

# Water Ecosystems in Europe

## BOOKLET

September 2019 – August 2022



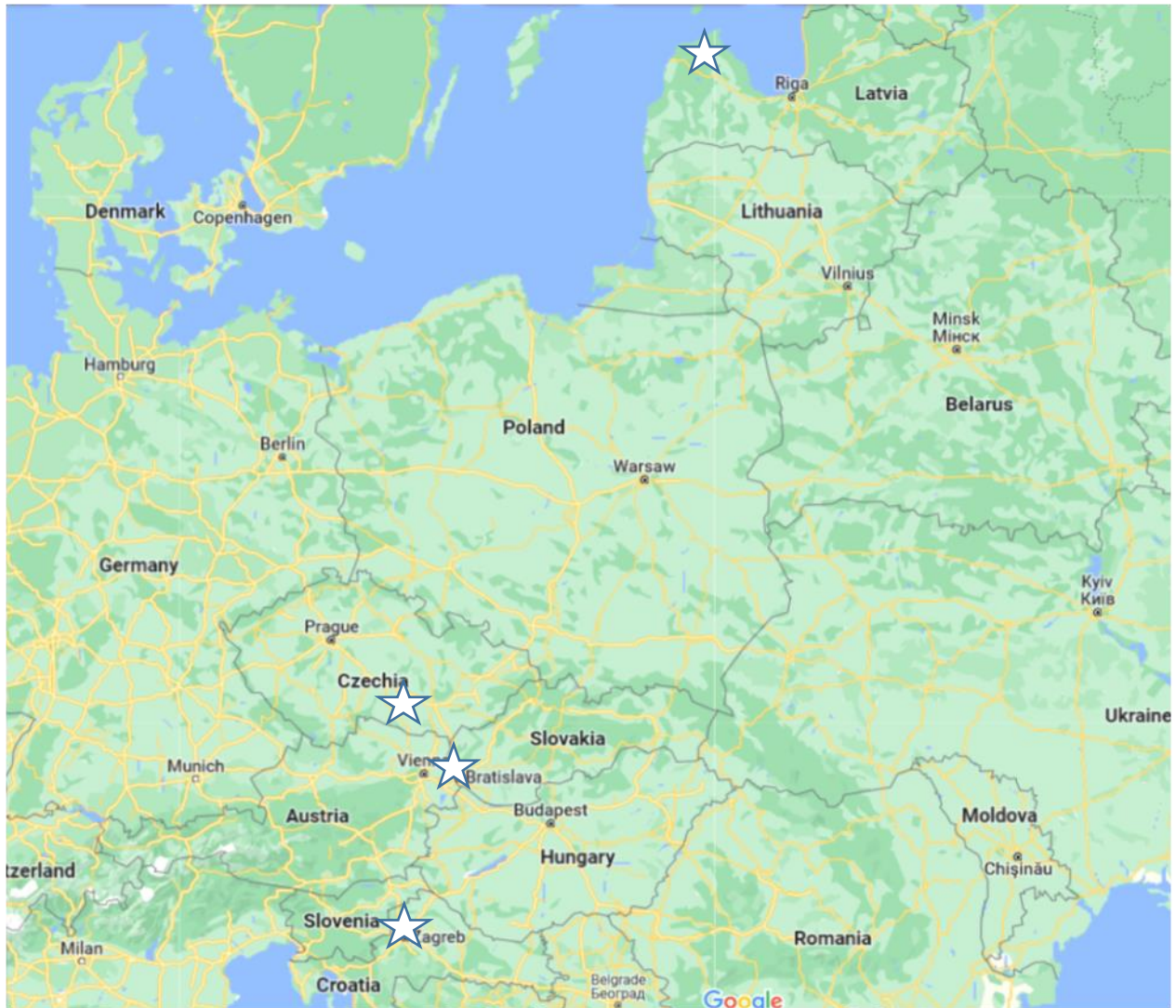
### ERASMUS WATER ECOSYSTEMS IN EUROPE



With the support of the  
Erasmus+ Programme  
of the European Union

Through the **ERASMUS+ project 2019-1-CZ01-KA229-061438: Water Ecosystems in Europe**, students conducted research on freshwater ecosystems in the area where the schools participating in the project are located:

- Základní škola, Třebíč, Czech Republic;
- Základná škola, Bratislava, Slovakia;
- Dundagas viduskola, Dundaga, Latvia;
- OS Marije Juric Zagorka, Zagreb, Croatia.



Picture 1: *Map of Europe with marked measuring stations.*

The main goal was to compare the quality of water in freshwater ecosystems and get to know the organisms that live by the water, in the water and on the bottom. We were most interested in the relationship between water temperature, air temperature, acidity and the amount of oxygen in the water. Organisms that live at the bottom of freshwater ecosystems are called macrozoobenthos and their life depends on the values of water temperature, acidity and the amount of oxygen in the water. The life cycles of organisms that we call macrozoobenthos are short and enable the life of other organisms around the water. The abundance of macrozoobenthos organisms indicates the quality of surface waters, the biodiversity in and around water, and the impact of humans on aquatic ecosystems.

Our research questions were related to those problems detected by the students of all schools through mutual cooperation and with the guidance of their teachers.

### **Research questions:**

Does the air temperature change depending on the water temperature?

Does water temperature affect the amount of oxygen in the water?

What is the water quality in our research stations?

Does the water at our measuring stations show pollution?

### **Our hypotheses:**

The air temperature changes depending on the water temperature.

Water temperature affects the amount of oxygen in the water.

The water in our measuring stations is of a different quality.

There is no pollution at our measuring stations.

### **Measurements**

We made measurements on stagnant freshwater ecosystems near schools.

Latvia measured at Dundagas pond at Dundaga village.

Czechia measured on the Vodovodní pond, which is part of the system of ponds in Třebíč and is fed by the Týnský stream.

Slovakia measured the Croatian Canal, it is excavated in the former branch of the Danube in Petržalka in Bratislava.

Croatia measured on Maksimir Lake II, which is an artificial lake inside Maksimir Park in the east of the city of Zagreb.

All water ecosystems are in urban areas and are regularly maintained. The surroundings are arranged because water surfaces are used as places for rest, walking and enjoying nature.

We sampled the water at the station in clean containers, took samples for macrozoobenthos in bottles and took them to schools for analysis. At our stations, we measured water temperature, air temperature, acidity, amount of oxygen and parameters indicating pollution

(alkalinity, nitrates, nitrites, phosphates, ammonia). For measurements, we used purchased sets from various manufacturers (Pascal, Hanna, Viscolor HE). We put the measured values in tables and graphs to make them easier to compare. We measured once a week from October 2019 to May 2022.

Weather conditions and the COVID pandemic prevented our regular measurements, so our data is incomplete. For this reason, we decided to analyze the data by year for only some dates during spring, summer, autumn and winter.

### **Data analysis**

For data comparison, we chose:

- spring dates: 21. 3. 2020, 21. 3. 2021. and 21. 3. 2022;
- summer dates: 22. 5. 2020, 22. 5. 2021. and 22. 5. 2022;
- autumn dates: 21. 10. 2019, 21. 10. 2020. and 21. 10. 2021;
- winter dates: 21. 11. 2019, 21. 11. 2020. and 21. 11. 2021.

## 1. Spring

Table 1: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on March 21, 2020.*

21. 3. 2020	air temperature	water temperature	pH	oxygen
LATVIA	9	8	7	8
CZECH	7	6	7	8
SLOVAKIA	8	6	7	7
CROATIA	7	8	8	8

From Table 1. we can see that the air temperature was the highest in Latvia, and the lowest in the Czech Republic and Croatia. The water temperature is higher in Latvia and Croatia, and lower in the Czech Republic and Slovakia. Water acidity (pH) is the highest in Croatia, and the least oxygen is in Slovakia.

Table 2: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on March 21, 2021.*

21. 3. 2021	air temperature	water temperature	pH	oxygen
LATVIA	8	6	7	8
CZECH	8	15	7	8
SLOVAKIA	8	8	8	8
CROATIA	8	5	7	8

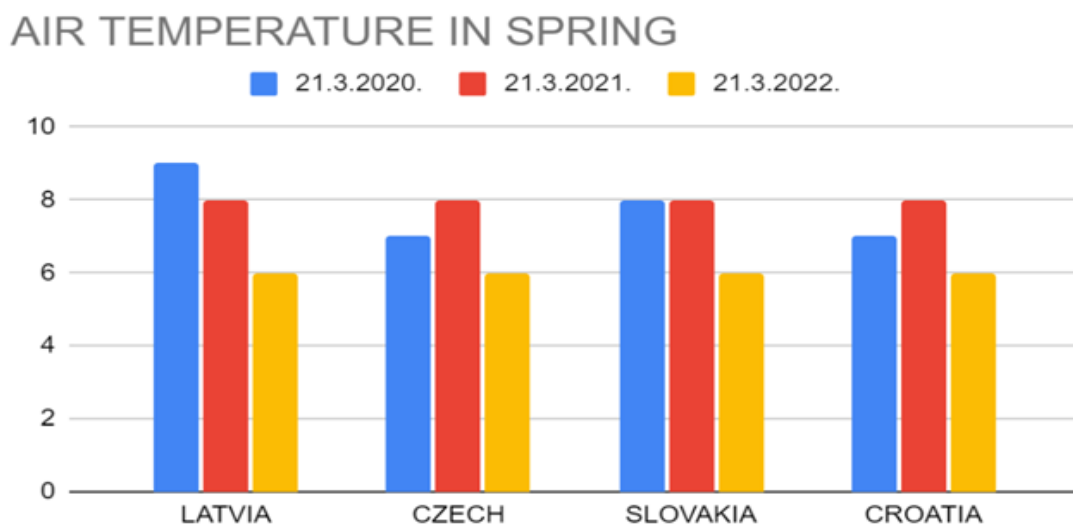
From Table 2. we can see that the air temperature on that day was the same at all stations. The water temperature was the highest in the Czech Republic, and the lowest in Croatia. The pH is the highest in Slovakia, and the amount of oxygen in the water is the same at all stations.

