GLOBE Estonia Learning Expedition

The effect of urban environment on the River Emajõgi

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Abstract

Human activity influences water quality in many ways. Life in cities can impact water bodies that are within city boundaries, and through them it can reach nature. That is why we wanted to study the water quality in River Emajõgi in Tartu, Estonia and how it changes throughout the city at different measuring sites. We found small changes in the water quality and suspect the impact of construction on the riverside area and riverside vegetation to have influenced these parameters. More studies like this are needed to draw more accurate conclusions.

Introduction

Water quality can be affected by nearby settlements (Anh et al., 2023; Glińska-Lewczuk et al., 2016). It is influenced by human activity and settlements, runoff and discharge from industrial and agricultural practices, but also from changes in land use and climate in the area (Anh et al., 2023). Although the influence of urban areas on river water quality has been studied in many places in the world, there are limited accessible studies about it for river Emajõgi.

The City of Tartu is located on the banks of River Emajõgi, one of Estonia's biggest rivers. It connects Lake Võrtsjärv to Lake Peipus and impacts various important habitats as it flows through the Alam-Pedja nature reserve and Peipsiveere nature reserve (Estonian Land Board, n.d.), ultimately flowing to Lake Peipus and thus connecting to the Baltic sea. The Emajõgi is classified as a lowland river with low water velocity and is 100km in length (Kõrs et al., 2012). The City of Tartu sits in the middle of these two lakes, with the river flowing through the city center. Research done on a similar river in Poland found that as river passes through a town, immediate changes can be seen to the water quality immediately downstream from the towns (Glińska-Lewczuk et al., 2016).

That is why we wanted to study how the urban environment might affect the water quality in the river, and how the hydrological parameters change throughout the city.

Research questions and hypotheses

We asked the following research questions:

1. How does the urban environment affect the water quality?
2. Do the hydrochemical and hydrophysical parameters change along the river?

Our hypotheses were:

1. The urban environment affects the water quality negatively.
2. The oxygen level decreases along the river.
3. Transparency decreases along the river because of the impact of the city.

Materials and Methods

Estonia is located on the north border of the hemiboreal forests climate zone.
58°22'48,5" N
26°43'20,9" E

