GLOBE Regional Learning expedition

Changes in microclimate with location and time at a coastal site in Estonia

Anna Maare Floren (Rakvere Riigigümnaasium)
Andri Kingisepp (Pärnu Jaagupi Põhikool)
Barbora Tomalová (Gymnázium a SOŠ Moravské Budějovice)
Tuuli Hommik (Antsla Gümnaasium)
Sirelin Käo (Põlva Kool)
Alex Rikkonen (Jõhvi Vene Põhikool)
Martin Kosmák (Gymnázium a SOŠ Moravské Budějovice)
Ivan Dukatš (Narva Keeltelütseum)
Helleri Hirv (Kääpa Kool)

Supervisors: Peter Falcon, Uku Andreas Reigo

Estonia 2023

Abstract

We explored a coastal site on Käsmu peninsula in the Gulf of Finland in Northern Estonia. We were interested in the changes in the microclimate with location and time at the coastal site. How the temperature and humidity change over time and in different locations. We had five different sites, starting from the shore to the forest, the distance between sites only 50 metres.

And our hypotheses were:

- The temperature will increase a little and will start decreasing as the sun is setting.
- The humidity will change only by a few percent, so it will stay even.
- The temperature will decrease as we are moving away from the shore and more inland.
- The humidity will also decrease as we are moving away from the water.
- The tree height will increase the further we go from the shore.

Out of the five hypotheses three were fully supported and two were partly supported. The biggest surprise was in how much the temperature changed and how uneven it was. One of the reasons for the mismatch could be because we did not consider how the coast is colder in the summer than the inland, as is typical for areas with maritime climate.

In the future the research should be more thorough, we should bring more tools and the methods to take measurements should be more clean and done more precisely. And it would be interesting to take measurements over a longer period of time.

Introduction

Käsmu village is located on a coastal area on the Gulf of Finland in Northern Estonia. It is an old captain's village where there have previously been no GLOBE expeditions, so we do not have much data about that region. It resides on the Käsmu peninsula on the west side of the Käsmu bay in Lahemaa National Park. Lahemaa National Park is the largest national park in Estonia. It was established to preserve, observe and promote North-Estonia´s nature, landscape, national and cultural heritage, ecosystems and biodiversity (Lahemaa National Park, n.d. - a-c).

Studying microclimate is important because gaining insight into the local characteristics of the climate helps us make more accurate climate change predictions and analyses. The purpose of our study was to find changes in microclimate with location and time at a coastal site in Käsmu village. Our research took place in August of 2022.

We had in total four research questions.They were formed knowing the data we were going to collect. The questions were:

1. How does the temperature and humidity change over time?
2. How does the temperature change while we are moving away from the shore to inland?
3. How does the humidity change while moving away from the water to inland?
4. How does the distance from the shore affect tree height?

And our hypotheses were:

- The temperature will increase a little and will start decreasing as the sun is setting.
- The humidity will change only by a few percent, so it will stay even.
- The temperature will decrease as we are moving away from the shore and more inland.
- The humidity will also decrease as we are moving away from the water.
- The tree height will increase the further we go from the shore.

Location, sites and weather conditions

The location of the research area was about 2km away from Käsmu village, Haljala parish, Lääne-Viru county. At the location area five sites were made. The distance between the sites was 50m. The first one being made at the shore and the last one 200m into the forest.

Site one (59°36’55.8"N 25°53’30.5"E) was 0m from the shore and a rocky, sandy beach. Site five (59°36’49.7"N 25°53’33.9"E) was 200m from the shore and a pine forest with an uneven landscape.

The research took place on August 3, 2022. The air temperature was 23°C, relative humidity 96% and air pressure 1022 hPa.

