GLOBE Regional Learning Expedition

Exploring the soils of the Käsmu peninsula

Authors: Ülle Anier, Aile Jaansalu, Nataliya Lobosok, Malle Mattisen, Renata Moistus, Bianka Pihla, Valentina Repina, Tatjana Sedova, Olga Zimina, Helle Vänzel, Reet Ööpik

Support: Hans-Kristjan Raid

Supervisor: Eelika Kiil

2023

Abstract

Soils play a vital role in our global ecosystems. Soils affect the quality of our everyday life in more ways than we understand, and we should put much more emphasis on it. We can gather soil information from different geographic information systems, soil maps and handbooks. Still, the best way to acquire knowledge is to go outside and collect the data yourself. The fieldwork for this report was conducted during the GLOBE Regional Learning Expedition in 2022 at Käsmu, Estonia. To test the hypotheses of our work, we performed two soil excavations following GLOBE soil protocols. As a result, we characterised different soil types and confirmed our hypotheses. We found out that the soil and the vegetation on top of it are strongly correlated because changes in the vegetation indicated a change in the soil type. Finally, the grain size analysis confirmed that the grain sizes of the soil horizons differ from the entire soil sample.

Keywords: soil, excavation, vegetation, grain size distribution

Research Question and Hypothesis

Soils form a thin layer on the Earth's surface called the pedosphere. Soils consist of three main components: minerals, organic matter and pores between particles that could contain water or air. The process of soil formation is very long and influenced by many factors like parent rock, climate, organisms, relief, and time. The most important properties of soil are providing a natural growth environment for plants, storing and cleaning water, providing habitat for soil organisms and modifying Earth's climate. Soil is also the foundation for construction, roads and other facilities. At the same time, soils are greatly affected by erosion, which carries away the fertile surface layer. As we learn more about the role of soil in affecting the aspects of our everyday life, we begin to understand the importance of soil in our global ecosystem and its preservation.

We can gather information about soil and its properties for many purposes. In Estonia, large-scale soil mapping began in 1954, and the first maps were for agricultural enterprises only. Today soil maps can also be the basis for detailed spatial analysis in other fields like geology, urban development and land reclamation planning. Therefore it is crucial to improve our soil maps further and collect additional information. (Republic of Estonia Land Board, 2001)

The data for this report was collected during GLOBE Regional Learning Expedition 2022 at Käsmu, Estonia, on 2-5 August 2022. A red circle on a soil map from the Republic of Estonia Land Board (ELB) represents our study area (Figure 1). We formed our research questions and hypotheses based on the ELB soil map by the given information about soil type and texture. Also, the explanatory letter of the digital large-scale soil map of the Republic of Estonia and the color chart were used.

