GLOBE Estonia Learning Expedition

The impact of the water level on the peat layer and vegetation near Varemurru

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Estonia 2022

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Abstract

We investigated peatlands in the coastal area of the Gulf of Riga in Western Estonia. We were interested in what species can grow in the peatland, and if and how water level affects the plants. We studied 6 different research sites across the Varemurru area. We found from the Estonian Land Board Geoportal search that the soils are very diverse in this area. We chose six different and evenly spread sites, two were wet fens, two were moist swamp forests and two were dry peaty forests. We decided to focus on finding out whether the water level affects the plants growing in the soil. Because at some point in history these places were all peatlands, these soils should have a peat layer.

Three hypotheses out of five were supported. Most interesting thing we found through research was that the peat quantity was not related to water level. One potential mismatch reason is that maybe this is due to the recent extreme drought that was a big problem all over Estonia in the summer of 2021. Other things were a bit more predictable, but overall the research was very instructive

1. Introduction

Peatlands are terrestrial wetland ecosystems in which waterlogged conditions prevent plant material from fully decomposing. Consequently, the production of organic matter exceeds its decomposition, which results in a net accumulation of peat. In cool climates, peatland vegetation is mostly made up of Sphagnum mosses, sedges and shrubs which are the primary builders of peat, whereas in warmer climates graminoids and woody vegetation provide most of the organic matter (International Peatland Society, 2020).

We set up four different research questions to study the connection between peat and water level.

How does peat water level influence:

1) peat quantity;

2) peat quality;

3) vegetation height;

4) vegetation composition?

We set up five different hypotheses. They were all connected to the water level as well. A higher water level supports:

1) a thicker peat layer;

2) less-decomposed peat;

3) taller vegetation;

4) less species;

5) more wetland specialist plant species.

2. Research sites

We had 6 different research sites. (Figure 1 and 2). When we were choosing those sites, we researched the area from the Estonian Land Board website called Geoportaal. There we were able to select places on the map with suitable soil. We named the six different research sites as follows: Jaan, Johannes, Clixu, Kristel, Hans, Sofja. The sites were named after our team.

- The sites called “Jaan” and “Johannes” were wet fens.
- The sites called “Clixu” ja “Kristel” were moist swamp forests.
- The sites called “Hans” and “Sofja” were dry peaty forests

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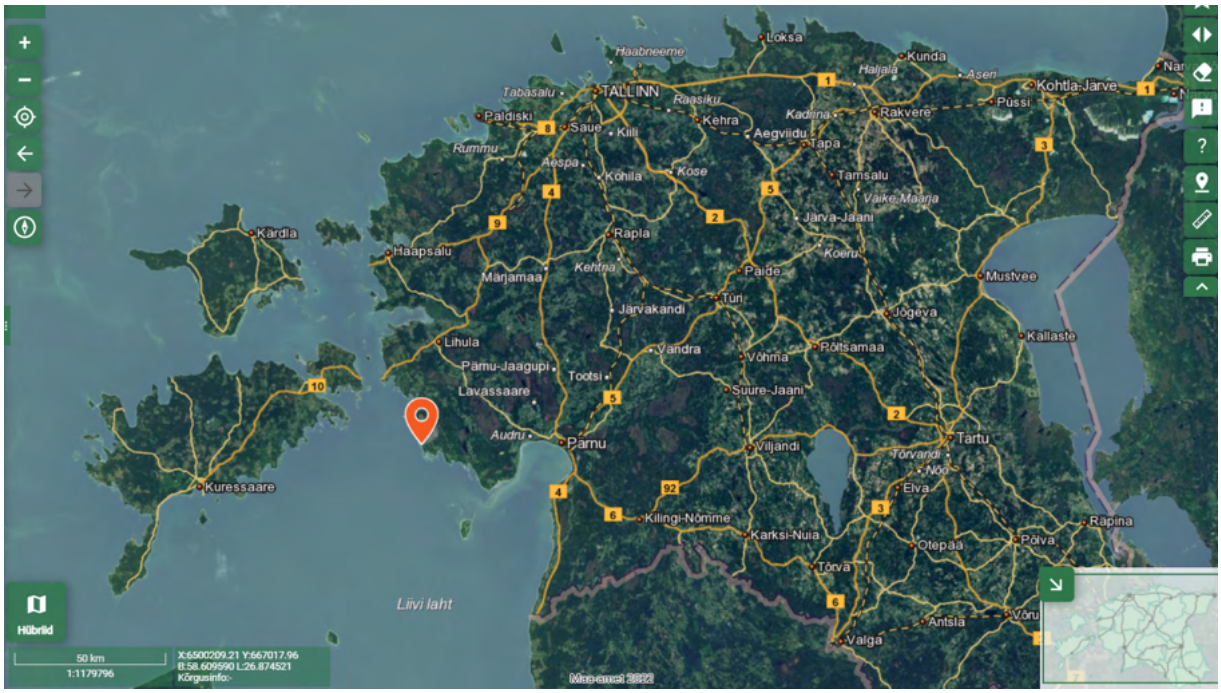

