to do that. We do not want to go out and make false promises."

The representative from the LTO also believes subsidies would form an incentive to switch to other land uses for many farmers, but once again states the importance of more research into how profitable those modes of production are and how effective they are in actually countering peat oxidation.

The farmer noted that, if a subsidy system was to be implemented as compensation for taking measures to counter peat oxidation, that this could be done in a similar way as it is currently done for nature management regarding the preservation of meadow birds. Also, for the province of Groningen, it would be worth looking at how it has been organized in the province of Friesland, that already has a system in place to compensate farmers for preserving peat. The farmer noted that this policy, *Valuta Voor Veen* (Value for peat) could also partly be copied in Groningen. The civil servant of the province of Groningen also made clear to have the ambition to put a similar system into place as Friesland has. The representative from the LTO was also enthusiastic about the way the process is done in Friesland, thereby explicitly noting that an independent process director could help in making sure that all different interests come to the table and are carefully weighed.

4.5.2 Higher water levels may work in favour of farmers

The interviewed farmer has been keeping water levels on his plots higher in the last years and said that this is good, as with the increasingly dry summers, the chances of damage due to droughts are becoming higher than damage due to wetness.

He also mentioned that more sustainable and eco-friendly ways of farming, including using higher water levels, do not necessarily have to lead to a reduced yield. According to the farmer, many farmers are "conditioned" to do their work in a certain way. This is however not necessarily the most efficient or environmentally friendly way. This is in line with findings from Rois-Díaz *et al.* (2017), who found that (family) traditions have a strong influence on the way a farmer works and strongly influences their choice (not) to apply certain measures.

Just like the farmer, the representative from the LTO noticed that the current Dutch water management tradition is mainly based on preventing flooding and wetness, whereas in the future this may have to shift to preventing droughts. Thus, it might even become more profitable for farmers to apply higher water levels in summer, with as a positive side effect that this reduces peat oxidation. Thereby he sees a role for the government in delivering (or putting resources into finding) evidence that higher water levels may actually be beneficial to farmers themselves, and that there may be less negative side effects of a higher water level than they presume.

4.6 Important considerations to make during the process

Regarding the process of developing a plan of action, the representative from the LTO said to strongly prefer a workgroup instead of a "*sounding board*" group (in Dutch: "*klankboord groep")*. The distinction between the two is that in a workgroup, the agrarians would be actively engaged and involved in the decision-making process from the start, whereas in a "sounding board" group, the agrarians would rather be telling the project leaders whether they are on the right track and giving advice, instead of having actual power to influence the decisions.

An important thing that was explicitly noted by all interviewees, was that farmers largely differ in their attitudes towards ecological practices and farming in general (also see Hofstee, 2020). For example,

some may be willing to cultivate their crops in a way that has a positive influence on the local biodiversity and ecology, even if that results in slightly less yield, while others may want to purely go for the business model that allows for maximum yield. These different types of farmers were also identified by Hyland et al., (2015) where the distinction was made between pro-environmental and productivist farmer identities. The interviewees also pointed out that the age of farmers and whether they have a successor plays an important role in farmers' willingness to change their business model. For example, if a farmer is relatively old and has no successor, it does not make sense to completely change their business model for such a short period of time.

The fact that farmers differ so much reinforces the call for an approach in which governmental parties closely cooperate with the stakeholders to find solutions that work best at each location, for each different set of stakeholders (in line with De Boer & Zuidema, 2014 and De Roo, 2003). However, as was noted by the civil servant from the province, the *peilvakken* (certain demarcated areas with the same water level) are rather robust. For water boards, it would be highly inefficient and costly to have a large amount of different water levels in a small area (e.g. if every single farmer were to have a different water level). Thus, it would be more efficient to have a certain water level in a larger geographical area, which also calls for communication among neighbouring farmers.

As a final note, the civil servant from the province mentioned that peat oxidation is not only a problem for the agricultural sector, as it is also increasingly leading to damages to houses and infrastructure. This should also be considered in making the "societal costs-benefit analysis" in countering peat oxidation, and these societal actors should also be involved in the process of creating a plan of approach.

5. Conclusions

The aim of this paper has been to identify the positions of stakeholders towards measures to counter peat oxidation in the province of Groningen. It can be concluded that peat oxidation is a very complex issue, which is why no simple list of "feasible measures" can be given. However, the identification of the positions of different stakeholders is an important step in finding out how peat oxidation can best be tackled in the province of Groningen.

It was found that the types of peat- and water systems within Groningen largely differ, and therefore, an area-based approach is required that considers local circumstances (in line with De Boer & Zuidema, 2014). Existing policies to counter peat oxidation that are applied in other provinces (Friesland, Noord-Holland) can only partly be copied, because those peat systems differ from the systems in Groningen.

Furthermore, awareness regarding the issue seems to be increasing, both among farmers and governmental agencies. As solutions are sought, the traditional system of Dutch water management (water level follows function) is called into question. Contrary to findings by Carlton et al., (2015), farmers seem to have become more aware of issues related to climate change after the droughts of 2018 and 2019.

