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The impact of the landscape surrounding the Saesaare reservoir on weather (microclimate)

Authors: Markus Vurm, Mariel Meeks, Artur Kroonberg, Liisi Nei, Joakim Albert, Jakob-Kristur Kiis, Sille Kriis

Supervisor: Uku Andreas Reigo

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Table of contents

Abstract

Bodies of water, including lakes and rivers, significantly influence the local climate, weather patterns, and ecosystems. While large bodies of water, such as oceans, have a major impact on global climate, smaller bodies like lakes and rivers also play a critical role in their immediate surroundings. This study aimed to examine how proximity to a body of water affects air humidity and temperature across different terrain types, specifically comparing forested areas, clearings, and forest edges. The hypothesis posited that air humidity would decrease with increasing distance from the water and that forested areas would have higher humidity levels compared to clearings. Additionally, it was hypothesized that temperatures in forested areas would be lower than in open fields. Measurements of air temperature, humidity, and surface temperature were taken at various points along the Saesaare Reservoir in three distinct terrain types. The results showed that while air humidity remained stable regardless of distance from the lake, forested areas exhibited higher humidity levels than open fields. Temperature data also confirmed that the forest was cooler than the open field. These findings highlight the role of vegetation and proximity to water bodies in shaping microclimates, providing valuable insights for environmental planning and climate modeling.

1. Introduction and review of literature

Bodies of water play a major role in the climate and ecosystem of the Earth. 71% of the Earth's surface is covered with water (NGWA, n.d.). This means knowing how the Earth's surface water affects its climate and weather patterns is extremely important. While the climate is affected most by the largest bodies of water, the oceans, it is also important to recognize and understand how smaller bodies of water like lakes and rivers can also have an effect on their immediate surroundings.

By knowing how lakes and rivers affect the microclimate around them, it is possible to determine how the presence of them might influence the ecosystem in the immediate vicinity. This is useful, for example, when planning an artificial body of water and trying to determine the effect it might have on the local environment.

Water has an extremely high heat capacity, which means it takes a lot of energy to warm up or cool down. Places closer to large bodies of water, such as the ocean, have much more moderate climates than places further inland, due to the ocean's ability to dampen temperature swings. Oceanic climate is generally defined as having mean temperatures of below 22 °C in the warmest month and above 0 °C in the coldest month (Soil Health, n.d.).

Water bodies can also have an effect on air humidity. Water is constantly evaporating from their surface and this can mean that close to a lake or river the air humidity is larger than would be expected of said area if there were no water bodies.

Another big variable to atmospheric measurements is the type of land cover in a particular location. Forested areas are generally cooler than clearings.

Studying how variables such as land cover and water bodies affect atmospheric measurements is important because it can help us gain insight on how different ecosystems might be affected by climate variations such as climate change.

Research Questions and Hypotheses

Our main question was: Does distance from a body of water measurably impact air humidity? This is important because the more humidity the air has, the harder it is to warm up due to the high specific heat of water, and this can decrease the effects of heat waves. Air humidity also affects many natural processes such as decomposition and it is useful to have better models about how these processes work.

We hypothesised that when moving away from a body of water, air humidity will steadily and noticeably decrease.

Our second question was: Is there a noticeable difference in air humidity between forested areas and clearings?
We hypothesised that air humidity would generally be higher in areas with more vegetation e.g forests.

Our third question was: Does distance from a body of water measurably impact air temperature?
We hypothesised that a body of water would keep temperature lower than in the surrounding area, given the measurements were taken in summer.

2. Research methods and materials

To determine how a water body might affect atmospheric measurements, we measured temperature, air humidity, and surface temperature. We also noted geographic coordinates, cloud cover, cloud types, land cover, surface temperature and later added distance from the lake as a datapoint. We used a digital thermometer, a psychrometer, a barometer, a phone, GLOBE Cloud Chart and an infrared thermometer.