Table 3: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on March 21, 2022.*

21. 3. 2022	air temperature	water temperature	pH	oxygen
LATVIA	6	4	6.5	8.5
CZECH	6	8	8	11
SLOVAKIA	6	7	8	7
CROATIA	6	9	8	14

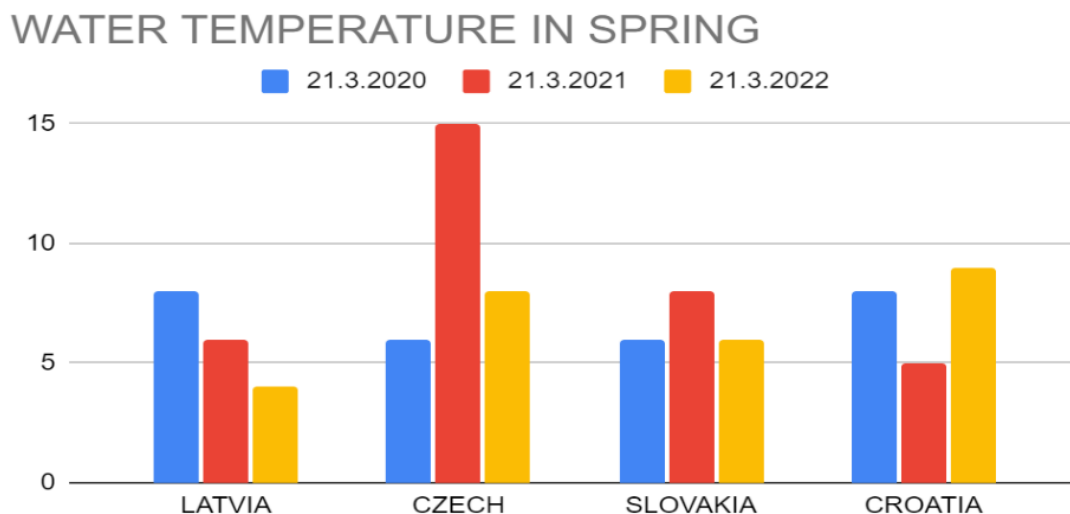
From Table 3. we can see that the air temperature on 3/21/2022 was the same at all stations. The water temperature was the lowest in Latvia and the highest in Croatia. The lowest acidity was in Latvia, and the most oxygen was in Croatian water.

Graph 1: *Values of air temperature in spring at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



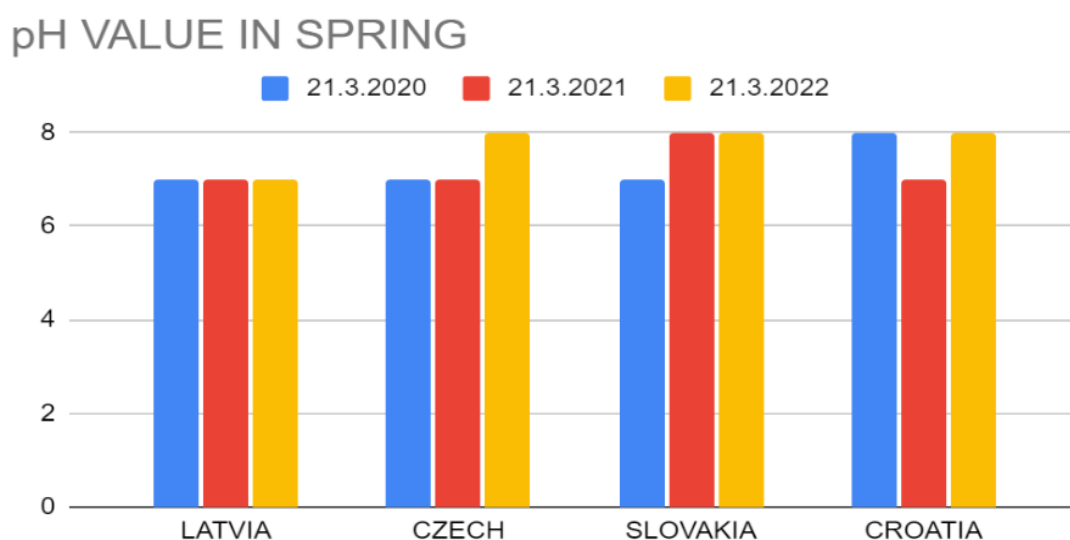
From Graph 1 we can see that the warmest first spring day in Latvia is 21. 3. 2022, and than in all countries 21. 3. 2022 was the coldest day.

Graph 2: *Values of water temperature in spring at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



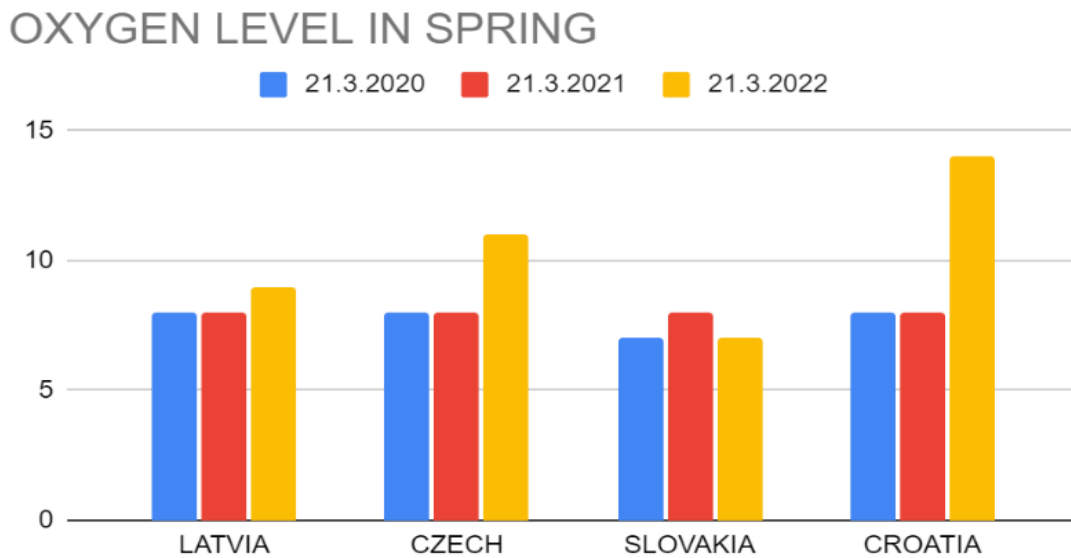
From graph 2 we can see that the highest water temperature was on March 21, 2021 in the Czech Republic, and the lowest water temperature was in Latvia on March 21, 2022. We can see that the water temperatures at all stations are of similar values in all years of measurement, which indicates the uniformity of weather conditions over Europe. Measured value of water temperature in the Czech Republic on 21.3.2021 it can be a consequence of sudden warming or shallow water or roof measurement. We don't know the real reason.

Graph 3: *Values of pH in spring at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



Graph 3 shows that the acidity of the water at the measuring stations is uniform, so our conclusion is that there is no influence of pollution. Natural waters have a pH of around 8, our measured values show more precipitation that reduces the acidity of the water, which is a characteristic of spring.

Graph 4: *Values of oxygen level in spring at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



The amount of oxygen during the spring was lower in 2020 and 2021, and higher in 2022. If we compare Graph 4 with Graphs 1 and 2, which show air and water temperature, we conclude that lower water temperatures affect the increase in the amount of oxygen. During the spring, there is more algae and photosynthetic production, which increases the amount of dissolved oxygen in the water.

From all the data, we conclude that the first day of spring in 2021 and 2022 had uniform weather conditions over the whole of Europe, so the same temperatures were measured. The water temperature is approximately the same as the air temperature or is lower, which is expected due to the properties of water. The amount of oxygen is higher during colder days and lower during warmer days.



## 2. Summer

Table 4: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on May 22, 2020.*

22. 5. 2020	air temperature	water temperature	pH	oxygen
LATVIA	16	14	9	7
CZECH	24	22	7	6
SLOVAKIA	17	16	7	7
CROATIA	25	17	8	7

Air temperature values 5/22/2020 are higher in the Czech Republic and Croatia, and lower in Latvia and Slovakia. The highest water temperature is in Slovakia, which also measured the least amount of oxygen in the water. During the summer, a range of oxygen levels was measured at all stations, compared to the oxygen level in the spring.

Table 5: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on May 22, 2021.*

22. 5. 2021	air temperature	water temperature	pH	oxygen
LATVIA	18	13	8.5	7
CZECH	13	14	8	9
SLOVAKIA	14	14	7	7
CROATIA	24	15	8	9

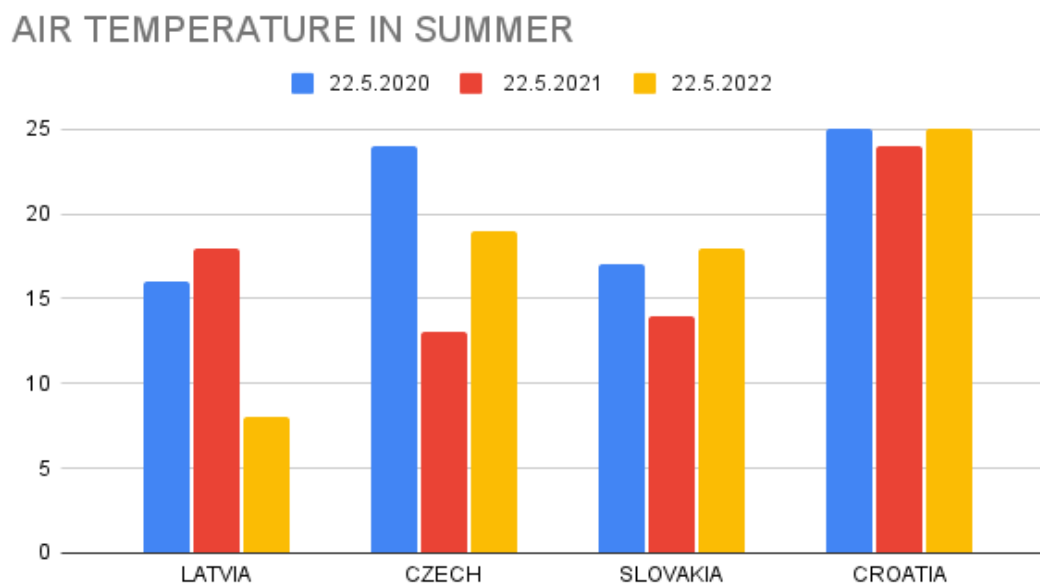
The highest measured air and water temperature on May 22, 2021 is in Croatia. The amount of oxygen in the water is the highest in the Czech Republic and Croatia. We assume that the difference in air temperature depends on the geographical features of each country. The Czech Republic and Slovakia are continental countries surrounded by mountains.