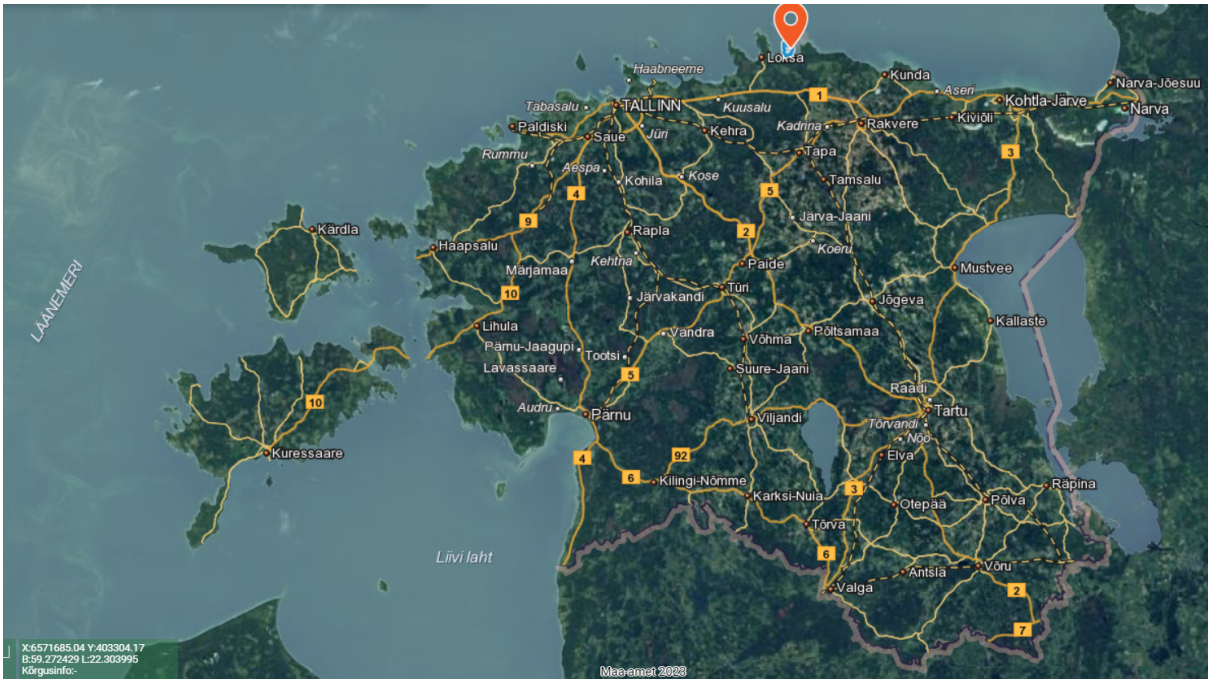

Figure 1. Location of Käsmu in Estonia. Source: Estonian Land Board (2023)

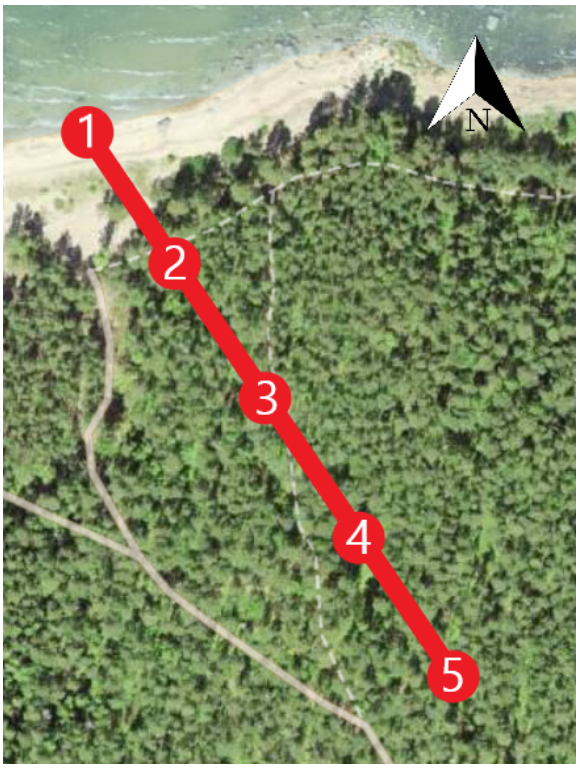

Figure 2. Research area description. Source: Estonian Land Board (2023) basemap with authors' own additions.