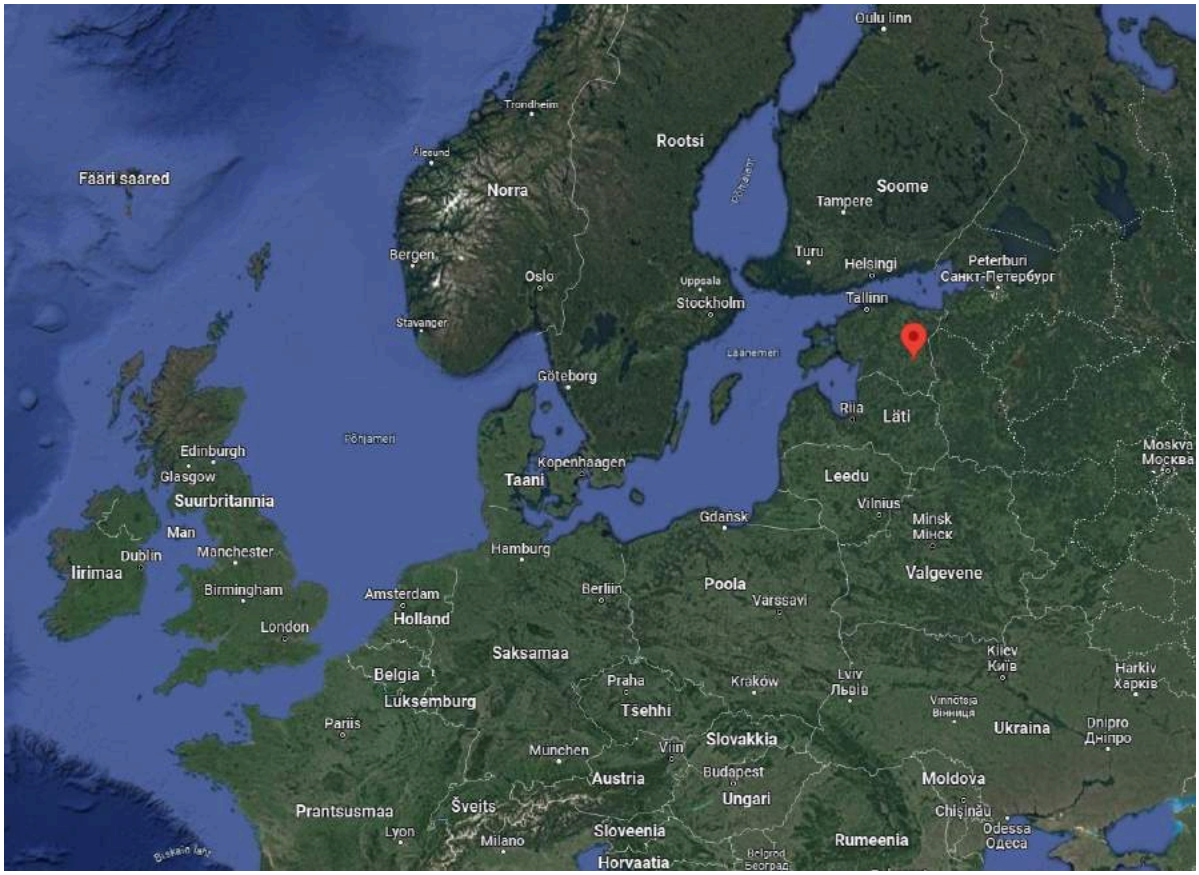

Figure 1. Location of Tartu, Estonia on a map of Europe (Google Maps).

The data was collected from river Emajõgi in South Estonia, which runs west to east from Lake Võrtsjärv to Lake Peipus (Peipsi in Estonian). The river is 100km long and flows through two nature reserves. We studied the river within the City of Tartu at three different study sites and shared data with another research group who collected data downstream from us. At the middle site, we noticed there was construction going on of a riverside pier or boulevard.