Table 6: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on May 22, 2020.*

22. 5. 2022	air temperature	water temperature	pH	oxygen
LATVIA	8	7	9	6.5
CZECH	19	20	7	6
SLOVAKIA	18	16	7	7
CROATIA	25	14	7	11

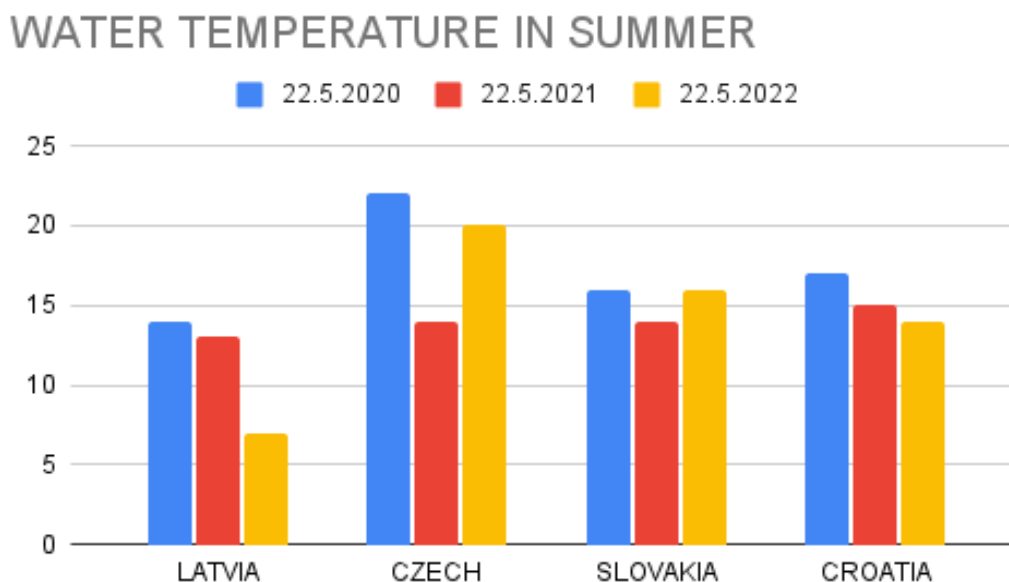
From table 6 we can see that the highest air temperature is in Croatia, and the lowest in Latvia. We expected that because Latvia is the northernmost country and Croatia is the southernmost. The water temperature is the highest in the Czech Republic. We believe that this is due to the shallow water at the measuring station. Water acidity is the same in the Czech Republic, Slovakia and Croatia, and higher in Latvia. The amount of oxygen is the highest in Croatia, and the lowest in the Czech Republic and Latvia. The high temperature of the water at the Czech station is a possible reason for the reduced amount of oxygen in the water.

Graph 5: *Values air temperature in sommer at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



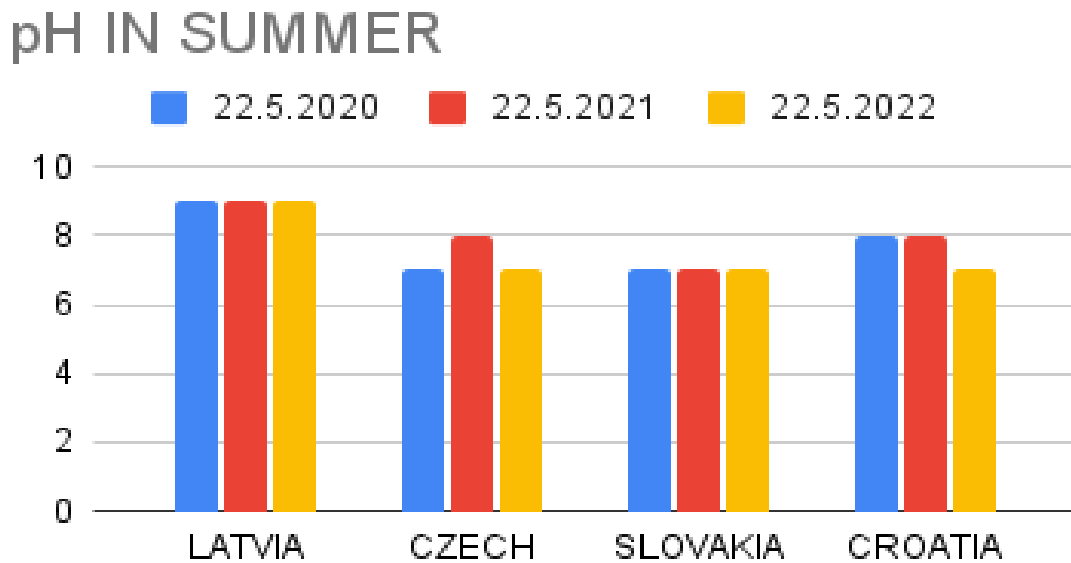
Graph 5 shows how air temperatures changes over the years at stations in Latvia, the Czech Republic and Slovakia, while the difference is small in Croatia. The year 2021 was colder than 2020 and 2022 in the Czech Republic, Slovakia and Croatia, and 2020 was warmer at the same stations. In Latvia, 2022 was the coldest, and 2021 was the warmest.

Graph 6: *Values of water temperature in sommer at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



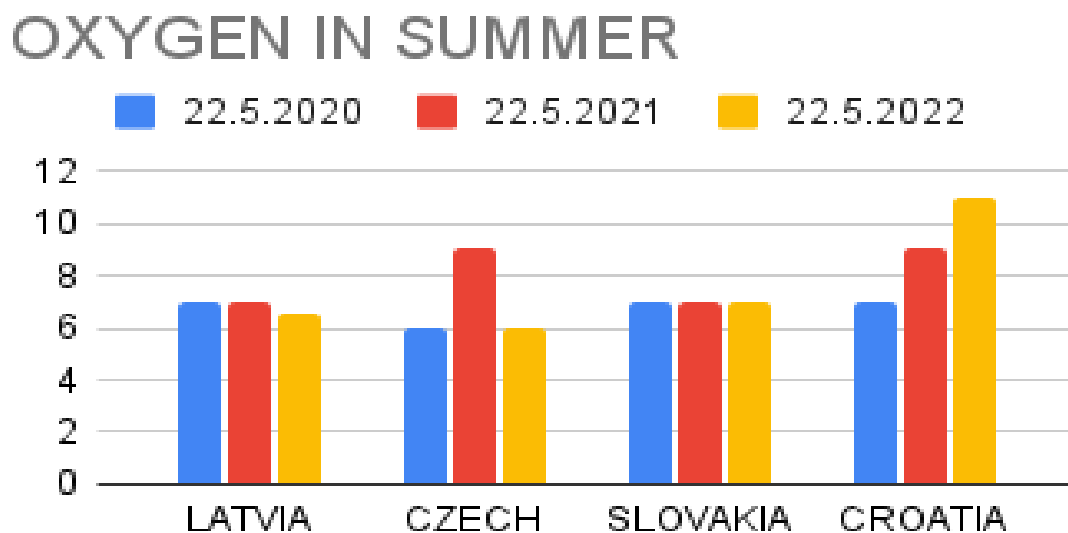
Graph 6 shows how the water temperatures at the measuring stations were the highest during 2020. In Latvia and Croatia, the water temperature is decreasing year by year. In the Czech Republic and Slovakia, the water temperature is the lowest in 2021.

Graph 7: *Values of pH in sommer at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



Graph 7 shows us that the pH values are the same in all years in Latvia and Slovakia, while they change in the Czech Republic and Croatia. Latvia has the highest acidity values, and Slovakia has the lowest measured water acidity values.

Graph 8: *Values of oxygen level in sommer at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



Graph 8 shows that the amount of oxygen in Latvia and Slovakia is the same, in the Czech Republic it is the highest in 2021, and the lowest in 2020 and 2022, while in Croatia it increases from year to year and is the highest in 2022. In 2021, the lake in Croatia was maintained by removing fallen plants and dead organisms, which may be the reason for higher oxygen values.

### 3. Autumn

Table 7: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on October 21, 2019.*

21. 10. 2019	air temperature	water temperature	pH	oxygen
LATVIA	11	12	7	9
CZECH	12	12	7	8
SLOVAKIA	21	18	8	7
CROATIA	16	13	8	7

From table 7 we can see that the air and water temperature is the highest in Slovakia, and the lowest in Latvia and the Czech Republic. The amount of oxygen is higher in Latvia and lower in Slovakia and Croatia. Water acidity is lower in Latvia and the Czech Republic, and higher in Slovakia and Croatia. Slovakia is a continental country that is protected by the high Tatras, so higher air temperature values are measured during autumn.

Table 8: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on October 21, 2020.*

21. 10. 2020	air temperature	water temperature	pH	oxygen
LATVIA	12	13	7	9
CZECH	20	20	7	5
SLOVAKIA	17	16	7	7
CROATIA	15	9	8	10

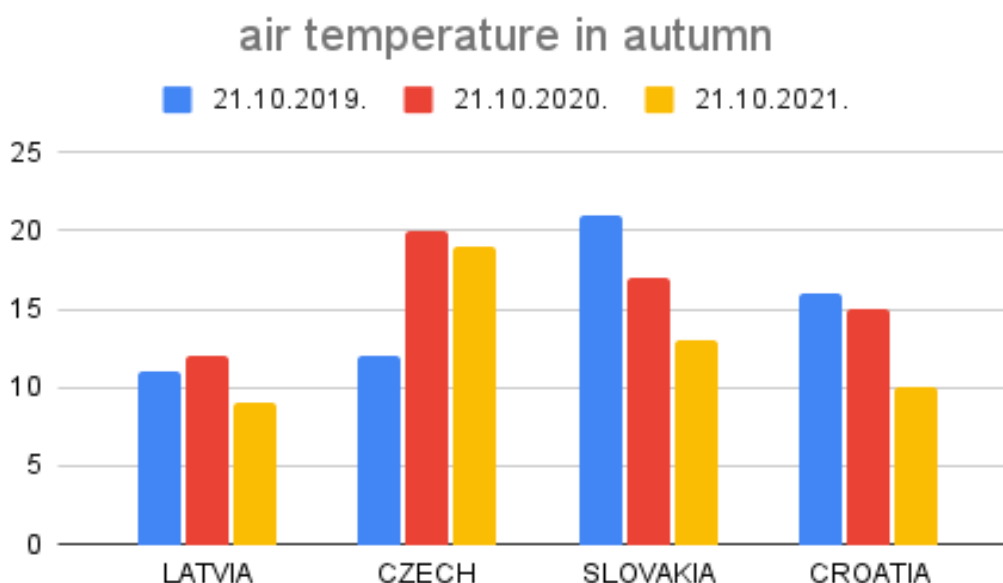
Table 8 shows that the highest air temperature was in the Czech Republic, and the lowest in Latvia. This is expected due to the geographical position of these countries. The water temperature is the highest in the Czech Republic, and the lowest in Croatia. Due to the lower water temperature in Croatia, more oxygen was measured in the water than in other countries, but the pH value was also higher.