Figure 1. Study area location on the map of Estonia. Source: Estonian Land Board

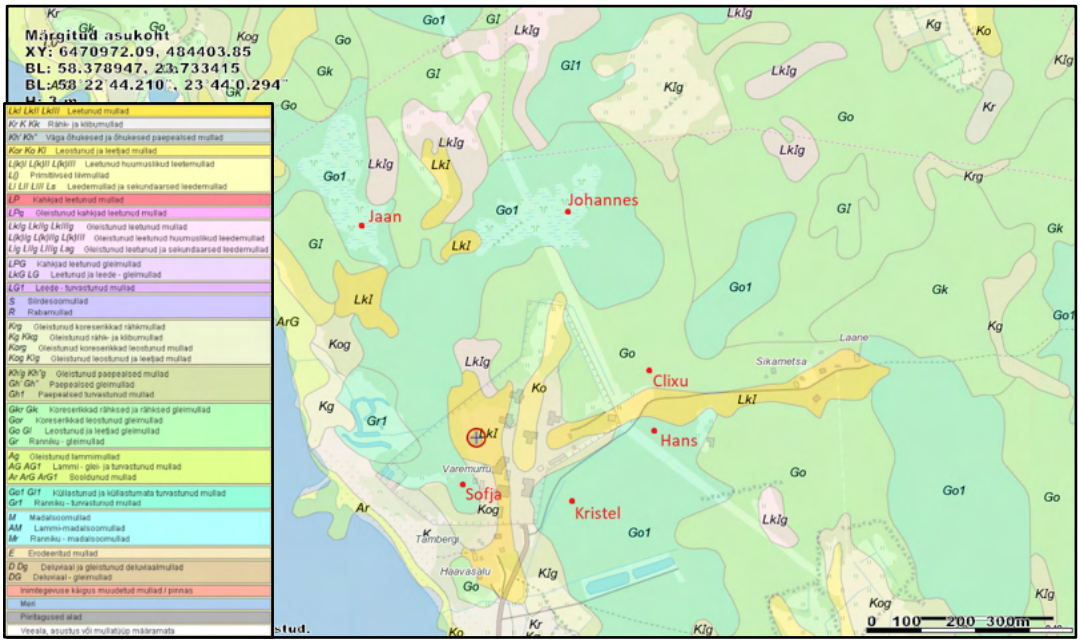

Figure 2. Map of research locations on the national soil map (1:10,000; Source: Estonian Land Board)

3. Research methods

We conducted field work at Varemurru on 10 August 2021. We observed the soil profiles, measured the thickness of the layers (Figure 5) and used tape measure for that. We put the main emphasis on the thickness of the peat layer.

On the peat layer we observed the state of decomposition. We did that by visually assessing and feeling by hand. We assessed humidity by squeezing the peat between our hands. We assessed the structural composition, again through visual observation, and studied what it mainly consisted of. We also observed what was under the peat layer. Under the peat layer was mainly sand, so we determined sand thread using GLOBE protocols, using the pedosphere and soils materials (GLOBE ProgramTM Teacher's Guide", Second edition 1996, version in Estonian).

