The impact of ecological factors on the quality of water

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Abstract

Surface water bodies are a natural part of our landscapes. They are home to many aquatic animals and plants. They give water and food for many animals living on dry land and for people as well. All living beings are in close connection with their environment. As a result of human activity, nutrients and pollutants enter surface waters.
Water quality influences the organisms and big changes can be dangerous to them.

Based on the first data collected we asked the research question: How ecological factors influence the quality of water?

In August 2020, five water bodies with six sites were studied. The water bodies were Lake Viljandi, the Raudna river, a pond at Sammuli holiday village, a beaver stream and a pond in the middle of a horse pasture. 6 sites were chosen and 5 slightly different sites were paired up for comparison. These were Lake Viljandi and Sammuli pond, Lake Viljandi and the Raudna river, Beaver stream and Beaver pond. The Horse pond was studied separately. Every pair of sampling sites was hypothesized to have at least one different ecological factor: temperature, nutrients, transparency, or dissolved oxygen. Samples were collected and water analyses were done according to GLOBE protocols.

Introduction and Review of Literature

Surface water bodies are a natural part of our landscapes. They are home to many aquatic animals and plants. They give water and food for many animals living on dry land, and for people as well. All living beings are in close connection with their environment. As a result of human activity, nutrients and pollutants enter surface waters. Water quality influences all the water organisms and big changes can be dangerous to them. Therefore, studying water bodies is important. (Ader, Tartes 2014)

This student research focused on five water bodies: Lake Viljandi, a pond at Sammuli holiday village, the Raudna river, a small stream and a pond in the middle of a horse pasture.

Lake Viljandi is located in Viljandi County, in the deep primeval valley of Viljandi that runs through the central part of the Sakala Uplands. Its average depth 5.6 m (maximum depth 11 m), length 4.6 km and width 450 m. (Laarmaa et al. 2019)
There is a pond at Sammuli holiday village which is connected with Lake Viljandi.
The Raudna River flows out from Lake Viljandi and is the right tributary of the Halliste River. Its length is 62.5 km (with additional branches 65.6 km).
The Beaver stream flows into the Raudna river. The horse pond is not far from the lake, situated in the middle of a horse pasture.

Research Question and Hypothesis

We propose the research question “How ecological factors influence the quality of water?” and based on the overview of the research topic, we propose the following hypotheses:

1. In Sammuli pond the temperature is higher and there are more nutrients compared to Lake Viljandi .
2. In the Raudna river the temperature is higher and there is more dissolved oxygen compared to the lake.
3. Sediments settle in front of the beaver dam, so the water downstream is more transparent.
4. The water in front of the beaver dam and behind it have different properties.

5. The pond located in the middle of the horse pasture is rich in nutrients due to horse manure. It increases the amount of nitrates and causes water bloom.

Research Methods and Materials

We collected data around Sammuli holiday village on 12 August 2020 from 9 a.m. to 1 p.m. We chose five water bodies and six sites (Figure 1).

The water bodies are Lake Viljandi, Sammuli pond, the Raudna river, the Beaver stream and the Horse pond.

Six sites were chosen and five slightly different ones were paired up for comparison. These are Lake Viljandi and Sammuli pond, Lake Viljandi and the Raudna river, Beaver stream and Beaver pond. One site - the Horse pond - was studied separately. Every pair of sampling sites represented the same water in different environmental conditions

At the sampling sites we defined the site using the GLOBE Data Entry app. We measured temperature, dissolved oxygen, pH, conductivity and transparency. Also, we took back some water in bottles for later research, such as for measuring alkalinity and the amount of nitrates and phosphates.