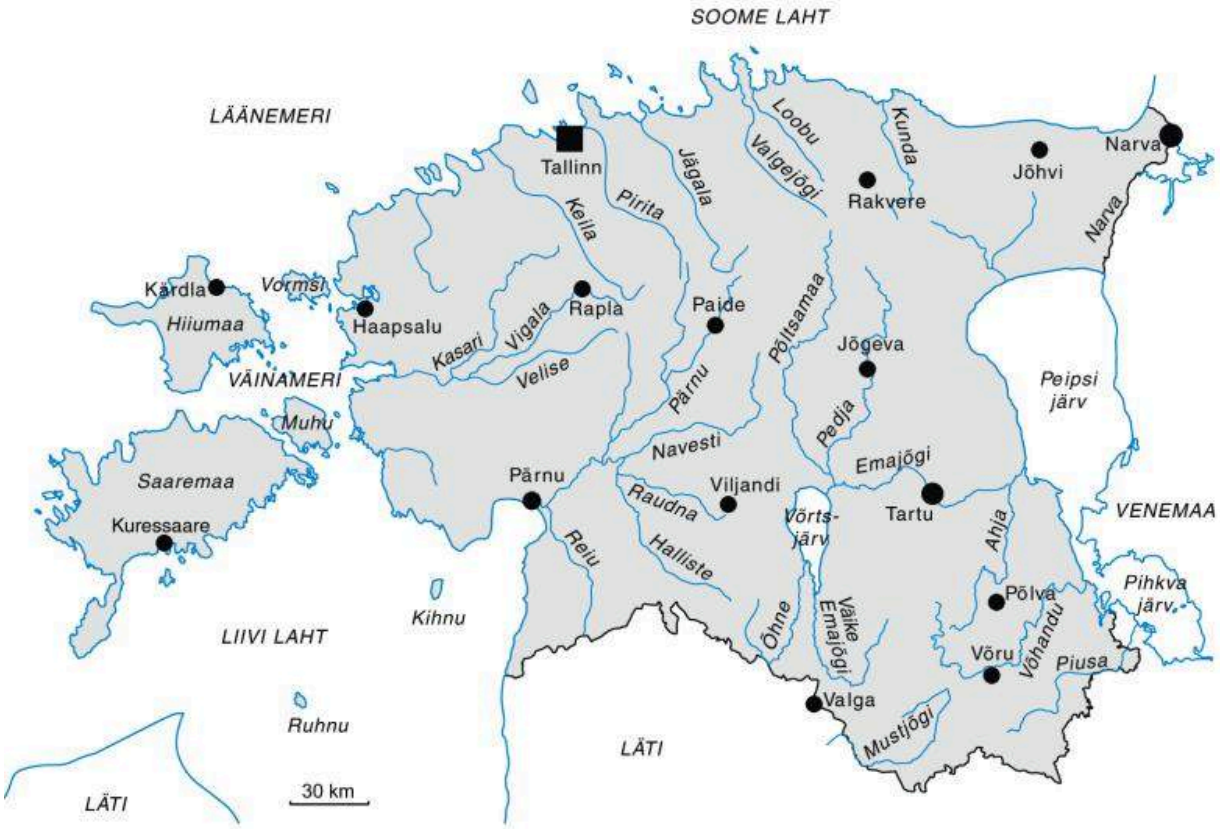

Figure 2. Location of river Emajõgi

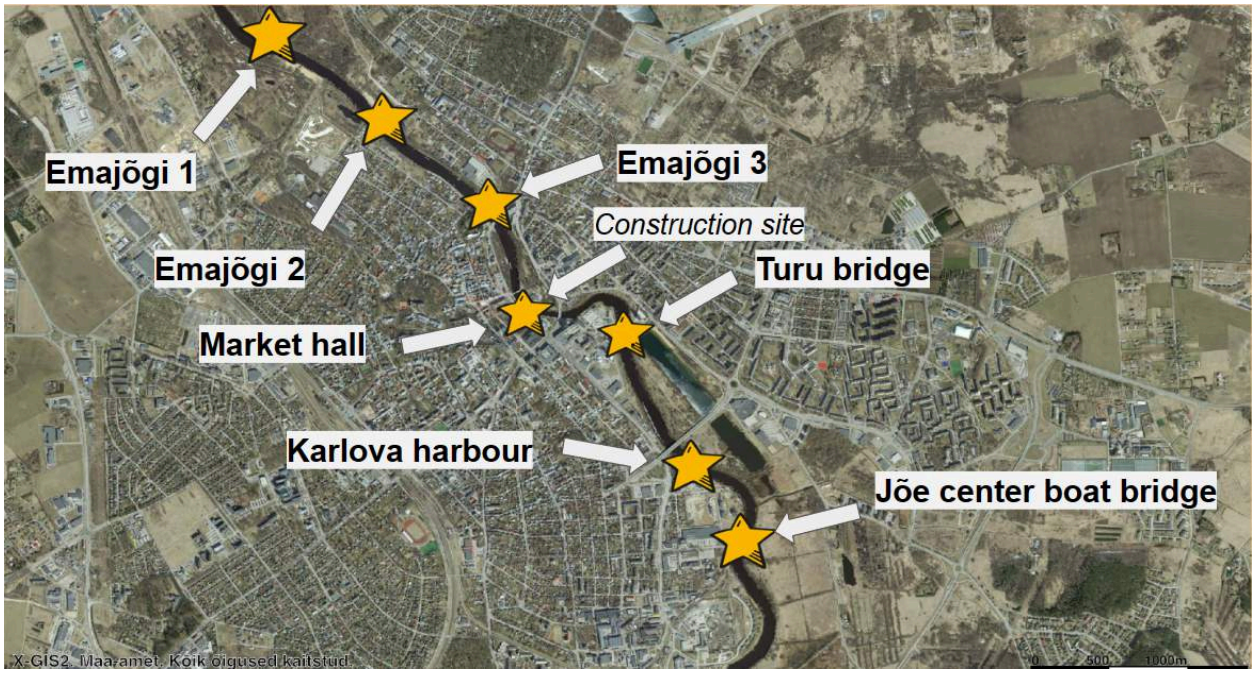

Figure 3. Measurement sites for two hydrology groups during the expedition. Three northernmost sites were our main study sites (Emajõgi 1-3). Map: X-GIS from Estonian Land Board

Figure 4. Research sites in photos. Location 1 is Emajõgi 1 on the map, and so forth. Photos: authors

Equipment:

- Vernier thermometer,
- Vernier conductivity probe,
- Vernier pH probe,
- a bucket with a rope,
- transparency tube,
- chemical kits (Visocolor): oxygen, nitrate, alkalinity.

GLOBE protocols used in the research:

- Temperature
- Conductivity
- pH
- Transparency
- Dissolved oxygen
- Alkalinity
- Nitrates
- Clouds

All of the data is uploaded to the GLOBE Data Entry.