Although this awareness is increasing, currently no measures are taken to counter peat oxidation in the province of Groningen. The reason for this seems to be that taking measures would require a huge change in business models for farmers and besides, farmers seem to experience too many uncertainties regarding the profitability and (im)practicalities of these business models. This confirms findings by Rois-Díaz et al. (2017) that confidence in profitability is a key factor in determining farmers willingness to switch to more sustainable modes of production.

In line with De Roo (2003), it was found that cooperation between different stakeholders is key in developing a strategy to counter peat oxidation, to make sure the different interests are well-represented. Hereby, the importance of a good knowledge base that all stakeholders agree on is emphasized. Furthermore, transparency in the way that governments use data to develop policies could result in a stronger trust between farmers and governmental agencies, benefiting the cooperation.

Subsidies could form an important incentive for farmers to apply business models that allow the preservation of peat. Another stimulant could be to raise awareness among farmers that raising water levels could also be in their interest, because often, farmers tend to be "conditioned" to do their work in a certain way (in line with Rois-Díaz et al., 2017). The government could play a role in raising this awareness by delivering a stronger evidence base on the (positive) effects of working with higher water levels.

Besides research into effects of working with higher water levels, further research into the practicalities and profitability of "wetter" (agricultural) business models is needed. Also, for further research, it would be recommended to investigate the exact causality between peat oxidation and various parameters such as water level, soil moisture and soil composition, so the effectiveness of different measures to counter peat oxidation can better be established.

As a result of the outbreak of the corona virus, the research design had to be altered and only a small number of interviews could be done. This may have had a negative impact on the quality of the research, although the researcher believes that this impact was limited as data was still collected from a variety of stakeholders. However, it should be noted that the results in this paper are based on only four interviews and thus can hardly be generalized. Nonetheless, this paper forms a valuable addition to the existing academic literature by identifying research gaps and revealing new perspectives and insights on the complex issue of countering peat oxidation.

Throughout the entire process of this research, from writing the research proposal to writing the conclusion, the researcher applied knowledge and skills that were gained throughout the past three years in the Bachelor Programme Spatial Planning and Design. Skills and knowledge from the courses "Introduction to academic research", "Methods of academic research" and "Governance dynamics" were particularly useful in designing and conducting the research.

Nonetheless, the researcher also experienced some difficulties throughout the process, for example in finding literature that would be appropriate to the very specific context of peat oxidation in the province of Groningen, and in finding the right people for interviews, especially under the exceptional circumstances regarding the corona virus. There is certainly a lot of room for improvement of these and many other research-related skills. However, the amount of new skills that were acquired during the relatively short time-span of this bachelor project have given the researcher confidence that an improved quality of research can be achieved by going through the research cycle over and over again and getting more experience in doing research.

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7. Appendices

Appendix 1: Interview guide

Below, the basic interview guide that was used for the interviews can be seen. The interview guide was tailored to the different interviewees and served as a backbone for conducting the interviews.

Introduction		
- **Thank interviewee for taking time to contribute to the research** - **Explain the aim of the research** - **Tell the interviewee something about yourself as a student** - **Explain that the goal is to find their position/attitude on the topic, there is no right or wrong** - **Explain how the interview is structured and the expected length of the interview** - **Inform interviewee about privacy and ask for permission to record the interview** - **Any questions?**		
Main question	**Sub questions/probing questions and (*answers)***	**Examples**
To start with, what is your view on peat oxidation?	What are the main causes and effects of peat oxidation according to you?	
What effects of peat oxidation do you perceive?	What do you expect the effects of peat oxidation to be in the future? Do you see it as part of your responsibility to do something against peat oxidation?	*Soil subsidence, CO2 emissions*
Are you currently taking measures to counter peat oxidation *or the previously mentioned effects of it?*	**If yes**: Which measures? What was the incentive for you to take those measures? How well do these measures work?	
	If no: Do you want to take measures to counter peat oxidation in the future? Why, why not? Do you know people that take measures against peat oxidation?	
What (further) measures are you aware of that could be taken to counter peat oxidation?	**If interviewee cannot think of any,** try inspiring them with examples; ask them about familiarity with these examples	*Switching to paludiculture, to nature, production of biomass (forests) or solar parks*
You just mentioned various measures *(measure 1, 2, 3, etc.)*. **How open would you be to take (*measure 1, 2, 3, etc.)?***	What is limiting you to perform *(measure 1, 2, 3, etc.)* right now? Would you be willing to perform *(measure 1, 2, 3, etc.)* under certain conditions? Under what conditions? What are the most important stakeholders according to you in countering peat oxidation?	*E.g. profitability, impact on landscape* *E.g., subsidies*
We have come to the end of my questions, is there anything that you would like to add?		
Closing the interview		
- **Thank you very much for this interview** - **Would you be interested in the results of this research?** - **Stay safe!**		