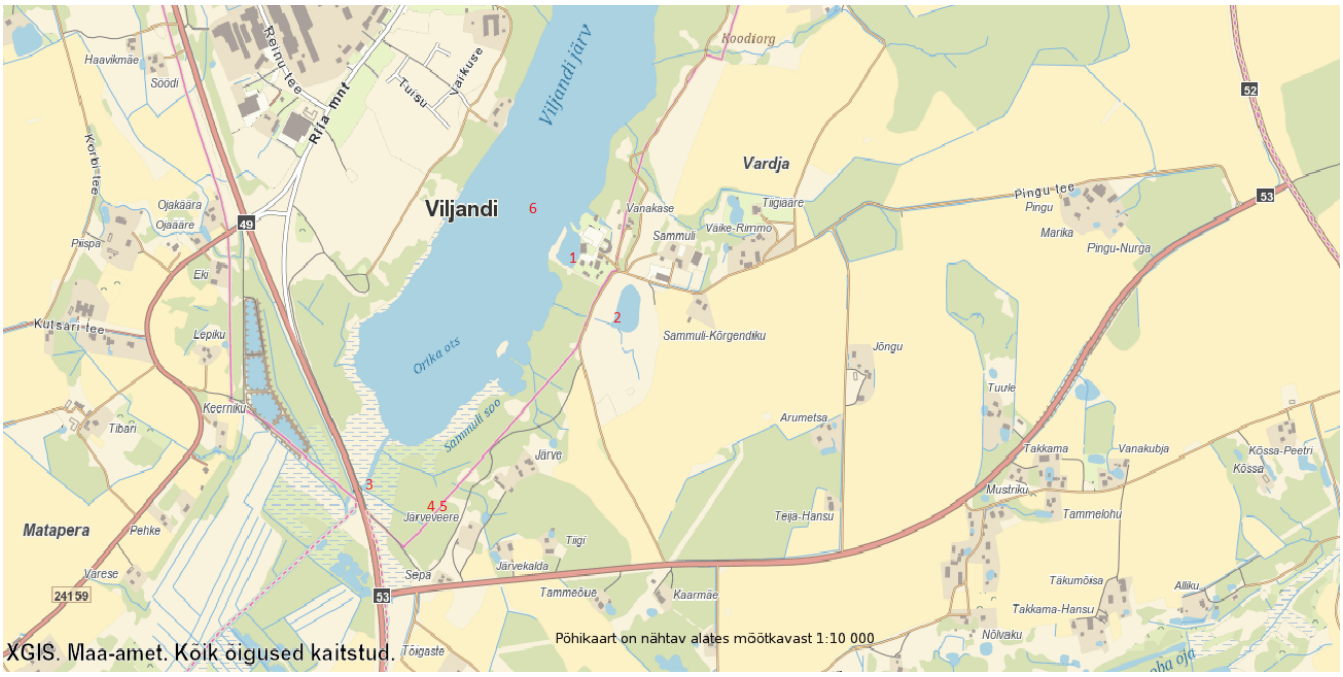

Figure 1. Map of research area

Equipment used:

- Vernier LabQuest 2: Stainless Steel Temperature Probe, pH Sensor, Optical DO Probe, Conductivity Probe
- Macherey-Nagel: Visocolor ECO Nitrat, Visocolor ECO Phosphate, Visocolor HE Alkalinität AL 7
- Transparency Tube

Results

The results were compared pairwise. Every pair of sampling sites represented the same water in different environmental conditions. Discussed data are highlighted in yellow.

Sammuli pond is a part of Lake Viljandi, so the water is the same, but the sizes are very different (Figures 2 and 3). The temperature was higher in Lake Viljandi (21,2°C), the oxygen level was higher in Sammuli pond (11,6 mg/l) and the NO_3 level was higher in the Lake (table 1).

Table 1. Data from sites 1 (Sammuli pond) and 6 (Lake Viljandi)

Site name	Site №	Temperature	Oxygen	pH	Conductivity	NO_3	PO_4	Alkalinity	Transparency
		° C	mg/l		µS/cm	mg/l	mg/l	mmol/l	m
Sammuli pond	1	20,4	11,6	8,3	276,7	0	0	4,5	>1
Lake Viljandi	6	21,2	10,73	8,7	275,9	1	0	4,1	>1

Figure 2. Site 6, Lake Viljandi

Figure 3. Site 1, Sammuli pond

The Raudna river flows out from the lake, so the water is the same but in the river the water is moving (Figures 4 and 2). The oxygen level was higher in Lake Viljandi (10,7 mg/l) and the NO_3 level was higher in the Lake (table 2).

Table 2. Data from sites 3 (the Raudna river) and 6 (Lake Viljandi)

Site name	Site №	Temperature	Oxygen	pH	Conductivity	NO_3	PO_4	Alkalinity	Transparency
		º C	mg/l		µS/cm	mg/l	mg/l	mmol/l	m
Raudna river	3	20,0	6,1	7,8	278	0,5	0	4,5	>1
Lake Viljandi	6	21,2	10,7	8,7	276	1	0	4,1	>1

Figure 4. Site 3, the Raudna river

There is a narrow stream which flows into the Raudna river. A beaver has built a dam, so there is

a pond upstream (Figure 5). The water is the same but downstream the dam it is moving. The temperature was the same in both water bodies, the oxygen level was higher in Beaver stream (2,2 mg/l) (table 3).