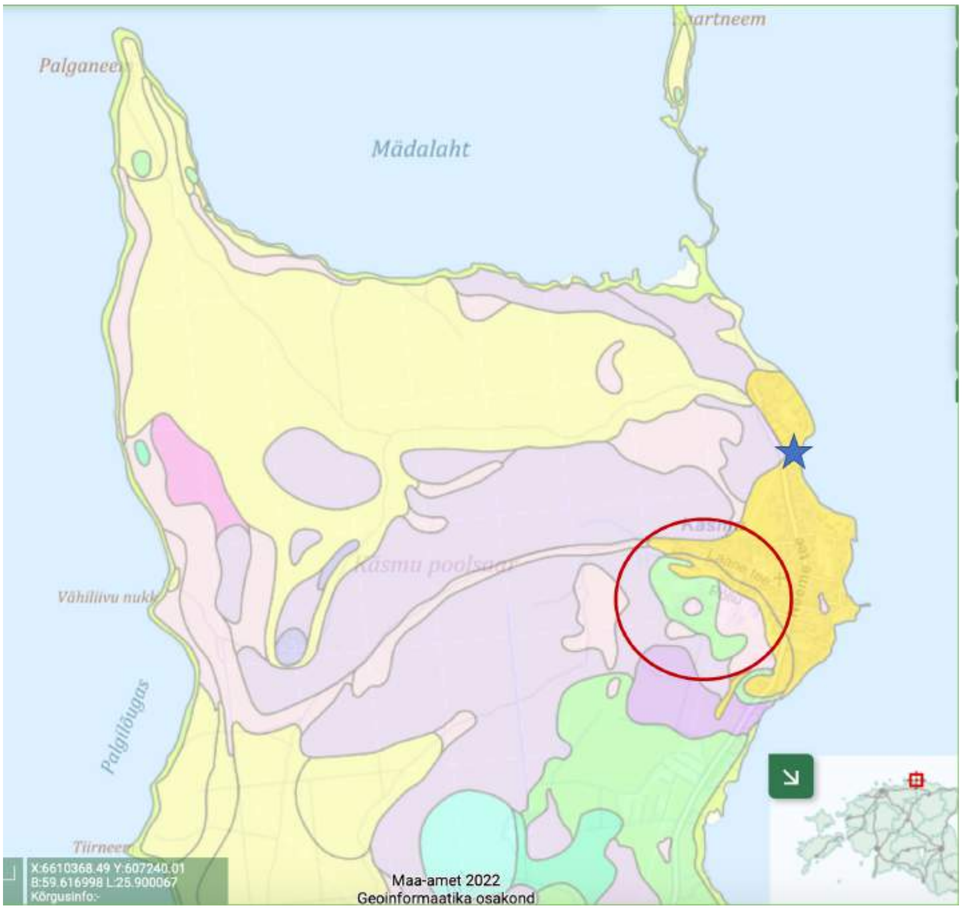

Figure 1. Map showing designated area for research at Käsmu, Estonia (Soil Map).

As we saw many different soil types presented with different colors on our site, we started asking questions based on that. What are the soil types we should see? How do they differ from each other? We had limited time for additional background research and little knowledge about the topic, so we formed simple but easily checked research questions.

Our research questions were:

1. Do different soil types occur in our selected small area as depicted on the soil map?
2. Does the type of soil affect vegetation?
3. Is there a variation between the grain size distribution of single horizons compared to the site average?

Following the research questions, our hypotheses were:

1. We will find different soil types in the Käsmu peninsula in our designated study area.
2. The soil type affects the flora that grows on it (and we can identify the change in soil type when we see the difference in vegetation).
3. Soil horizons will have different grain size distributions compared to the site average.

Materials and Methods

On the 3rd of August, we conducted fieldwork in the Käsmu peninsula and collected samples for additional testing. During fieldwork, we made two excavations and measured soil parameters. We followed instructions from GLOBE soil protocols. Excavations were at least 2 meters away from the roads and more significant objects. We also ensured that we would have natural sunlight for the soil layers afterwards.

Activities during fieldwork:

1. Excavation - we used a spade and shovel for digging the hole, a plastic film cover to separate the excavated soil and a tape measure or meterstick for measuring the depth of the hole. Also, we tested different smartphone applications to determine the location's coordinates.
2. Identifying soil layers - we used nails for marking different layers, a tape measure for measuring, a spray bottle with water to moist the soil and Munsell Books of Color for identifying the color of the layers.
3. Temperature measurements - we used analogue and digital thermometers to measure temperature from the surface, 5 and 10 cm below the ground.
4. Observing soil parameters - we observed moisture, grain size distribution, texture and clay content.
5. Sampling - we used metal sample vessels to collect soil samples from each layer.
6. Identifying plant and tree species - we used identification handbooks for the specific names and searched the internet for reference pictures.
7. Photographing - we took photos of our excavation from the north, east, south, and west, looking upwards and downwards.

Activities after fieldwork:

1. pH measurement - we used plastic cups, distilled water and pH measuring strips
2. Acid test - we used plastic cups and acetic acid (vinegar).
3. Drying - samples were dried overnight on a sheet of paper for the sieving tests.
4. Sieving - we used soil sieves (3.35 mm, 2.00 mm, 0.5 mm, 0.25 mm, 0.125 mm, 0.063 mm) and a digital scale.

Data Summary and Analysis

We named our excavation sites two easily distinguished plant species most common in the area. Accordingly, the first site we called “Blueberry”, and the second site “Fern”. The locations of the sites are shown in Figure 2.