We identified all the plant species using our supervisor`s expertise, identification handbooks like "Eesti taimede kukeaabits" by Toomas Kukk, and the website called taimenimed.ut.ee.

We measured the height of trees and the height of undergrowth. We chose the best fitting trees that were neither too old or too young. We selected the trees visually through external observation. From each species we measured three individuals and then calculated the average height of that species. For measuring the undergrowth, we used a tape measure (Figure 4), but for measuring the tree's height we used a clinometer.

We measured soil oxygen level and water level as well. We measured the water level from the edge of the site down to the water. (Figure 3). The flashlight was very useful, because the bottom of the site was dark. We measured the soil oxygen level with the PreSens soil oxygen level sensor. We chose to measure the oxygen level from the bottom of the sites, because it was easier to identify the bottom of the site than the edge of the grass-covered site.

With a soil thermometer we measured the soil temperature from 10 cm from the bottom of the site.

We divided the identified plant species into undergrowth, bushes and trees. Some species were generalists (wide habitat) and some were specialists (narrow habitat).

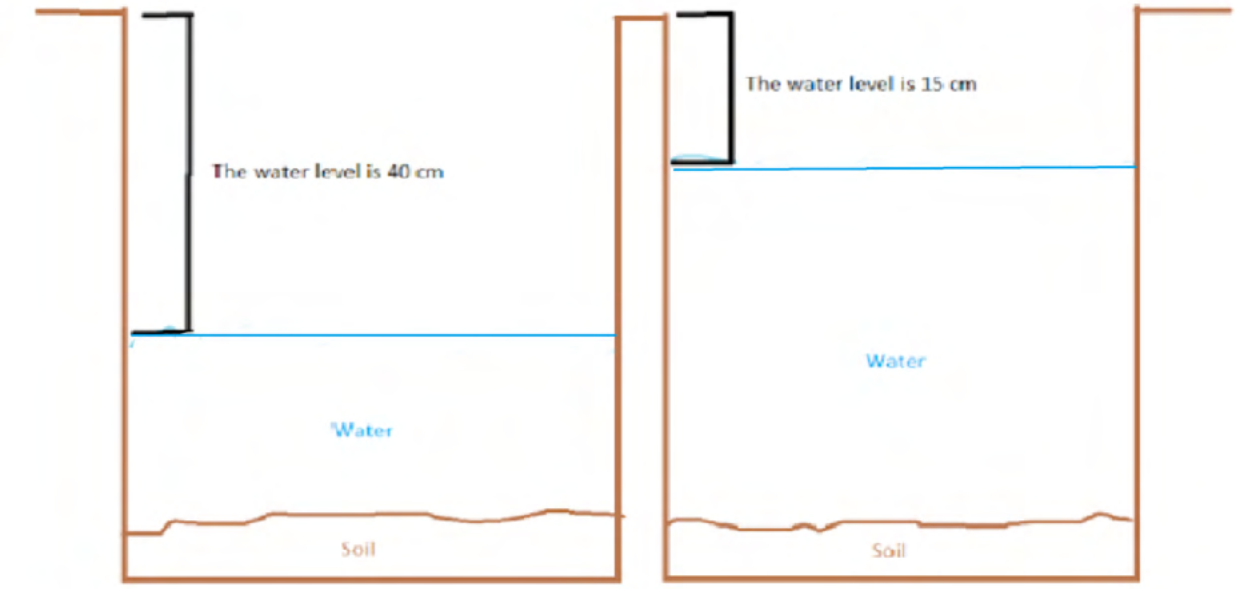

Figure 3. The example of the water level measuring.

Figure 4. Measuring the height of the undergrowth. Photo by: Hans-Kristjan Raid

Figure 5. Measuring the thickness of the peat layer. Photo by Hans-Kristjan Raid

4. Results

There were 36 different species. 30 of them were generalists and 6 of them were specialists.