Table 9: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on October 21, 2021.*

21. 10. 2021	air temperature	water temperature	pH	oxygen
LATVIA	9	10	7	9
CZECH	19	11	7	8
SLOVAKIA	13	10	7	7
CROATIA	10	9	7	10

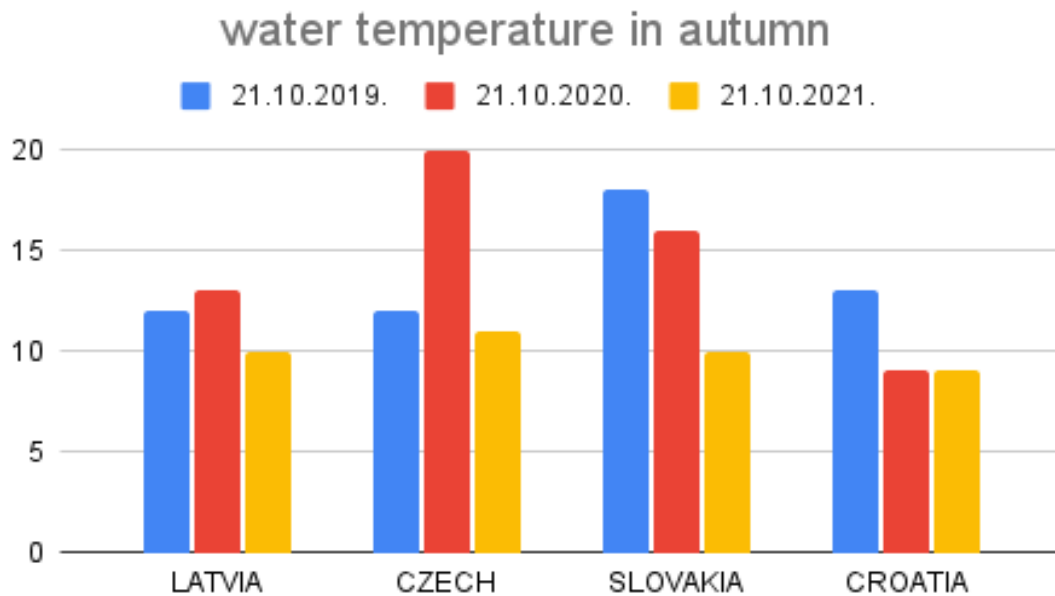
Table 9 shows the highest air temperature and water temperature at the Czech station. The lowest air temperature is in Latvia, and the water temperature is in Croatia. The pH value is the same at all stations. The amount of oxygen is the highest in Croatia, and the lowest in Slovakia.

Graph 9: *Values air temperature in autumn at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



From graph 9 we see that air temperatures in all countries were the lowest in 2021. In Latvia, temperatures on all measured days were lower than expected due to its geographical location. In Slovakia and Croatia, the air temperature was the highest in 2019, and the lowest in 2021. In Latvia and the Czech Republic, the air temperature was higher in 2020. We assume that such a distribution of air temperatures at our measuring stations is a consequence of the geographical position and the flow of warm and cold air in the upper layers of the atmosphere.

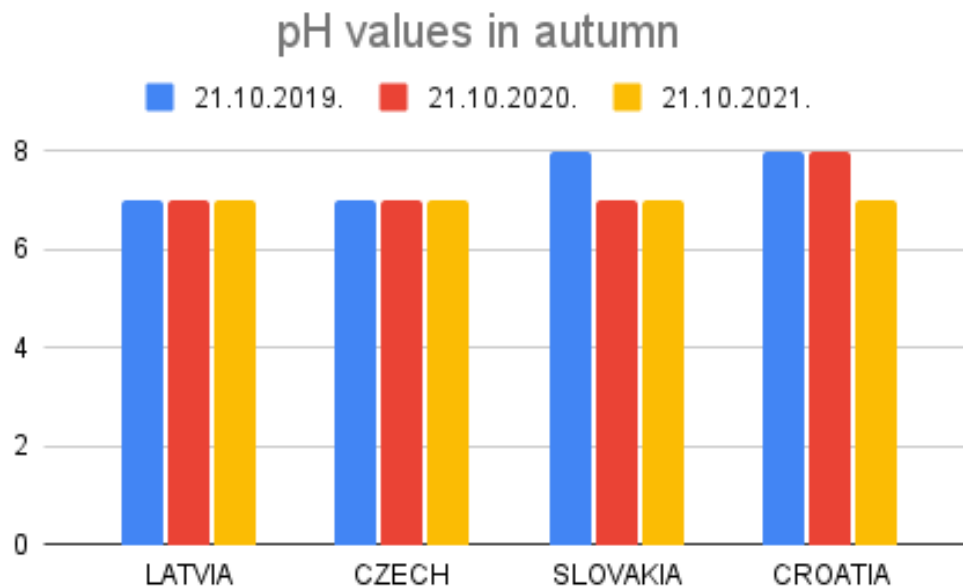
Graph 10: *Values water temperature in autumn at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



The lowest water temperature values were measured in 2021 at all stations. Water temperature values in Latvia show a similar distribution as air temperatures at that station. The highest water temperature was in 2020, and the lowest in 2021. The highest water temperature was measured in the Czech Republic at the measuring station in 2020. The water temperature measured in 2019 at the measuring station in Slovakia has a higher value than other stations.

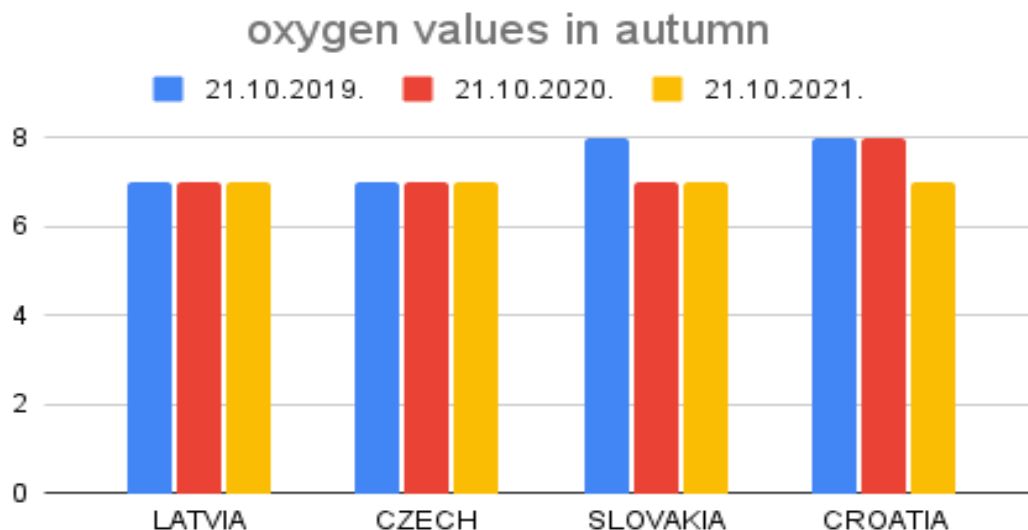
Comparing graph 9 with graph 10, we can see that the range of measured values of air and water temperatures has a similar distribution. Therefore, we conclude that air temperatures are related to water temperatures.

Graph 11: *Values of pH in autumn at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



From graph 11 we see that in Latvia and the Czech Republic, the pH value is the same. Measuring stations in Slovakia and Croatia show that the water acidity was slightly higher in 2019. These values are within the permissible limits for freshwater ecosystems.

Graph 12: *Values of oxygen level in autumn at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



Graph 12 shows that the measured oxygen levels at the stations in Latvia and the Czech Republic are the same. As with graph 11, we see that in Slovakia and Croatia the amount of oxygen in the water is higher in 2019 and lower in 2021.



## 4. Winter

Table 10: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on November 21, 2019.*

21. 11. 2019	air temperature	water temperature	pH	oxygen
LATVIA	12	13	7	9
CZECH	9	6	8	8
SLOVAKIA	13	11	8	8
CROATIA	13	10	8	7

From table 10 we see that on that day, November 21, 2019, it was the coldest temperature in the Czech Republic. The water temperature at the measuring stations is the lowest in the Czech Republic. Water acidity is the same at the measuring stations in Croatia, Slovakia and the Czech Republic, and lower at the measuring station in Latvia. The amount of measured oxygen is the highest in Latvia, and the lowest in Croatia.