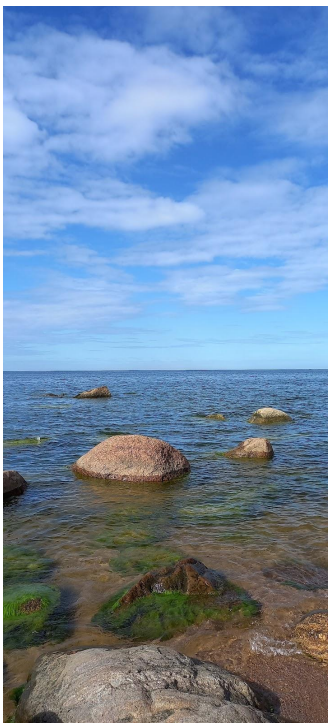

Figure 3. Site one.

Figure 4. Site five.

Methodology

For the data collection we used measuring tape and flags to mark our five sites (figure 5). On the sites we wrote down each site's coordinates and measured air temperature and relative humidity. On sites one and five we continued to measure temperature and humidity every 20-30 minutes from 3 PM till 5.30 PM. We also measured the height of the trees while moving from shore to inland. We did two atmosphere protocols on the GLOBE site. We observed clouds, measured air temperature, humidity, precipitation and air pressure.

To measure air temperature we used a digital thermometer and a meteorology thermometer. We used a GPS to register the site's precise coordinates. For the relative humidity we used a sling psychrometer and a regular psychrometer or a wet and dry-bulb thermometer.

We filled the sling psychrometer with distilled water and then slung it around for 40 seconds (figure 6) and repeated the slinging three or more times and used a chart to calculate the humidity. With the regular psychrometer we looked at the wet and the dry bulb and then calculated the humidity.

We used a 50 metre measuring tape to measure the distance from shore to inland and measured the height of every tree located two feet on both sides of the tape. To measure the trees we used the GLOBE Observer app and a clinometer.

Figure 5. Site one's mark.

Figure 6. Using the sling psychrometer.

Results

For a better overview of the collected data we gathered it into graphs. The points on the graph show that the temperature was uneven and changed regularly, but the trendline shows that it started to slightly decrease at the end of the research (Figure 7).

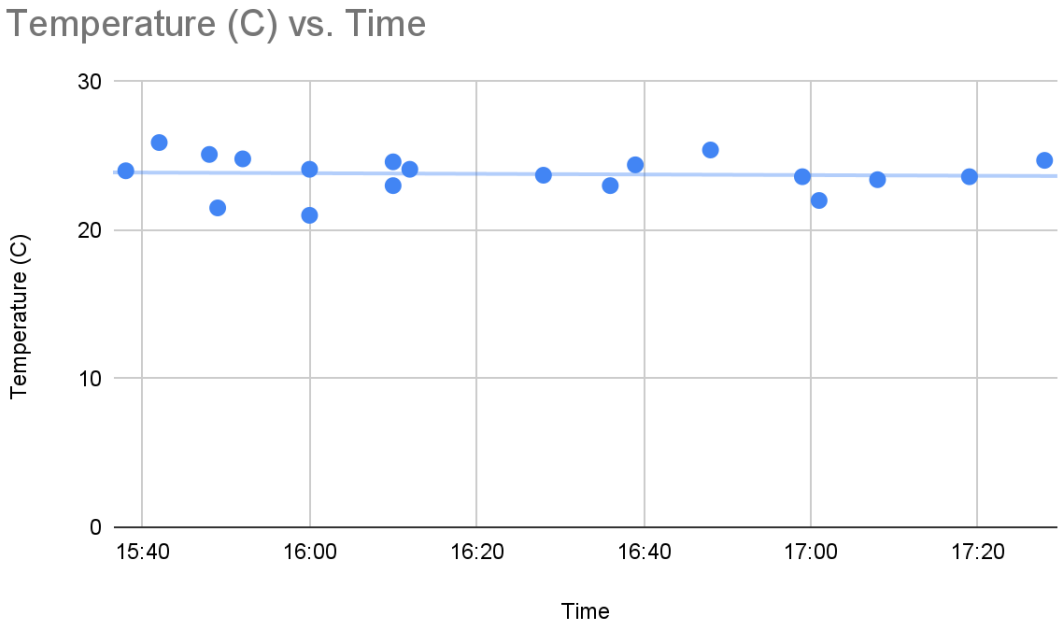

Figure 7. Temperature variation with time.