Table 1. The plant species. Index of Estonian Plant Names. Nota bene: when the box is painted, the corresponding plant grows on this site

Scientific plant name	Estonian name	“Jaan”	“Johannes”	“Clixu”	“Kristel”	“Sofja”	“Hans”
Picea abies	Harilik kuusk	■	■		■	■	■
Pleurozium schreberi	Harilik palusammal	■	■		■	■	■
Potentilla palustris	Soopihl	■	■	■			
Quercus robur	Harilik tamm				■	■	■
Carex rhynchophysa	Nokktarn	■	■				
Betula pubescens	Sookask	■	■				
Sorbus	Pihlakas				■	■	

Phragmites australis	Pilliroog						
Chamaenerion	Põdrakanep						
Alnus glutinosa	Must lepp						
Vaccinium vitis-idaea	Pohl						
Oxycoccus palustris	Harilik jõhvikas						
Filipendula ulmaria	Harilik angervaks						
Rubus idaeus	Harilik vaarikas						
Convallaria majalis	Piibeleht						
Pinus sylvestris	Harilik mänd						
Acorus calamus	Koeraputk						
Betula pendula	Arukask						
Carex panicea	Hirsstarn						
Dryopteris expansa	Laiuv sõnajalg						
Lysimachia thyrsiflora	Ussilill						
Tilia cordata	Harilik pärn						

Figure 6. Characteristic plants across the profile of sites. Photo by Kristel-Elis Siidra

4.1 Overview of the sites

4.1.1 First site “Jaan”

The first site was called “Jaan”. It was one of the two wet fens. The peat layer was 24 cm. Its peat layer consisted of the same plants that were growing on top of the peat layer, so mainly of *Phragmites australis* and *Carex rhynchophysa.* The state of decomposition was according to the GLOBE protocol “mid”. Under the peat layer was gley sand. The sand and soil under the peat layer was wet and the water level reached down to 16 cm. The oxygen level was below 3.2 mg/L. The temperature was 15.2 °C. The undergrowth on this site were: *Potentilla palustris, Pleurozium schreberi, Carex rhynchophysa, Phragmites australis, Vaccinium vitis-idaea, Oxycoccus palustris, Carex panicea, Dryopteris expansa*. The trees on this sits were: Picea abies, Betula pubescens, Pinus sylvestris.

Figure 7. The overall view of the site called “Jaan”. Photo by Kristel-Elis Siidra

4.1.2 Second site “Johannes”

The second site was called “Johannes”. It was the second of the two wet fen sites. The peat layer was 27 cm. Its peat layer consisted of the same plants that were growing on top of the peat layer, so mainly of *Phragmites australis*. The state of decomposition was according to the GLOBE protocol “poor”. Under the peat layer was typical sand. The sand and soil under the peat layer was wet and the water level reached down to 28 cm. The oxygen level was below 5.14 mg/L. The temperature was 16.8 °C. The undergrowth on this site were: Carex panicea Pleurozium schreberi, Potentilla palustris, Vaccinium vitis-idaea, Carex rhynchophysa, Phragmites australis, Oxycoccus palustris, Acorus calamus, Dryopteris expansa. The trees on this site were: *Saxifraga sancta, Salix viminalis, Betula pubescens, Alnus glutinosa,* Betula pubescens, Pinus sylvestris

Figure 8. The view of the site called “Johannes”. Photo by Kristel-Elis Siidra

Figure 9. The soil profile. Photo by Kristel-Elis Siidra

4.1.3 Third site “Clixu”

The third site was called “Clixu”. It was one of the two moist swamp forests. The peat layer was 30 cm, which was the thickest peat layer from our observation. Its peat layer consisted mainly of *Carex nigra* and tree leaves. The state of decomposition was according to the GLOBE protocol “mid”. Under the peat layer was gley sand. The soil and sand under the peat layer was wet and the water level reached down to >60 cm. The oxygen level was 8.3 mg/L. The temperature was 16.0 °C. The undergrowth on this site were: Potentilla palustris, Phragmites australis, Vaccinium vitis-idaea, Filipendula ulmaria. The trees on this site were: Pinus sylvestris.