Table 11: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on November 21, 2020.*

21. 11. 2020	air temperature	water temperature	pH	oxygen
LATVIA	15	16	7	7
CZECH	18	17	6	8
SLOVAKIA	4	4	7	7
CROATIA	7	5	8	9

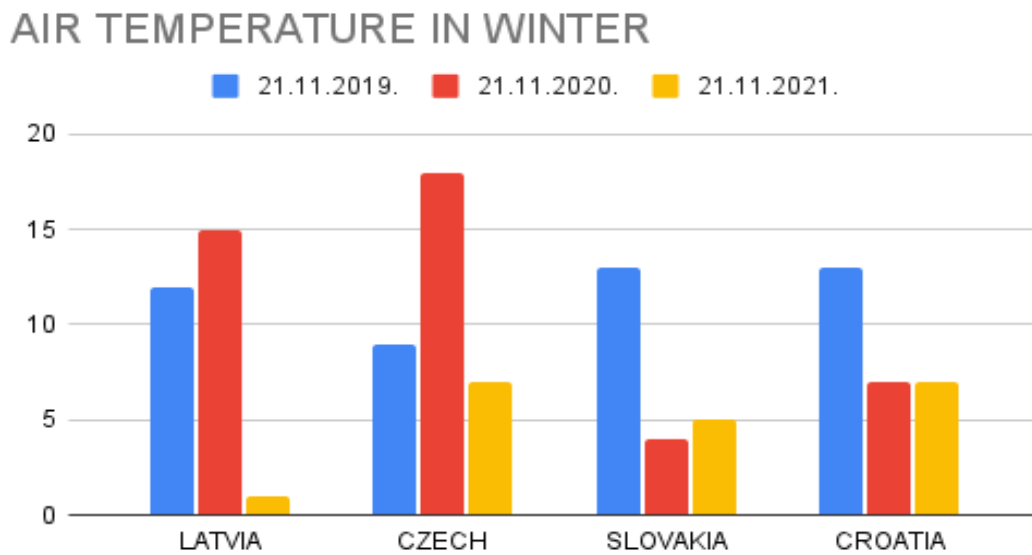
From table 11, we see that the coldest was in Slovakia, and the warmest in the Czech Republic. Water temperatures are lower in Slovakia and Croatia, and higher in the Czech Republic and Latvia. The amount of measured oxygen and water acidity is the highest in Croatia.

Table 12: *Values of air temperature, water, pH and oxygen in water at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia on November 21, 2021.*

<b>21. 11. 2021</b>	<b>air temperature</b>	<b>water temperature</b>	<b>pH</b>	<b>oxygen</b>
<b>LATVIA</b>	<b>1</b>	<b>14</b>	<b>7</b>	<b>7</b>
<b>CZECH</b>	<b>7</b>	<b>5</b>	<b>7</b>	<b>6</b>
<b>SLOVAKIA</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>7</b>
<b>CROATIA</b>	<b>7</b>	<b>5</b>	<b>8</b>	<b>9</b>

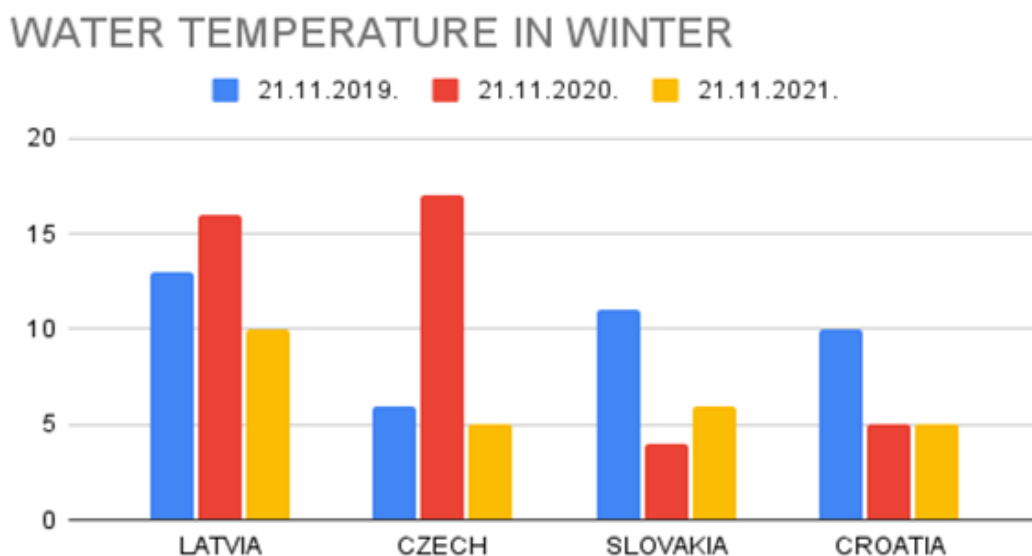
From table 12 we can see that the lowest measured air temperature is in Latvia, and the highest in the Czech Republic and Croatia. The highest water temperature was measured in Latvia. This information does not seem correct to us, we believe that there was an error in the measurement or recording of the data. The acidity of the water on that day, 21. 11. 2021 was equal at the stations in Latvia, the Czech Republic and Slovakia, and higher at the station in Croatia. The amount of oxygen was the highest at the measuring station in Croatia, and the lowest in the Czech Republic.

Graph 13: *Values air temperature in winter at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



From graph 13, we can see that the measured air temperatures were the highest in 2020 in the Czech Republic and Latvia, and the lowest in 2021 in Latvia. It is 2019 in Slovakia and Croatia. measured higher air temperature than in 2020 and 2021.

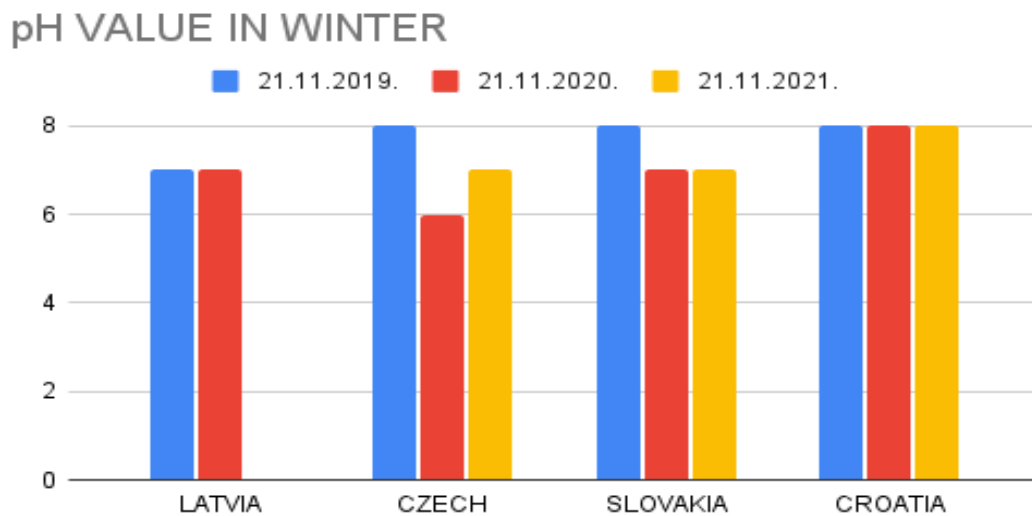
Graph 14: *Values water temperature in winter at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



From graph 14, we can see that the water temperatures measured at measuring stations in the Czech Republic and Latvia were the highest in 2020, and the lowest in 2021. In Croatia and Slovakia, the highest water temperatures at measuring stations were measured in 2019.

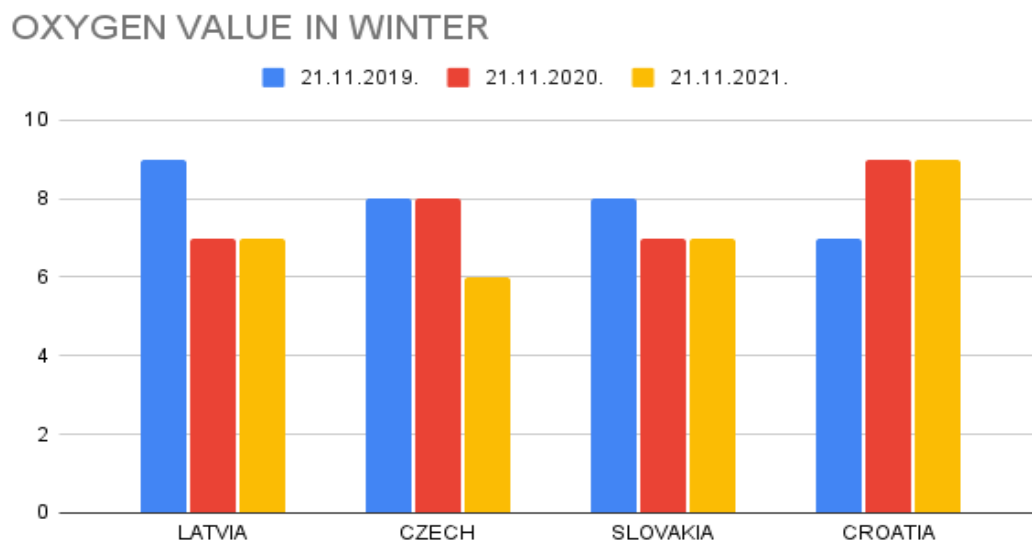
Comparing graphs 13 and 14, we can see that the water and air temperature values have similar distributions. We conclude that air and water temperatures are mutually dependent.

Graph 15: *Values of pH in winter at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



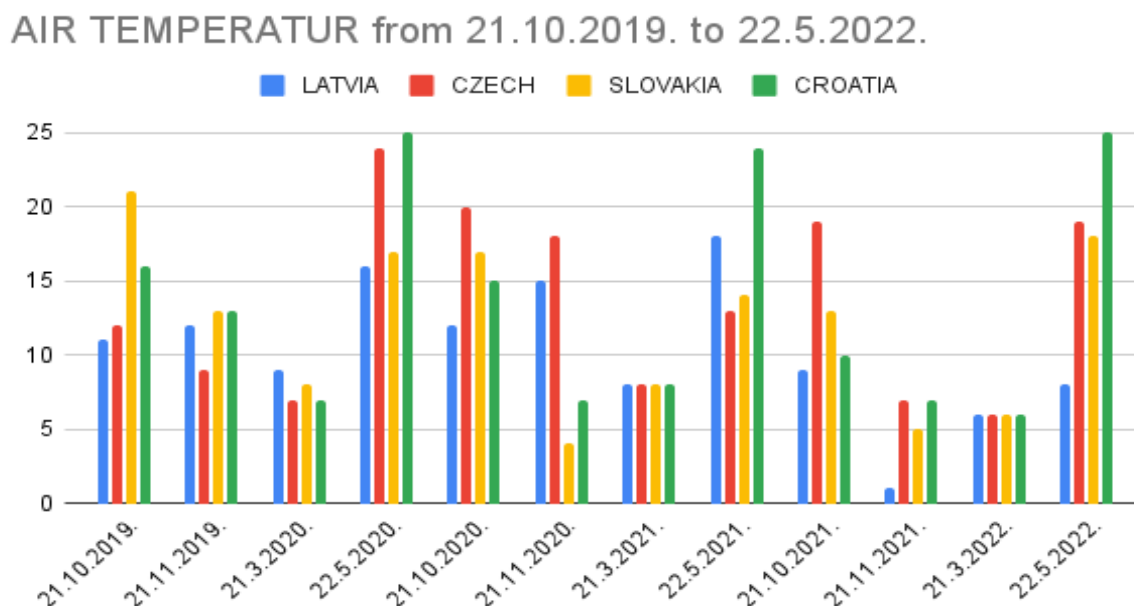
From graph 15, we can see that water acidity values at measuring stations in Latvia and Croatia do not change over the years, but they change at measuring stations in the Czech Republic and Latvia.