Interestingly the air temperature changed noticeably at site two but started to gradually rise and was higher at sites four and five than it was at site one (Figure 8).

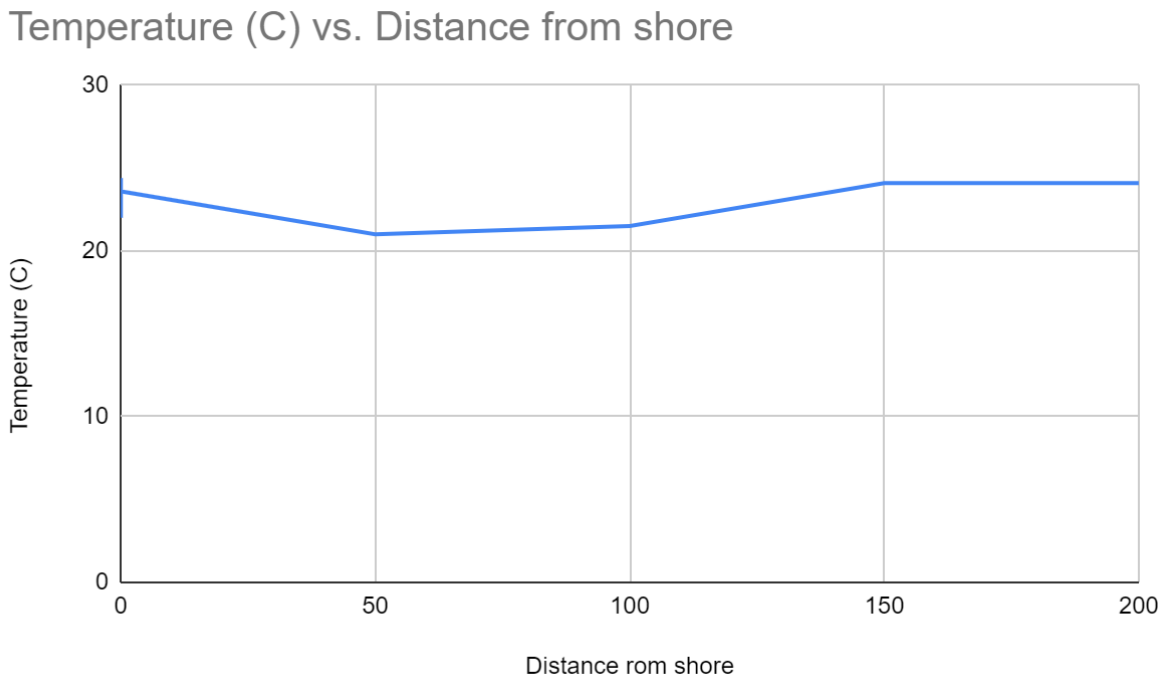

Figure 8. Distance from the shore´s effect on temperature.

The humidity started to decrease the more inland we went, although at site four it increased and decreased again on site five (Figure 9).