Figure 9. Distant view on the site called “Clixu” at the horizon. Photo by Kristel-Elis Siidra

4.1.4 Fourth site “Kristel”

The fourth site was called “Kristel”. It was the second of the two moist swamp forests. The peat layer was 16 cm. Its peat layer consisted of the same plants that were growing on top of the peat layer, so mainly of *Carex nigra*. The state of decomposition was according to the GLOBE protocol “well”. Under the peat layer was typical sand of southern Estonia.

The typical sand of southern Estonia consists of reddish-colored Devonian sandstone. This sand is very weakly cemented and crumbles easily between bare hands. (Eesti Loodus, 2012)

Contains a lot of crystallized minerals.. The soil and sand under the peat layer was wet and the water level reached down to >60 cm. The oxygen level was below 0,26 mg/L. The temperature was 16.2 °C. The undergrowth on this site were: *Pleurozium schreberi, Filipendula ulmaria, Convallaria majalis.* The trees on this site were: *Picea*

abies, Quercus robur, Sorbus, Alnus glutinosa, Pinus sylvestris. The bushes on this site were: *Rubus idaeus*

Figure 10. The view of the site called “Kristel”. Photo by Kristel-Elis Siidra

4.1.5 Fifth site “Hans”

The fifth site was called “Hans”. It was one of the two dry peaty forests. The peat layer was 16 cm. Its peat layer was so decomposed that it was impossible to tell what it consisted of. According to the GLOBE protocol the decomposition was “well”. Under the peat layer was arenosol sand. The soil and sand under the peat layer was rather dry and the water level reached down to >60 cm. The oxygen level was 8.3 mg/L. The temperature was 15.8 °C. The undergrowth on this site were: *Pleurozium schreberi, Chamaenerion, Filipendula ulmaria, Convallaria majalis, Dryopteris expansa, Lysimachia thyrsiflora.* The trees on this site were: *Picea abies, Quercus robur, Sorbus, Alnus glutinosa, Pinus sylvestris, Betula pendula.* The bushes on this site were: *Rubus idaeus*.

Figure 11. The view of the site called “Hans”. Photo by Kristel-Elis Siidra

4.1.6 Sixth site “Sofja”

The sixth site was called “Sofja”. It was the second of the two dry peaty forest sites. The peat layer was 19 cm. Its peat layer consisted of roots and tree leaves. The state of decomposition was according to the GLOBE protocol “mid”. Under the peat layer was again typical sand of southern Estonia (the typical sand of southern Estonia is explained in 4.1.4). The soil and sand under the peat layer was dry and the water level reached down to >75 cm. The oxygen level was not detected. The temperature was 15.9 °C. The undergrowth on this site were: *Pleurozium schreberi, Chamaenerion, Filipendula ulmaria, Convallaria majalis.* The trees on this site were: *Picea abies, Quercus robur, Alnus glutinosa, Pinus sylvestris, Betula pendula.* The bushes on this site were: *Rubus idaeus.*

Figure 12. The view of the site called “Sofija”. Photo by Kristel-Elis Siidra

Figure 13. Site “Sofja” soil profile. Photo by Kristel-Elis Siidra

Table 2. The overall review of the sites.