Graph 16: *Values of oxygen level in winter at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



From graph 16, we can see that the measured amount of oxygen in the water at the measuring stations was the highest in Croatia during 2020 and 2021, and the lowest in the Czech Republic in 2020. At the measuring stations in Slovakia and Latvia, there was more oxygen in the water in 2019.

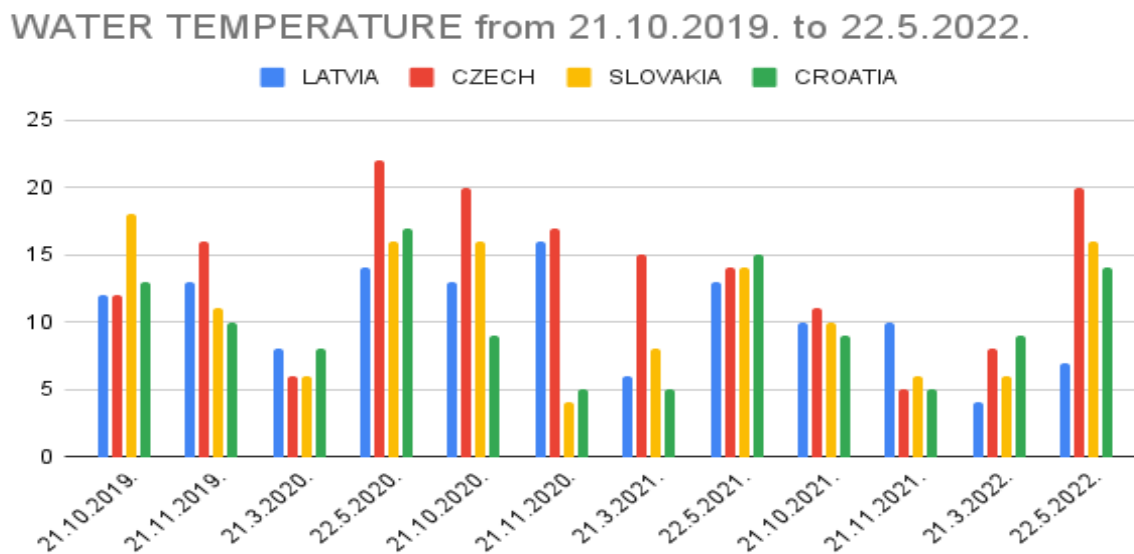
Graph 17: *Air temperature from 21.10.2019. to 22.5.2022. at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



Comparing the measured air temperatures at our measuring stations on graph 17, we observe that on 21. 3. 2021 and 21. 3. 2022 the same air temperature values were measured at all stations. Selected days during winter 2021 and spring 2022 were colder than other years. The highest air temperatures at the station in Croatia were on May 22, and the coldest in Latvia was 21. 11. 2021. The warmest autumn days were in the Czech Republic in 2020 (October 21 and November 21) and October 21, 2021. From the data comparison, we believe that most of 2020 was warmer, and 2021 was colder at all stations.

According to air temperature values, the stations in Slovakia and Croatia are more similar even though they are in different geographical positions (Slovakia Bratislava, latitude: 48.1439 N; longitude: 17.1097 E and Croatia Zagreb, latitude: 45.7816 N; longitude: 16.0065 E). The station in the Czech Republic, Třebíč (latitude 49.167 N; longitude 16.117 E) is more similar to the station in Latvia, Dundaga (latitude 57.49972 N; longitude 22.36028 E). We have yet to determine the reasons for such a distribution of data with new research. We believe that the High Tatras in Slovakia are one of the reasons.

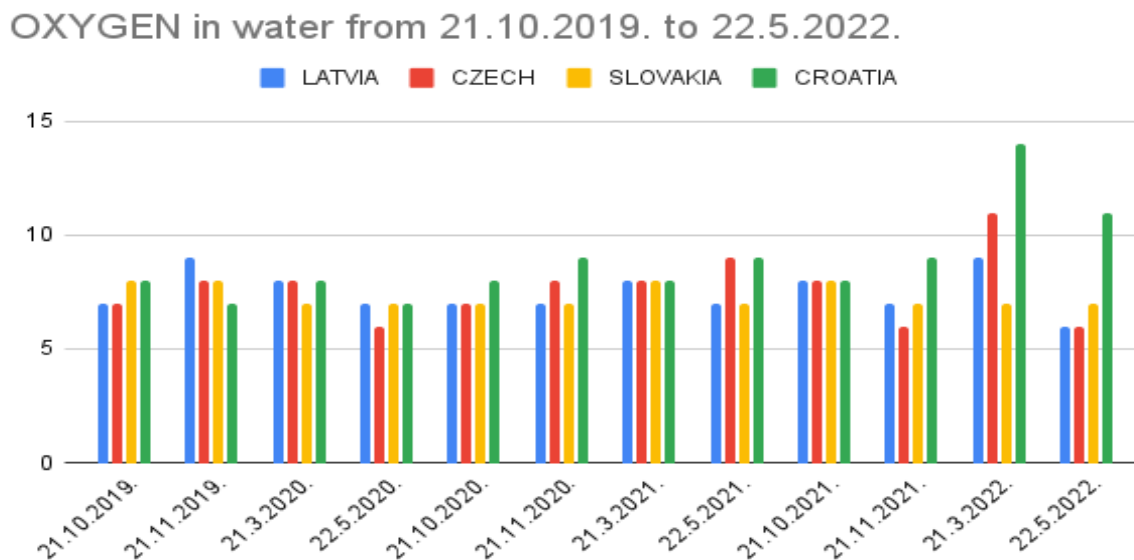
Graph 18: *Water temperature from 21. 10. 2019 to 22. 5. 2022 at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



The data from graph 18 shows that the highest water temperature at the measuring stations was in the Czech Republic during 2020. The lowest water temperature was at the measuring station in Latvia on March 21, 2022 and Slovak 21. 11. 2020. During autumn (the month of October) and winter (the month of November), the water temperature is uniform in 2019 at most stations, but it differs during 2020.

By comparing graph 17 and graph 18, we can see that most of the measured water and air temperatures at the measuring stations are lower during spring (March) and higher during summer (May). During 2019 and 2020, water and air temperature values show an even distribution. The biggest discrepancies are from the fall of 2021.

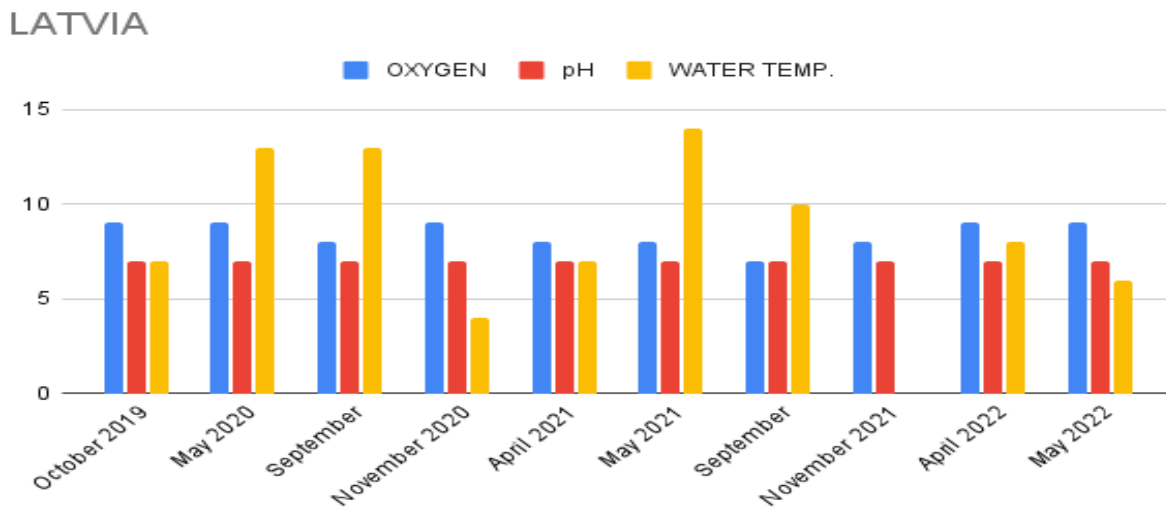
Graph 19: *Oxygen level in water from 21. 10. 2019. to 22. 5. 2022. at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia.*



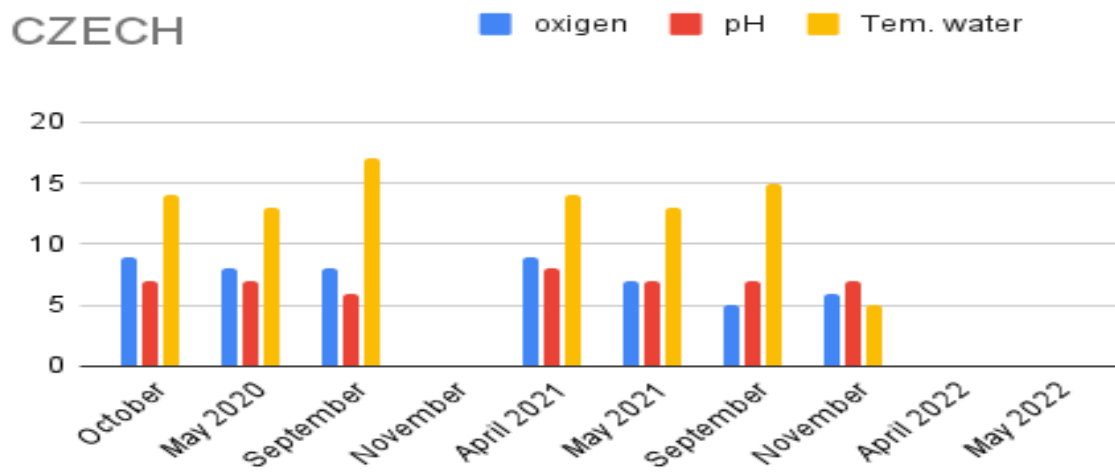
Graph 19 shows that the amount of oxygen in the water at our measuring stations over time (from October 21, 2019 to May 22, 2022) is within the range of values from 6 to 8. The highest oxygen was measured on March 21, 2022 at the station in Croatia. The reason for this is that the station in Croatia was renovated, the water was removed from the lake during the winter and in the spring, after the shoreline was improved, the water was returned to the bed of the lake where we measured. As time passes, the amount of oxygen decreases.