In the beginning we attempted to measure temperature with our digital thermometer, but we noticed that its measurements seemed to fluctuate less than would be expected and we figured this was because we stayed at each location for a relatively short time, so it did not have time to adjust to the temperature. We ended up using the dry bulb temperature from the psychrometer as air temperature data instead, because it appeared more accurate and changed faster.

Surface temperature was measured using an infrared thermometer and, where possible, we noted both the temperature in the shade and in the sunlight. For each measurement we also noted the land cover on which it was taken. This allowed us to compare for example how moss cover affected surface temperature compared to a grassy patch or a dirt road.
We also noted cloud cover and type because they are related to humidity in the atmosphere, so we could use them to make conclusions about our measurements later on.
The measurements were marked into Google Sheets along with the observations so we could later easily analyze the data, create charts and draw conclusions.

Locations

We roughly divided our 8 measuring locations into 3 categories: clearing, forest and the border of a clearing and a forest (Figure 1). This allowed us to have another variable in addition to distance from a body of water. Of our locations, 4 fell into the forest category, 1 was in a field, and 3 were in between.

Figure 1. Measuring locations

3. Results

Terrain and air humidity

One of our research questions asked how different terrain impacts air humidity (Figure 2). For this we divided our measuring locations into 3 categories: clearing, forest and the border of the two. Of our locations, four were classified as forest, one as a field, and three were on the border. The average humidity in the forested areas was 65.3%, 59.0% in the clearing and 76.5% on the forest's edge.

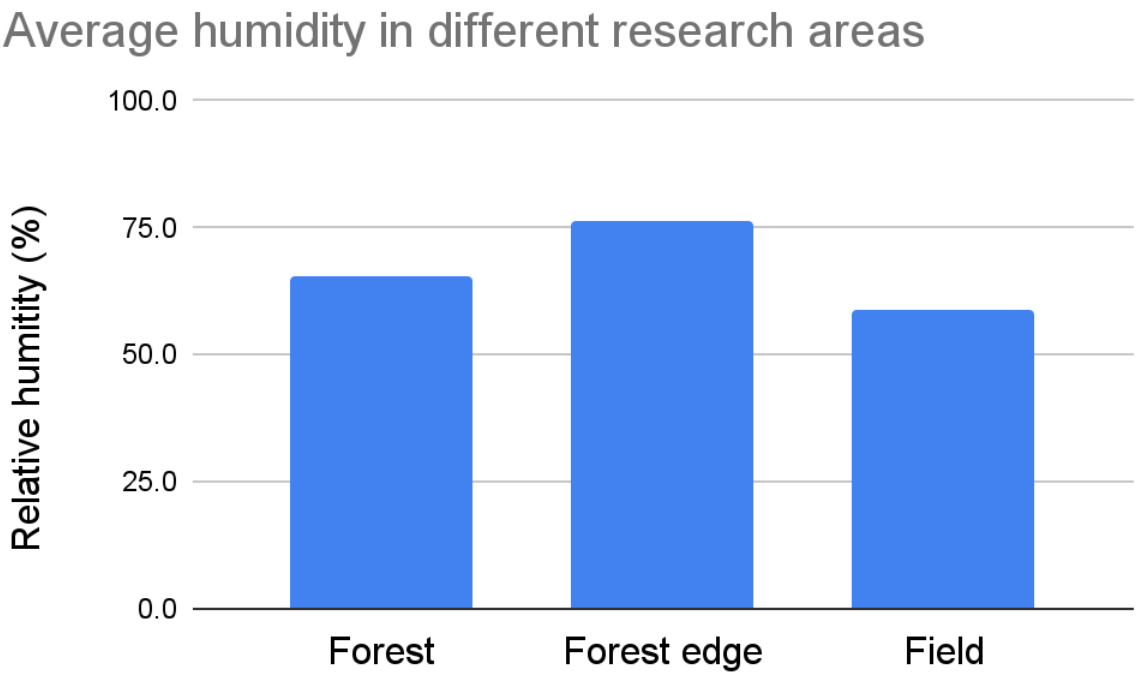

Figure 2. Average humidity in different research areas

Air humidity as a factor of distance from the lake

To measure how air humidity was affected by distance from the lake, we noted down the coordinates of each measuring point and later, using an online mapping tool, for each point, measured its distance from the lake (Figure 3). Our distances ranged roughly from 0 meters to 300 meters. We found a slight increase in the average air humidity at around the 150 meter mark, but overall there was no strong correlation and we determined the bump to most likely be a coincidence.