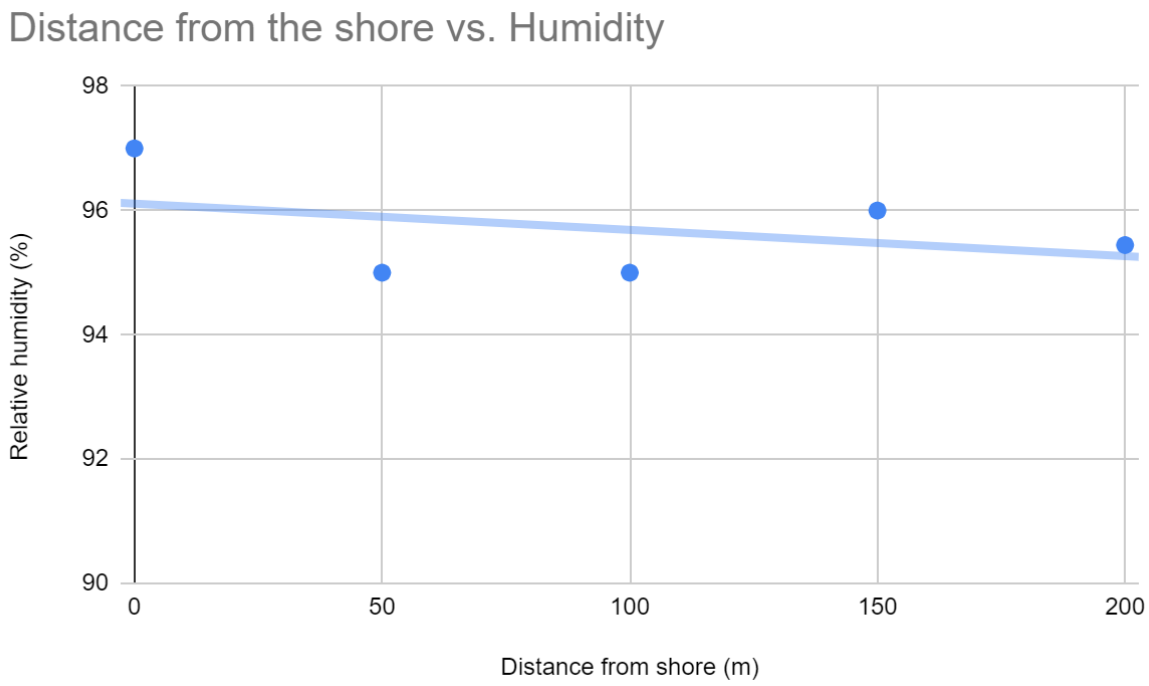

Figure 9. Distance from the shore´s effect on humidity.

On both sites the temperature was uneven and was constantly changing (Figure 10).

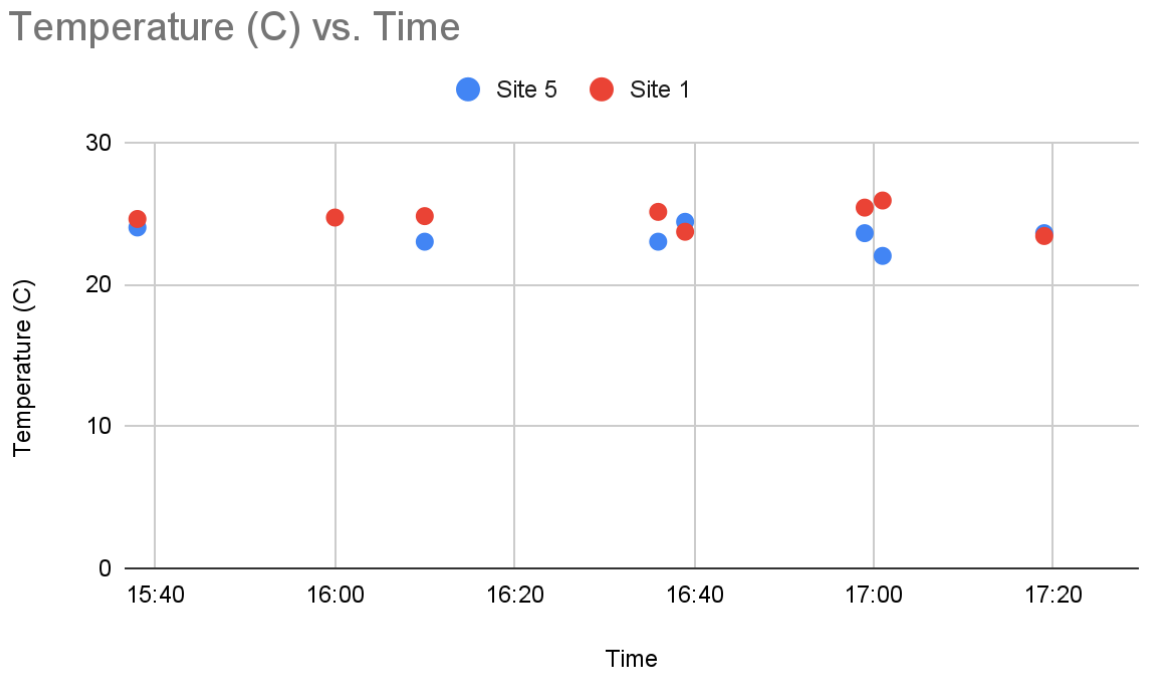

Figure 10. Temperature variation in two different locations.