By comparing graph 18 and graph 19, it can be seen from our data that the amount of oxygen does not change with a change in water temperature.

Graph 20: *Values of measured oxygen, pH, water temperature at the measuring station in Latvia.*

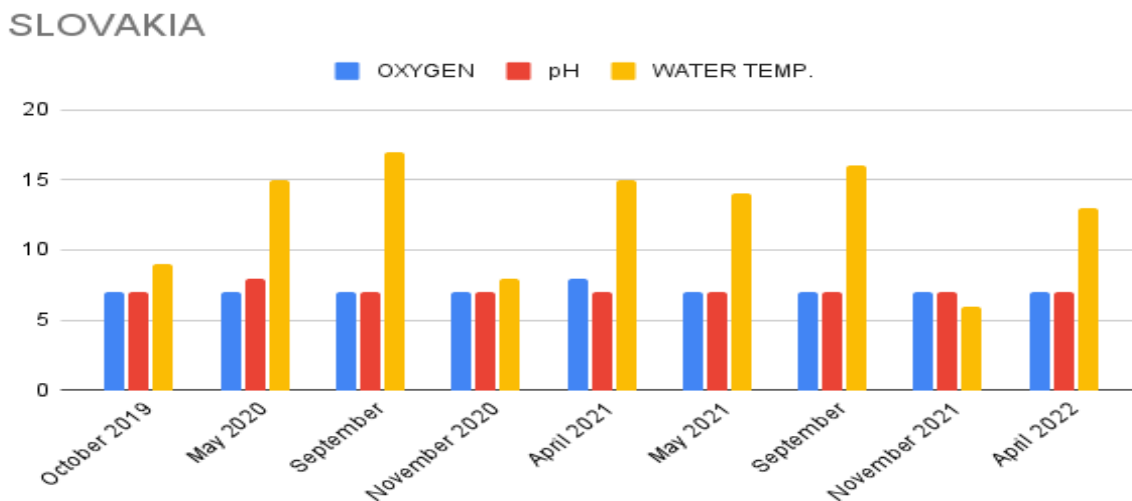


Graph 21: *Values of measured oxygen, pH, water temperature at the measuring station in Czech Republic.*

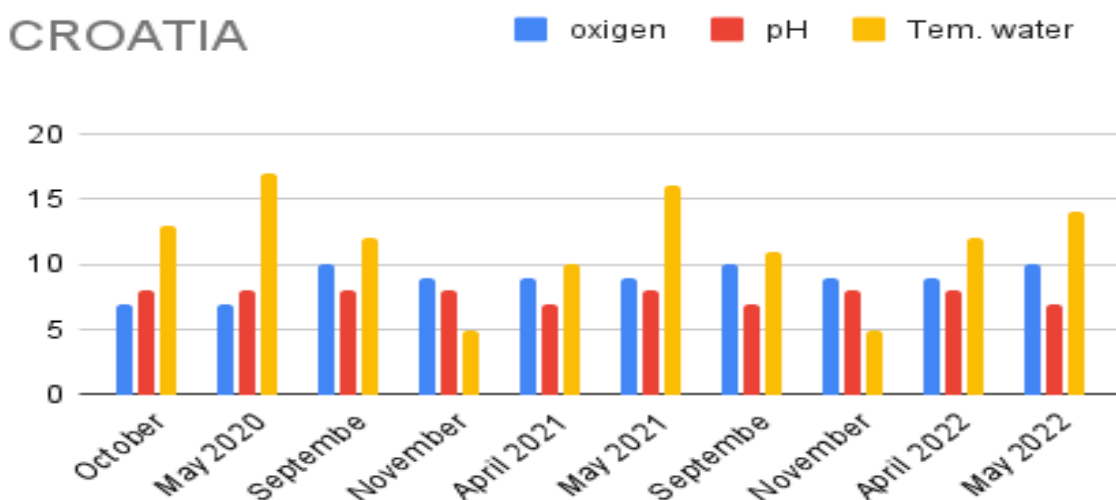




Graph 22: *Values of measured oxygen, pH, water temperature at the measuring station in Slovakia.*



Graph 23: *Values of measured oxygen, pH, water temperature at the measuring station in Croatia.*

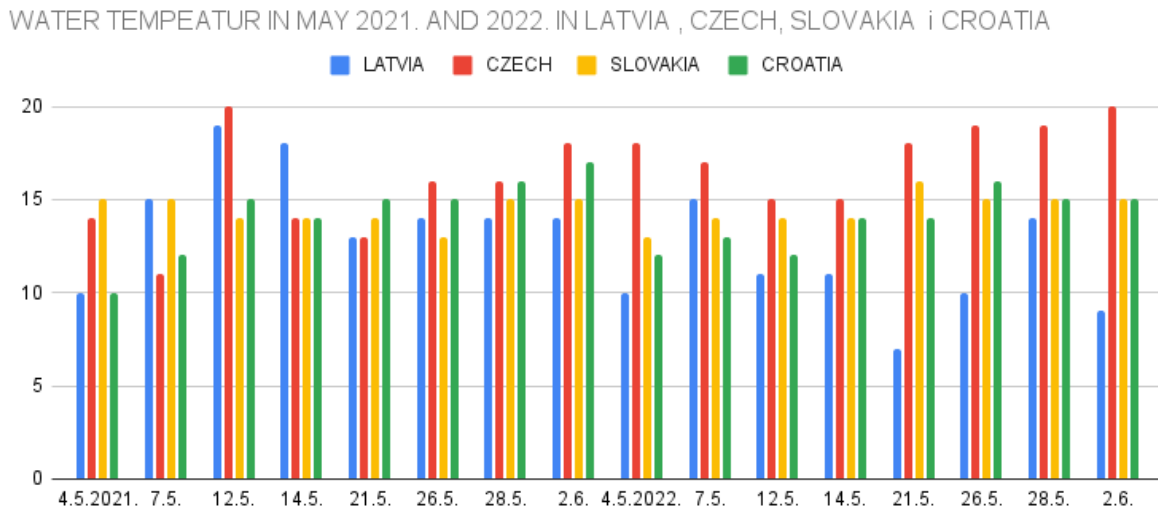


If we compare the values of the amount of oxygen and the temperature of the water in graphs 20, 21, 22 and graph 23, we can see that the amount of oxygen does not change significantly in relation to the temperature of the water we measured on certain days in the years 2019, 2020 and 2021 and 2022.

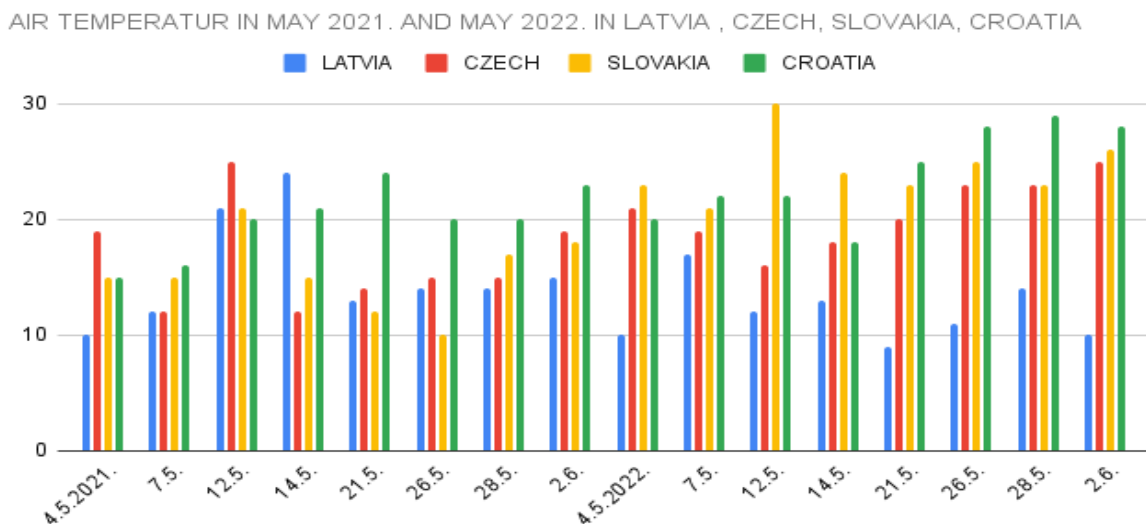
Scientific data says that gases dissolve better in colder water, but our data shows that the amount of oxygen is constant in water. We believe that this is due to the shallow, wavy area and the different plant and animal organisms along the coast. The banks of our measuring stations are mostly overgrown with plants (reeds, grass).

From the many data, we decided to select some dates in May 2021 and May 2022 for comparison. We have shown the data for water and air temperature with graphs.

Graph 24: *Water temperature in May 2021 and May 2022 in Latvia, Czech, Slovakia and Croatia.*



Graph 25: *Air temperature in May 2021 and May 2022 in Latvia, Czech, Slovakia and Croatia.*



Graph 24 and graph 25 show us that water and air temperature do not change equally at all stations. During the month of May 2021, the changes are uniform, if the air temperature is lower, the water temperature is also lower (except for May 7, 2021 and May 14, 2021). We believe that this is due to warmer weather during May 2021 and less precipitation. During May 2022, this trend is not observed. We believe that this is due to the weather conditions during the month (colder days, a lot of precipitation).