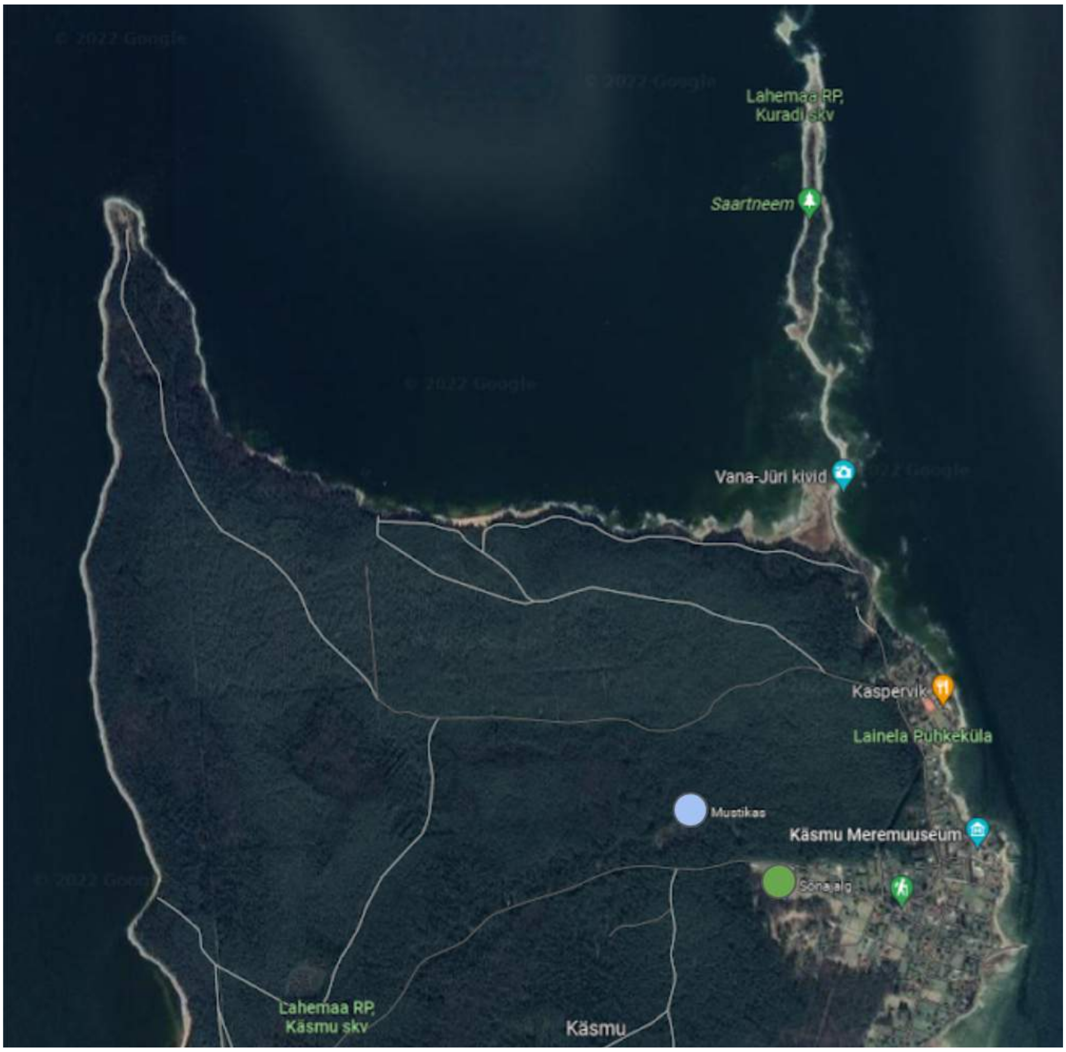

Figure 2. Map showing our two study sites - Blueberry (Mustikas) with a blue circle and Fern (Sõnajalg) with a green circle (Google, 2022).

The Blueberry site

The first site (N 59.60524, E 25.903986) was in a dry boreal forest with an altitude of 12 m (Figure 3). It was about 5 meters away from a nearby camping trail, surrounded by trees and some ant nests around. Three main tree species were *Pinus sylvestris, Picea abies* and *Sorbus aucuparia*. Three main plant species were *Vaccinium myrtillus, Oxalis acetosella* and *Pleurozium schreberi*.

Figure 3. The Blueberry site.

The Fern site

The second site (N 59.60286, E 25.909574) was in a paludified forest with an altitude of 9 m (Figure 4). It was about 20 meters from a nearby meadow, and no other significant objects were nearby. Three main tree species were *Alnus incana, Sorbus aucuparia* and *Salix.* Three main plant species were *Dryopteris filix-mas, Urtica dioica* and *Equisetum.*

Figure 4. The Fern site.

The excavation site description for the site Blueberry is in figure 5, and for the site Fern in figure 6. Sometimes a soil sample can have more than one color (primary and secondary). We detected this in the Blueberry site, where layer A had two colors.