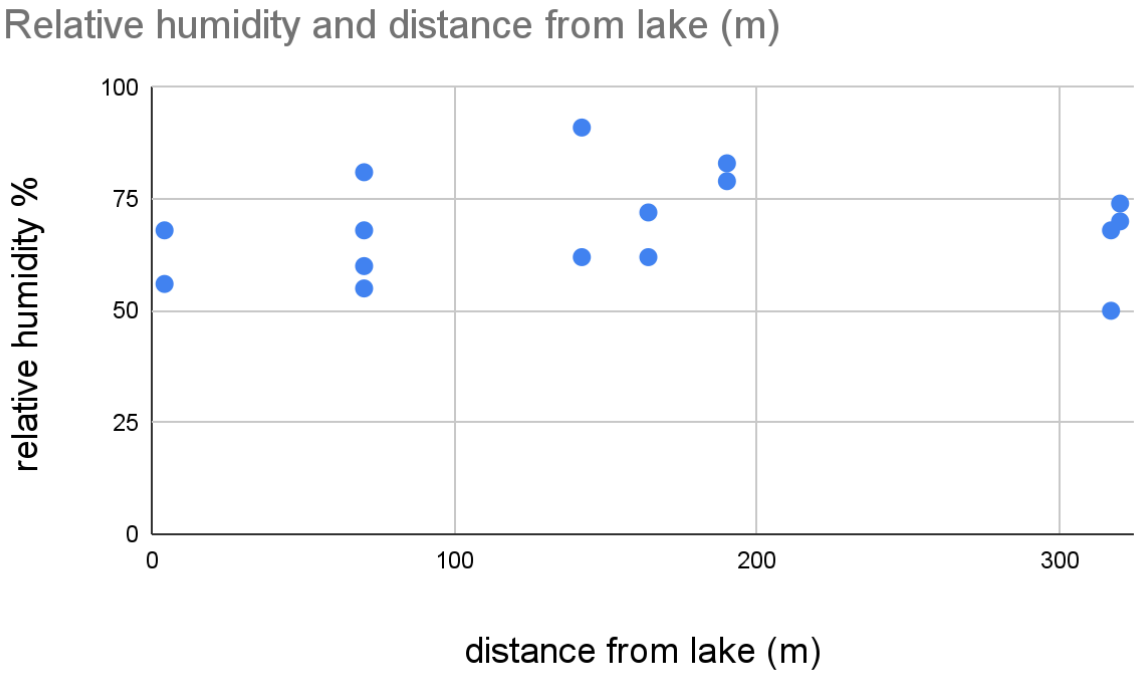

Figure 3. Relative humidity and distance from lake

Terrain and air temperature

For this we used the same three types of terrain we used when considering air humidity in varying terrain: clearing, forest, and the border of the two (Figure 4). The average temperature in forested areas was 24.2°C, in the clearing it was 25.8°C and on the border it was measured at 23.7°C.