Figure 5. Equipment. Photo: authors

Figure 6. Collecting samples. Photos: Riin Värton

Figure 7. Collecting data, analysing samples. Photos: Riin Värton

Results

Table 1. Results of water quality indicators, arranged from upstream to downstream.

		Emajõgi 1	**Emajõgi 2**	**Emajõgi 3**	**Market hall**	**Turu bridge**	**Karlova harbour**	**Jõe keskus boat bridge**
Temperature	°C	23.0	22.2	22.3	22	22	22	22
Conductivity	µS/cm	373.0	360.0	325.0	258	381	387	379
pH		8.34	8.62	8.50	8.23	7.98	7.8	7.8
Transparency	m	0.26	0.31	0.27	0.32	0.17	0.29	0.21
Dissolved oxygen	mg/L	7.20	6.00	7.50	6.2	6.2	6.5	6.6
Alkalinity	mg/L	221.43	234.85	215.33	195.2	225.7	201.3	195.2
Nitrates	mg/L	0.20	0.20	0.20	<0.2	<0.2	0.2	0.2

Water temperature remained approximately constant throughout the sites.
Conductivity was highest at the Karlova harbour site and the lowest at the Market hall site. Conductivity reduced by a small amount when moving towards the city center. Conductivity was significantly lower at the Market Hall site, which we suspect could have something to do with the ongoing construction in the area. However, the conductivity level recovered quite soon after. We think there could also be an error in measuring the conductivity at this site.

The pH level lowered by about 0.5-0.8 points when comparing upstream sites Emajõgi 1-3 to downstream sites Turu bridge, Karlova harbour and Jõe keskus boat bridge. pH was the lowest in Karlova harbour and Jõe keskus boat bridge (7.8), and highest at Emajõgi 2 (8.62).

Transparency was the lowest at Turu bridge, and highest at the Market hall and Emajõgi 2 sites. Overall the river had quite low transparency. We saw that the water was brownish and not very clear.

Dissolved oxygen was the highest at the Emajõgi 2 site, followed by Market hall and Turu bridge. These areas also had the least amount of vegetation around and had several riverside buildings, which is why oxygen levels were lower.

Alkalinity was lowest at the Market hall site and highest at Emajõgi 2. Nitrates were lowest at the Market hall and Turu bridge.

We noticed that the parameters we measured were most different at the Market hall site compared to other sites.

Discussion and conclusions

The hydrochemical and hydrophysical parameters did not vary much as our test results show. Parameters are very similar to the other results from literature. This also indicates that the urban environment did not affect water quality so much at our sampling points. The water quality was good overall along our transect.
However, we also shared our data and received data from another group who worked downstream from us. When we looked at the data along the entire river transect, we saw some changes in parameters downstream from the city center, as has been found in previous research (Glińska-Lewczuk et al., 2016).

This is what we think of the hypotheses based on the data we collected:

1. *The urban environment affects the water quality negatively.* - Partially true. The parameters indicate the conditions are good, but there was a lot of human impact on the shores. We could see construction on the river banks which might have affected the water indicators.
2. *The oxygen level decreases along the river.* - Not true. It increases if you look at the results taken after the rain. It should be investigated furthermore. Also, it might be higher in places surrounded by more vegetation.
3. *Transparency decreases along the river because of the impact of the city.* - Partially true. The river comes from lake Võrtsjärv and its water transparency is already poor, in addition to the active boat traffic in the city.

Overall, we found some evidence of the impact of urban areas on the river water quality in the Emajõgi. More studies like this are needed over a longer period of time because changes in water indicators can be influenced by weather, changing seasons and many other things (e.g. Buhvestova et al., 2011). We think it is important to study river water quality and how it is influenced by cities because rivers carry all the pollution from human activity downstream and therefore impact the natural habitats outside of the city (Buhvestova et al., 2011; Glińska-Lewczuk et al., 2016; Anh et al., 2023). This is a global problem that has impacts on a local level.

We want to thank our supervisor Ronald Laarmaa for his guidance. We also want to thank team Reykjavik, the other hydrology research group at the GLOBE Estonia Learning Expedition, for collecting data downstream and sharing it with us. Together we were able to get a better picture of how the water quality changes throughout the city.

Figure 10. Research group “Johannesburg” with supervisor Ronald Laarmaa (right) at the GLOBE Estonia Learning Expedition. Photo: Riin Värton.

References

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