The points on the graph show that the humidity was relatively even and there were only a few times when the humidity either increased or decreased significantly, which could also be due to measurement error. This observation is supported by the trendline (Figure 11).

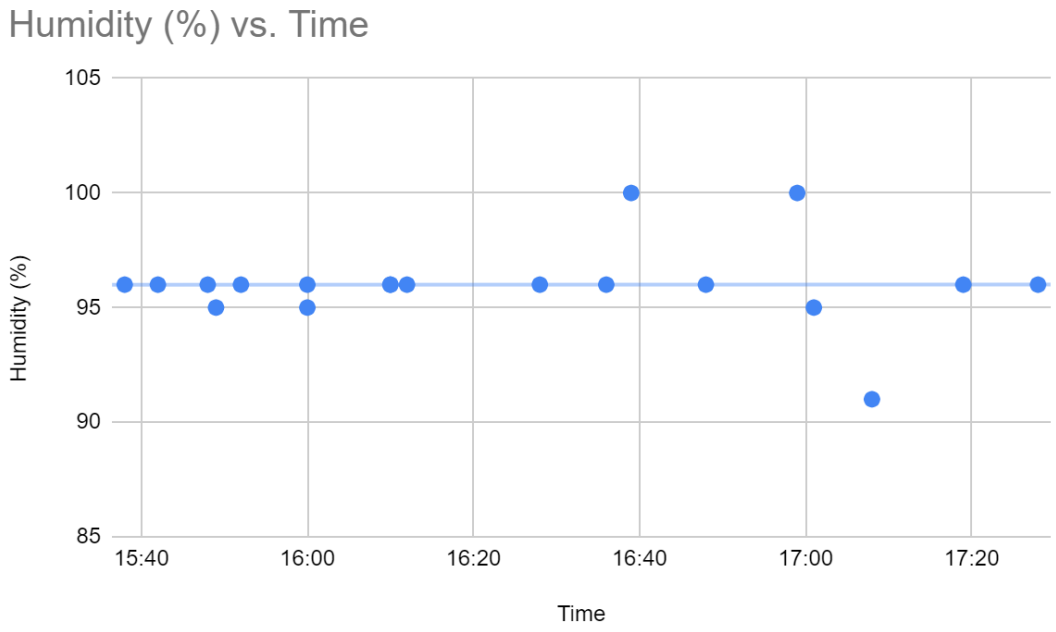

Figure 11. Humidity variation with time.

The further away that we moved from the shore, the more the tree height increased. The graph shows that the trees started to grow from about 20 metres away from the shore (Figure 12).