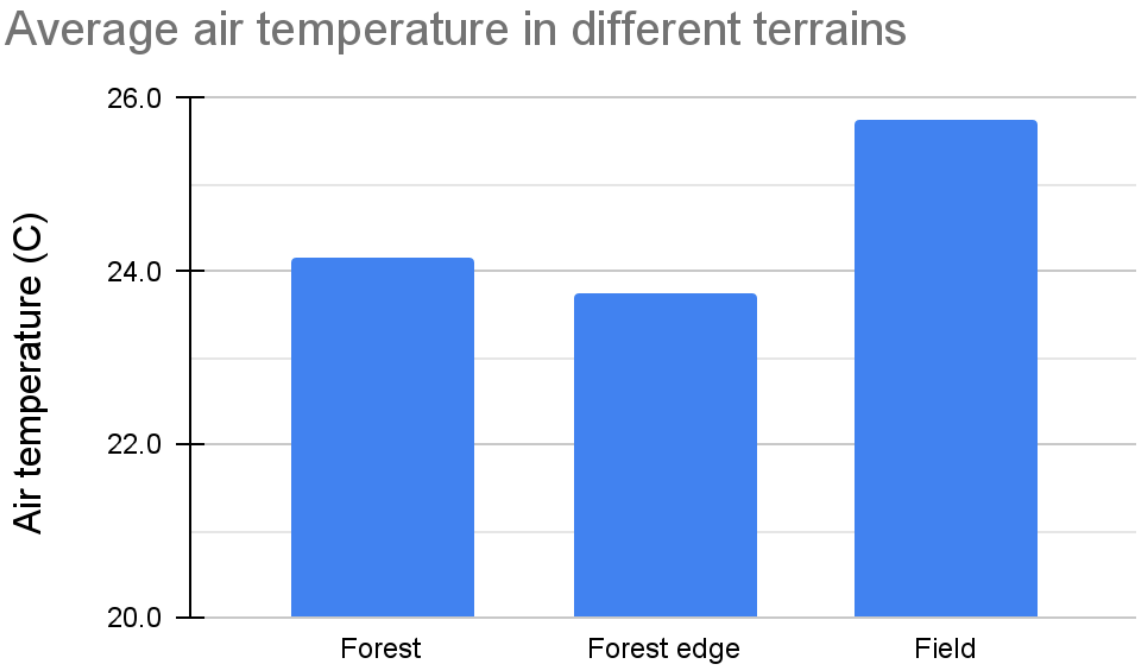

Figure 4. Average air temperature in different terrains

4. Discussion

Our measurements were affected by many factors, such as changing weather, difference in the time of day between measurements and the fact we used measuring equipment that might not have been entirely accurate. This means the data presented might be slightly inaccurate.

We tried to minimise variations caused by weather and time of day by moving between our measuring points as fast as possible. To check the temperature readings from our digital thermometer we also noted the dry bulb temperature of our psychrometer, which helped us minimize errors in our measurements.

Terrain and air temperature

On average, the temperature in the forest was 1.6°C lower than in the clearing and 0.5°C higher than in the forest's edge. According to the results, the most humid area was the forest edge, followed by the forest, while the driest area was the field. The warmest area was the field, with the forest being second, and the coldest area was the forest edge.

Humidity levels did not change significantly as the distance from the lake increased.
These findings indicate distinct microclimatic conditions in different land types, with the forest edge providing a more humid and cooler environment compared to the warmer and drier conditions in the field.

5. Conclusions

Hypothesis Verification:

1. **Air humidity decreases as we move away from Saesaare Reservoir:**
    - Based on the results, it seems that **humidity levels did not change significantly** as the distance from the lake increased, which **contradicts the hypothesis**. The air humidity remained relatively stable regardless of the distance from the reservoir.
2. **Relative humidity in the forest is higher than on the open field:**
    - The **forest edge** showed higher humidity levels than the field, which supports the hypothesis that **humidity is greater in the forest than in the open field**. Forests tend to retain more humidity due to the presence of vegetation and less exposure to direct sunlight.
3. **Temperature in the forest is generally lower than on the open field:**
    - According to the results, the **field** was the warmest area, and the **forest** was second in terms of temperature, confirming that **temperature is generally lower in the forest** compared to the open field, likely due to shade and the cooling effects of the forest canopy.

Challenges Encountered:

- We only had one measurement point on the **open field** (lagendik), as we accidentally ended up in a **pasture**. To avoid potential conflicts with the **cows** in the area, we decided to leave the site shortly after, which limited our data collection there.
- The initial goal was to move away from the lake in a **straight line**; however, due to **obstacles**, this plan could not be executed perfectly, which may have affected the accuracy or consistency of the measurements.
- There were also issues with one of the **measurement instruments**, which could have been **prevented** by bringing **additional equipment** to ensure a smoother data collection process.

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