Soil horizon	Thickness (cm)	Munsell Soil Color
O	3	
A	7	5YR 4/2
E	5	75YR 4/2
B	9	10YR 5/4
C	>24	10YR 7/4

Figure 5. Blueberry site soil horizons, thicknesses and Munsell Soil Colors with codes.

Soil horizon	Thickness (cm)	Munsell Soil Color
O	4	
A	14	10YR 2/2
E	18	10YR 4/3
C	> 9	5Y 4/2

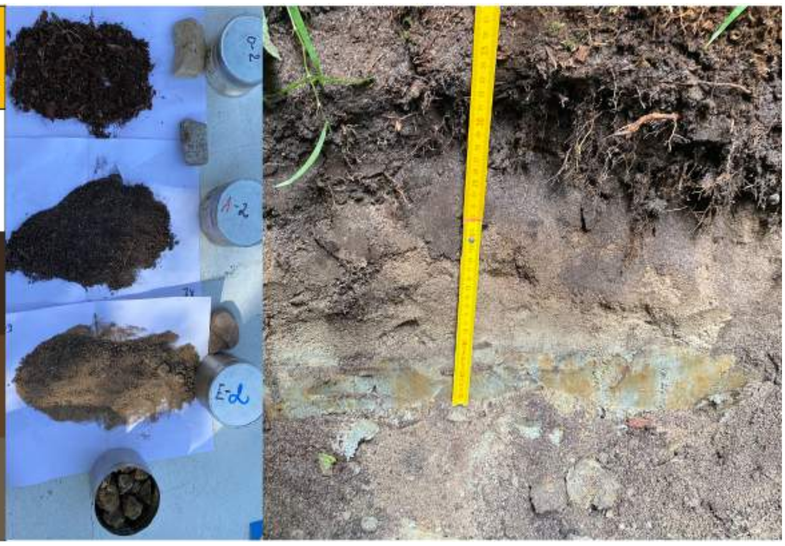

Figure 6. Fern site soil horizons, thicknesses and Munsell Soil Colors with codes.

Neither soil reacted to the acid test, indicating the absence of free carbonates. In both sites, the soil was arid, indicating the lack of precipitation in the area.

We measured temperature on the surface, 5 and 10 cm below the ground. The results are in figure 7, where we see a decrease in temperature with depth.

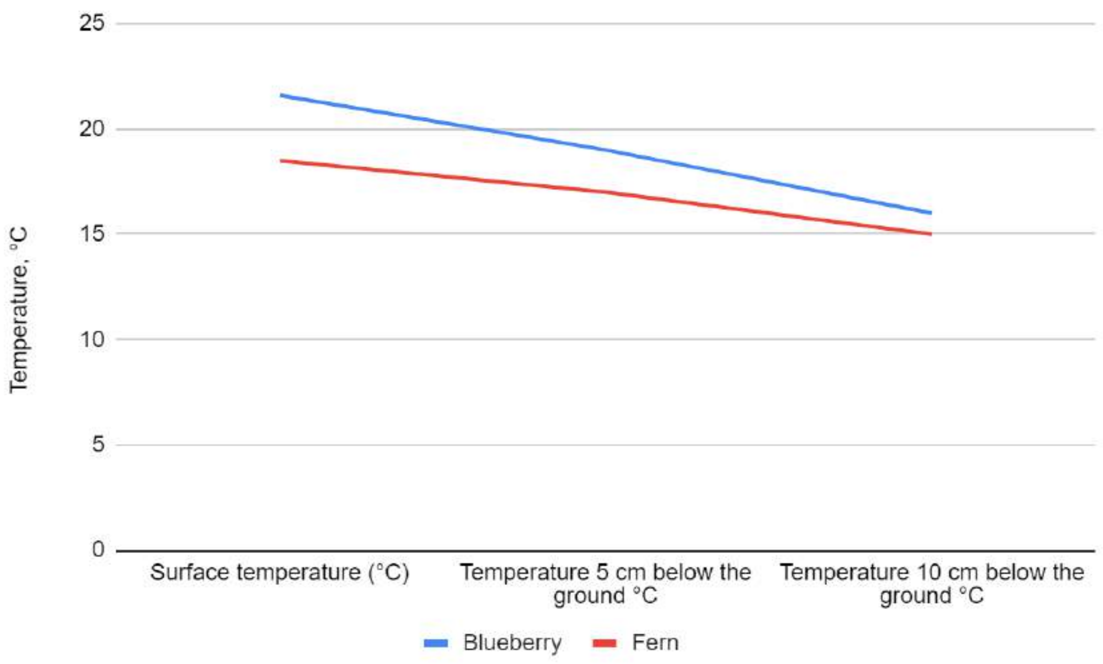

Figure 7. Temperature changes in study sites as the depth increases.