	"Jaan"	"Johannes"	"Clixu"	"Kristel"	"Hans"	"Sofja"
Peat layer thickness	24 cm	27 cm	30 cm	16 cm	16 cm	19 cm
Peat composition	The same plants that grow in the soil	The same plants that grow in the soil	Carex rhynchophysa and tree leaves	The same plants that grow in the soil	Could not be identified	Roots and the same plants that grow in the soil
Sand under the peat	Gley sand	Sand	Gley sand	Sand	Arenosol sand	Sand
Soil humidity	Wet	Wet	Moist	Moist	Dry	Dry
Water level	16 cm	28cm	60 cm	60 cm	60 cm	75 cm
Oxygen level	> 3.2 mg/L	>5,14 mg/L	>8.33 mg/L	0.26 mg/L	8.3 mg/L	-
Temperature	15.2	16.8	16	16.2	15.8	15.9
The state of decomposition	Mid	Poor	Mid	Well	Well	Mid
The height of the trees	2-3 meters		8-12 meters		11-22 meters	

5. Discussion

Hypothesis 1 (a higher water level supports a thicker peat layer). As we can see from table 3, the water level was in fact higher in the wetter site, but the peat layer thickness does not vary because of that. This hypothesis was not supported because the sites with low water level were younger peatlands, these consist more peat than the oled peatlands, because most of the peat in the old peatlands have already decomposed. And we can see that from table 3 and figure 14.

Table 3. Peat layer thickness compared to water level.

	"Jaan"	"Johannes"	"Clixu"	"Kristel"	"Hans"	"Sofja"
Peat layer thickness	24 cm	27 cm	30 cm	16 cm	16 cm	19 cm
Water level	16 cm	28cm	60 cm	60 cm	60 cm	75 cm

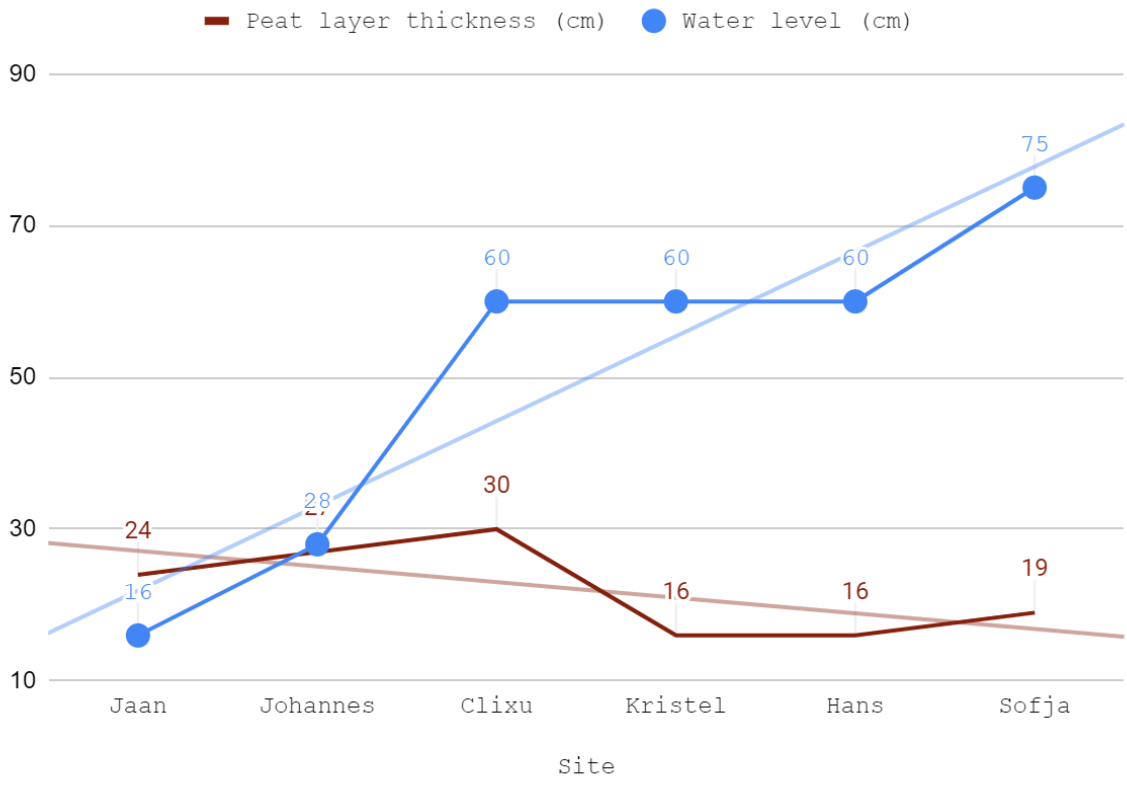

Figure 14. Peat layer thickness compared to water level. Explanation to hypothesis 1.