Table 3. Data from sites (Beaver pond) and 5 (Beaver stream)

Site name	Site №	Temperature	Oxygen	pH	Conductivity	NO_3	PO_4	Alkalinity	Transparency
		º C	mg/l		µS/cm	mg/l	mg/l	mmol/l	m
Beaver pond	4	15,6	1,2	7,9	291,3	0	0,5	5,8	>1
Beaver stream	5	15,6	2,2	7,8	293,2	0,1	0,5	5,5	>1

Figure 5. The Beaver pond

There is a pond in the middle of a horse pasture (Figure 6). The pond is not connected with other

water bodies but the site was interesting because of the horses.

The NO_3 level was 0 and the transparency was 0,39m (table 4).

Table 4. Data from site 2 (Horse pond)

Site name	Site №	Temperature	Oxygen	pH	Conductivity	NO_3	PO_4	Alkalinity	Transparency
		º C	mg/l		µS/cm	mg/l	mg/l	mmol/l	m
Horse pond	2	20,9	8,31	8,0	264,5	0	0	3,8	0,39

Figure 6. Site 2, the Horse pond

Discussion

We studied five water bodies and tried to understand how different ecological factors influence the quality of water.

We set up five hypotheses, two of which were not confirmed and some partially confirmed.

1) We thought that the Sammuli pond, which is connected to the lake, has a higher temperature and more nutrients than the lake because the pond is smaller. This hypothesis was not confirmed. Temperatures are almost similar. The results show the dependence of oxygen solubility on water temperature. At higher temperatures, there is less dissolved oxygen in the water. Nitrates were found in the lake but not in the pond. This may be due to the large number of plants in the pond. Plants and algae have used up nutrients. There are no plants in the middle of the lake. In general, these bodies of water have similar water because they are interconnected.
2) Water from Lake Viljandi flows into the Raudna River. We thought that the water is quite similar, but the Raudna River has a lower temperature and more oxygen than the lake, because the river has flowing water. This hypothesis was also not fully confirmed. The results show that the oxygen content is higher in the lake. The temperature is really a bit lower in the river, but we measured it several hours earlier. As water temperatures are not very different, and there are more photosynthetic plants in the river, we cannot explain this result. We noticed that, based on our results, there are fewer nitrates in the river. This may be due to the large number of plants that use nitrogen to grow.
3) A very interesting observation point was at the beaver dam. On one side of the dam the water stands still, and at the bottom there is a very thick layer of mud with a layer of water about 20 cm thick on top. Stepping into the pond, the feet sank half a meter into the mud. There was the smell of rotten eggs. On the other side of the dam, the stream continued to flow. Our hypothesis was that sediments would be trapped behind the beaver dam and, as a result, there would be more transparent water downstream. However, the water was equally transparent on both sides.
4) Another hypothesis was that the water in front of and downstream of the beaver dam will share different water qualities. This was partially confirmed. In fact, the main difference was in the oxygen content. There was almost two times more oxygen in the flowing water. However, the amount of oxygen at both measuring points is very low. We explain this by the decomposition process in thick mud, where bacteria use up oxygen. The smell of rotten eggs also proved this. The water temperature was surprisingly low, probably from cold and oxygen-poor springs. Other water qualities were similar.
5) One of our hypotheses was that horse manure flows with rainwater into the horse pond, which increases the nitrogen content, and the pond is in bloom. When we analyzed the

water, we did not find any nitrates or phosphates, but the transparency of the water was very low - only 0.39 m. There may have been a lot of phytoplankton consuming the nutrients. Thus, the latter hypothesis was partially confirmed.

Conclusion

The whole expedition was very inspiring because we saw that there was a lot to learn.

We got interesting results about which we did not have any hypotheses. For example, the water temperature in the beaver stream was very low compared to other waters.
We were not able to explain all the results, so to make conclusions we need more time and data. We could collect more data during different periods from the same locations using the same methodology.

The whole group found the learning expedition very interesting and we learned to do scientific research.

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