We compared the grain size distribution data by each soil horizon to the site average. Results for the site Blueberry are in figure 8, and for the site Fern in figure 9. According to the grain size, we divided these ranges into the following categories:

- >2.00 mm - gravel
- 2.00 - 0.5 mm - coarse sand
- 0.5 - 0.25 mm - medium sand
- 0.25 - 0.125 mm - fine sand
- <0.125 - very fine sand (and smaller particles)

We divided the soil from both of these sites into categories and calculated the proportions (Table 1).

Grain size categories	Blueberry site	Fern site
Gravel	13.8%	41.6%
Coarse sand	51.3%	19.0%
Medium sand	29.3%	9.4%
Fine sand	5.1%	7.7%
Very fine sand (and smaller)	0.5%	22.3%

Table 1. Grain size distribution by grain size for both sites.

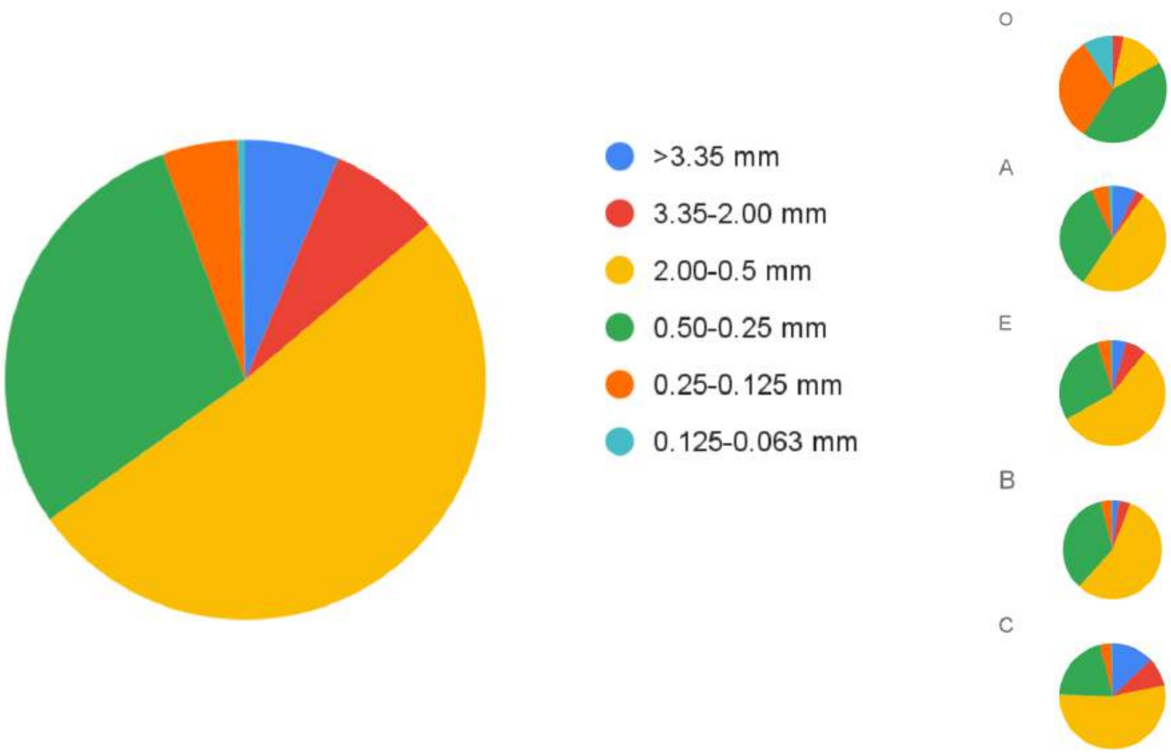

Figure 8. Grain size distribution by soil horizons compared to the Blueberry site average.