Hypothesis 2 was supported - the wettest peats were poorly to medium decomposed while the fresh peats were medium to well decomposed. The table supports this hypothesis as well.

Table 4. The soil humidity compared to the state of decomposition.

	"Jaan"	"Johannes"	"Clixu"	"Kristel"	"Hans"	"Sofja"
Soil humidity	Wet	Wet	Moist	Moist	Dry	Dry
Water level	16 cm	28cm	60 cm	60 cm	60 cm	75 cm
State of decomposition	Mid	Poor	Mid	Well	Well	Mid

Hypothesis 3 was supported, where the water level was 16 cm to 28 cm below the ground, the trees were 2 to 3 m tall, and where the water level was 60-75 cm below the ground, the trees were 11 to 22 m tall. (Table 4) However the wet peats supported

the tallest undergrowth while the sparsest undergrowth occurred on fresh peat. (Figure 14)

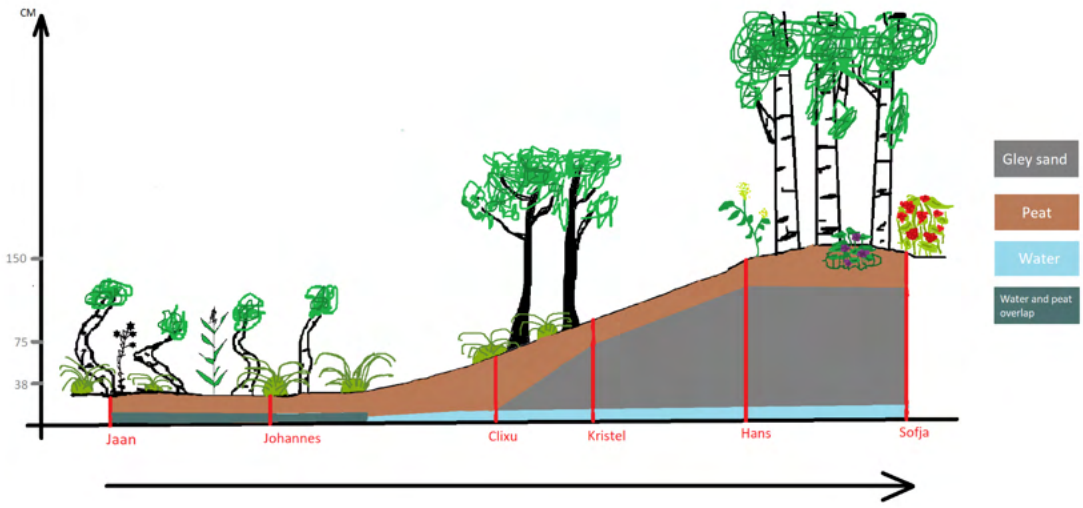

Figure 15. Landscape profile of study sites. Explanation to hypothesis 3.

Hypothesis 4 was not supported. The number of undergrowth species was equally 7 in both the wet and fresh peat sites.

Hypothesis 5 was supported. The number of wetland specialists was 5-6 in the wet sites, while in the fresh sites we found only one wetland specialist species.

6. Conclusion

Through research we found that peat quantity was not related to water level. One potential reason for the mismatch is that maybe this is due to the recent extreme drought that was a big problem all over Estonia in the summer of 2021.

Peat decomposition rate is negatively related to water level. So this means peat was decomposed from medium to well at the dry sites. Peat decomposition was poor to medium at the wet sites.

The same goes with tree height being negatively related to water level. Where water level was low, trees were high and vice versa.

Water level had no clear effect on plant diversity, as both wet and fresh peats supported high species numbers.

Most of the species in the wet peatlands were specialist plants.

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