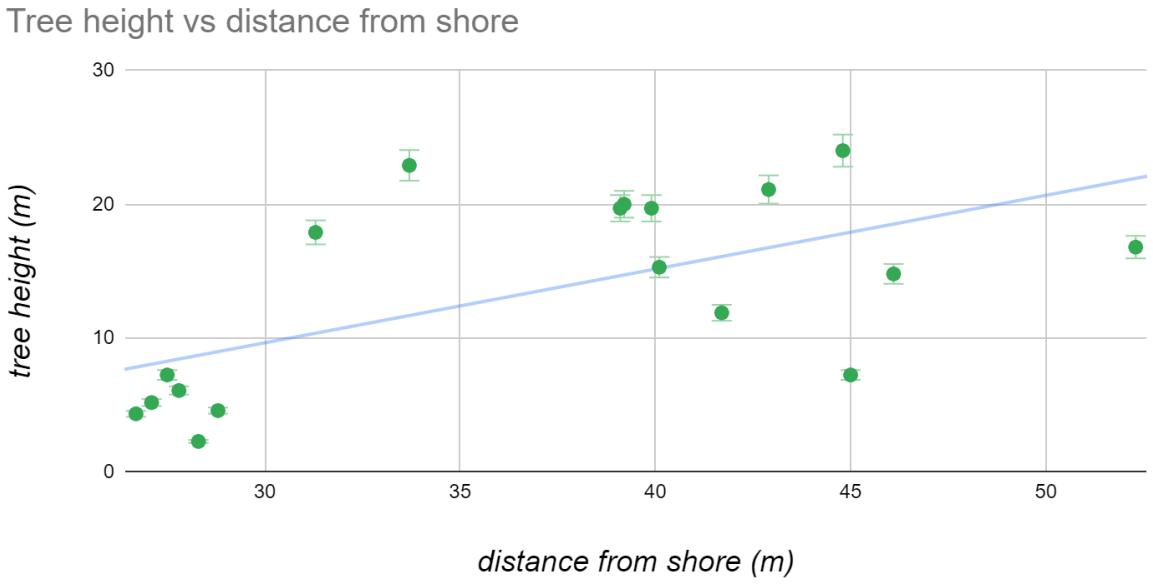

Figure 12. Distance from the shore´s effect on tree height.

Discussion

Based on the collected data we found that the temperature changed minimally over time in all of the sites but was overall still slightly decreasing. So our first hypothesis, that the temperature would increase a little at the start and start to progressively decrease was partly supported because the temperature did decrease but it was uneven and did not increase at the start like we predicted. One of the reasons why the air temperature measurements were so different and always changing could be the wind which we did not measure or consider. If we had continued to collect data, the decrease in the temperature would have been more noticeable.

Our second hypothesis - the humidity will change only by a few percent over time, so it will stay even - was supported as the humidity was even and did change only by a few percent, because it was always measured at the same place and there weren't other factors that could affect the humidity or the data collected.

The third hypothesis - the temperature will decrease as we are moving away from the shore and more inland where there is more tree coverage and less sunlight - was also partly correct, as the temperature decreased as we moved away from the shore but then suddenly and as a surprise to us started to rise again at site three and site four and then was even in site five. As mentioned before one of the factors that could have changed the results was the wind, but also we did not consider that the shore in summer is usually colder as the water is heating up slowly, but is warmer in winter, as water cools slowly as well so keeping the area's air temperature warmer.

Our fourth hypothesis - the humidity will also decrease as we are moving away from the water as the humidity is the highest near the water - was supported as on the graph the trendline shows the noticeable decrease in the humidity as we are moving away from the shore.

And our final hypothesis - the tree height will improve because of the soil improvement which has less sand and more nutrition the further we go from the shore - was also supported as the further away we went from the shore the more the tree height improved because soil improved and it contained less sand.

Conclusions

According to our research, at a coastal site on the Käsmu peninsula the air temperature is uneven and changes a lot but over time starts to decrease at the end of the day, as expected. The changes could be because of the wind which we did not measure or consider during the research.
The humidity changes very little over time, if only by a few percent.
While moving away from the shore the air temperature decreases for a short distance but increases which could be because in the summer the shore is colder because the water heats up slowly, which we did not consider while making our research questions, so it surprised us.
The humidity will also decrease as we are moving away from the shore because we are moving away from the water where the humidity is the highest.
The research also shows that the further away we went from the shore the more the height of the trees improved, most likely thanks to the soil improvement and that the soil consists of less sand.

If we were to do this research again, we would plan our activities more ahead and talk more thoroughly about what we are going to research and our questions and hypotheses. We would also take more tools with us so we can collect more data and everybody has something to do all the time while on the expedition. Also, write all the data that we collect in a notebook in case the technology lets us down.

If we were to continue this research, it would be interesting to see the changes in microclimate over a longer period of time because this time we only collected data for two and a half hours but we should do it for a couple of days 24/7 or even throughout the year to see how the different seasons affect those changes.

References

Estonian Land Board. (2023). *X-GIS 2.0 [core_aluskaardid]*. Maaameti Aluskaart (Estonian Land Board's Basemap). Retrieved March 9, 2023, from https://xgis.maaamet.ee/xgis2/page/app/core_aluskaardid

Lahemaa National Park. (n.d. - a). Kaitsealad. Retrieved November 5, 2022, from https://kaitsealad.ee/et/kaitsealad/lahemaa-rahvuspark

Lahemaa National Park. (n.d. - c). Wikipedia. Retrieved November 5, 2022, from https://en.wikipedia.org/wiki/Lahemaa_National_Park

Lahemaa National Park. (n.d. - b). Loodusega koos. Retrieved November 5, 2022, from https://www.loodusegakoos.ee/kuhuminna/rahvuspargid/lahemaa-rahvuspark