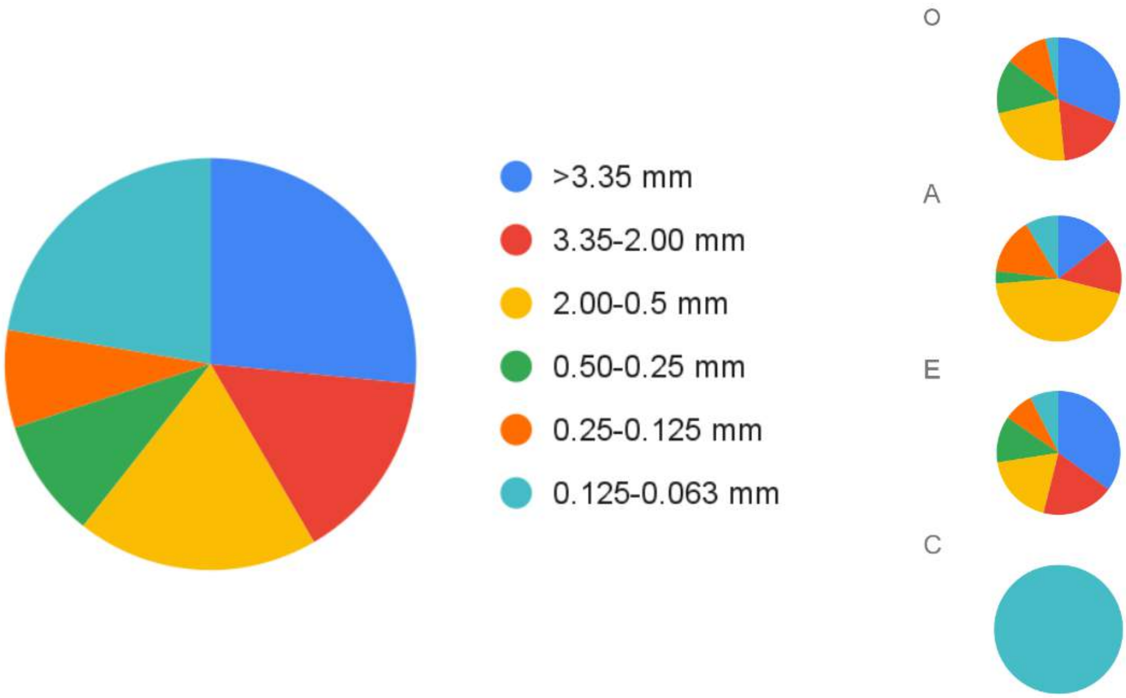

Figure 9. Grain size distribution by soil horizons compared to the Fern site average.

Results, Conclusions and Discussion

When studying soils, it is crucial to remember that humans or geological factors may have altered them. The last glacial period in Estonia ended about 10 000 years ago, and it has hugely impacted the type of soil in Estonia. Like most of Estonia's soils, the parent rock in Käsmu is glacial till, which affects all the other properties.

We found two different soil types in our study area, as depicted on the ELB soil map. As we located the site for the second excavation by the change in vegetation, we can conclude that the soil type affects the flora. Our sieving test also concluded that soil horizons have different grain size distributions compared to the site average. Also, our two sites had very different proportions of different grain size categories.

Our activities initially after fieldwork included pH testing and measuring the moisture content. But these results did not make it to this report. Unfortunately, we had some errors with pH measurements because the distilled water had a lower pH. As a result, our soil samples were very acidic (pH 4.5). We made an error during sample drying, so the moisture content was impossible to calculate. We could have used that data to see if there was a relationship between relief, elevation, and precipitation. As NASA satellites measure soil moisture, it would have been amazing to see if we have any correlation there. In Käsmu, we had four different soil expedition groups. Discussing and sharing our findings with others would have been a great way to improve our data.

There are excellent soil maps in Estonia, the accuracy of which is very high. Even though we always have room for improvement. As mentioned, soil maps can be used in many advanced processes like urban city planning and land reclamation. Each day we have more and more automated methods for data collecting and remote sensing via satellites, planes and even drones. The results contribute to a better understanding of the interdependence of climate, water, relief, vegetation and soil. As our possibilities improve, we could act faster, get real-time information in crises and target our attention to specific areas where help is needed the most.

References

Google (2022). Käsmu peninsula 1:500. https://www.google.com/maps/@59.616532,25.8796127,4484m/data=!3m1!1e3 Accessed: 04.08.2022

Republic of Estonia Land Board. Soil map https://xgis.maaamet.ee/xgis2/page/app/mullakaart Accessed: 04.08.2022

Republic of Estonia Land Board (2001). Vabariigi digitaalse suuremõõtkavalise mullastiku kaardi seletuskiri. Tallinn.