At the measuring stations, we monitored the values of nitrate, nitrite, phosphate and alkalinity, because we wanted to detect possible pollution and determine the quality of the water. We put the data in tables.

Table 13: *Values of nitrates, nitrites, phosphates and alkalinity at the measuring station in Latvia.*

<b>LATVIA</b>				
DATE	Nitrates / mg/L	Nitrites /mg/L	Phosphates / mg/L	Alkalinity /mg/L
19.09.2019	0	0	0	120
01.10.2019	0	0	0	120
11.09.2020	0	0	0	180
25.09.2020	0	0	0	160
06.05.2021	0	0	0	120
10.05.2021	0	0	0	100
13.05.2021	0	0	0	120
17.05.2021	0	0	0	100
21.05.2021	0	0	0	120
24.05.2021	0	0	0	180
27.05.2021	0	0	0	120
28.05.2021	0	0	0	100
08.03.2022	0	0	0	100
10.03.2022	0	0	0	100
22.03.2022	0	0	0	120
24.03.2022	0	0	0	100
25.03.2022	0	0	0	100
29.03.2022	0	0	0	120
31.03.2022	0	0	0	100
06.04.2022	0	0	0	120
11.04.2022	0	0	0	100
19.04.2022	0	0	0	100

Table 14: *Values of nitrates, nitrites, phosphates and alkalinity at the measuring station in the Czech Republic.*

<b>CZECH REPUBLIC</b>				
DATE	Nitrates / mg/L	Nitrites /mg/L	Phosphates / mg/L	Alkalinity /mg/l
19.9.2019	2	0,05	0,4	120
8.10.2019	0,3	0,05	0,5	180
17.10.2019	1	0,5	6	160
24.10.2019	5	0,1	3	140
31.10.2019	7,5	0,05	0	100
7.11.2019	4	0,09	<0,2	160
12.12.2019	1	0,18	0,8	160
16.1.2020	0,1	0,05	<0,2	140
13.2.2020	21	0,1	0,3	200
6.3.2020	<1	<0,02	0,1	100
17.7.2020	9	0,26	0,3	120
31.7.2020	6	0,2	0,2	140
8.8.2020	18	0,42	1,2	120
16.9.2020	10	0,37	15	120
21.4.2021	>40	0,32	<0,2	100
4.5.2021	12	0,34	1,2	100
6.5.2021	24	0,35	0,3	100
11.5.2021	27	0,34	<0,2	100
14.5.2021	9	0,31	0,1	100
17.5.2021	17	0,46	0,5	120
20.5.2021	23	0,38	0,5	120
27.5.2021	13	0,35	0,5	140
1.6.2021	3	0,4	0,3	140
3.6.2021	27	0,17	1,2	140
28.6.2021	11	0,39	1,5	140
4.8.2021	11	0,38	1,3	120
25.8.2021	3	0,36	0,6	130
2.9.2021	<1	0,2	0,5	100
8.9.2021	10	0,5	0,34	100
15.9.2021	0,1	0,25	0,3	140
4.10.2021	0,1	0,15	0,3	180
20.10.2021	0,3	0,15	0,3	160
10.11.2021	0,35	0,25	0,3	160
23.11.2021	0,24	0,11	0,44	160
24.11.2021	0,24	0,11	0,44	160
8.12.2021	0,2	0,12	0,2	120
19.1.2022	0,1	0,09	0,09	140
9.2.2022	0,1	0,24	0,1	60
28.2.2022	0,10	0,1	0,03	120
6.3.2022	<1	<0,02	0,1	100

Table 15: *Values of nitrates, nitrites, phosphates and alkalinity at the measuring station in Slovakia.*

<b>SLOVAKIA</b>				
DATE	Nitrates /mg/L	Nitrites /mg/L	Alkalinity /mg/l	Ammonium /mg/L
12.11.2019			80	0,2
18.11.2019		0,1	60	
03.12.2019	7,47		50	
09.12.2019			70	
19.12.2019		0,1	80	
09.01.2020	6,28	0,1	100	
30.01.2020	5,18		60	
05.02.2020	6,21		80	
13.02.2020		0,38	70	0,02
26.4.2020	6,22	0,05	70	0,2
29.4.2020	6,19	0,05	80	0,05
3.5.2020	6,22	0,02	80	0,05
6.5.2020	6,41	0,05	80	0,2
10.5.2020	7,11	0,1	70	0,05
13.5.2020	6,04	0,02	60	0,2
17.5.2020	4,09	0,02	80	0,2
20.5.2020	6,98	0,05	80	0,2
24.5.2020	7,15	0,02	60	0,2
27.5.2020	6,16	0,05	100	0,2
10.9.2021	6,42	0,05	70	0,2
13.9.2021	6,11	0,02	80	0,2
16.9.2021	6,15	0,05	70	0,2
24.9.2021	6,92	0,05	60	0,2
7.10.2021	6,22	0,05	80	0,2
14.10.2021	6,76	0,05	70	0,2
18.10.2021	7,15	0,02	70	0,2
11.11.2021	6,82	0,05	80	0,2
17.11.2021	6,98	0,02	70	0,2
30.11.2021	6,75	0,02	70	0,2
1.3.2022	6,44	0,05	80	0,2
3.3.2022	6,25	0,02	80	0,2
4.3.2022	6,33	0,05	100	0,2
7.3.2022	6,98	0,05	70	0,2
9.3.2022	6,58	0,05	80	0,2
14.3.2022	6,47	0,05	80	0,2
16.3.2022	7,05	0,02	70	0,2

22.3.2022	7,09	0,05	70	0,2
24.3.2022	6,95	0,05	80	0,2
28.3.2022	6,82	0,02	70	0,2

Table 16: *Values of nitrates, nitrites, phosphates and alkalinity at the measuring station in Croatia.*

<b>CROATIA</b>					
DATE	Nitrates / mg/L	Nitrites /mg/L	Phosphates / mg/L	Alaklinity /mg/L	Ammonium /mg/L
19.10.2019	0.1	0.02	0	213,5	0.05
2.11.2019	0.1	0	0	274,5	0
9.11.2019	0.1	0.02	0	85,4	0.2
23.11.2019	0	0.02	0	85,4	0
29.11.2019	0	0.02	0	183	0
7.12.2019	0.1	0.02	0	183	0
14.12.2019	0	0	0	85,4	0.05
20.12.2019	0	0.1	0	213,5	0.05
28.12.2019	0	0.02	0	274,5	0.05
4.1.2020	0	0.02	0	(3) 183	0.05
10.1.2020	0	0.02	0	(3)183	0.2
18.1.2020	0.1	0.02	0	183	0,2
25.1.2020	0	0.02	0	213,5	0,05
1.2.2020	0	0.02	0	183 (3)	0,2
8.2.2020	0	0.1	0	610 (10)	0,05
15.2.2020	0	0.1	0	274,5	0,05
22.2.2020	0	0.02	0	439,2	0,05
29.2.2020	0	0.02	0	274,5	0,05
7.3.2020	0	0.1	0	183 (3)	0,2
14.3.2020	0,1	0,02	0	183	0,2
21.3.2020	0,1	0,02	0	183	0,2
28.3.2020	0,1	0,02	0	183	0,2
18.4.2020	0	0.1	0	183 (3)	0
25.4.2020	0	0.02	0	138,6	0,05
4.5.2021	25	0,1	0	183,0	0,05
7.5.2021	25	0,3	0	152,5	0,05
12.5.2021	0	0,1	0	134,2	0,05
14.5.2021	10	0,02	0	61,0	1,0
21.5.2021	10	0,02	0	152,5	0,2
26.5.2021	10	0,02	0	122	0,2
28.5.2021	0	0,02	0	122	0,05
2.6.2021	25	0,1	0	207,4	0,05
6.6.2021	10	0.02	0		0.2

Table 17: *Permitted limit values for certain types of water from the Regulation on Water Classification of the Republic of Croatia.*

TABLICA 1

SKUPINE POKAZATELJA	POKAZATELJI mjerna jedinica	I VRSTA	II VRSTA	III VRSTA	IV VRSTA	V VRSTA
FIZIKALNO-KEMIJSKI  A	pH	8,5-6,5	6,5-6,3 8,5-9,0	6,3-6,0 9,0-9,3	6,0-5,3 9,3-9,5	<5,3 >9,5
	Alkalitet * mg CaCO <sub>3</sub> /l	>200	200-100	100-20	20-10	<10
	Električna vodljivost μScm <sup>-1</sup>	<500	500-700	700-1000	1000-2000	>2000
REŽIM KISIKA  B	Otopljeni kisik ** mgO <sub>2</sub> /l	>7	7-6	6-4	4-3	<3
	Zasićenje kisikom ** %					
	tekućice:	80-110	70-80 110-120	50-70 120-140	20-50 140-150	<20 >150
	stajaćice: -epilimnij	90-110	70-90 110-120	50-70 120-130	30-50 130-150	<30 >150
	-hipolimnij	90-70	70-50	50-30	30-10	<10
KPK -Mn mgO <sub>2</sub> /l	<4	4-8	8-15	15-30	>30	
BPK <sub>5</sub> mgO <sub>2</sub> /l	<2	2-4	4-8	8-15	>15	
HRANJIVE TVARI  C	Amonij mgN/l	<0,10	0,10-0,25	0,25-0,60	0,60-1,50	>1,50
	Nitriti mgN/l	<0,01	0,01-0,03	0,03-0,10	0,10-0,20	>0,20
	Nitrati ** mgN/l	< 0,5	0,5-1,5	1,5-4,0	4,0-10,0	>10,0
	Ukupni dušik mgN/l	<1 0	1,0-3,0	3,0-10,0	10,0-20,0	>20,0
	Ukupni fosfor mgP/l					
tekućice:	<C 10	0,10-0,25	0,25-0,60	0,60-1 5	>1,5	
stajaćice:	<C 01	0,01-0,025	0,025-0,06	0,06-0,15	>0,15	
MIKROBIOLOŠKI  D	Broj koliformnih bakt UK/l	<5x10 <sup>2</sup>	5x10 <sup>2</sup> -5x10 <sup>3</sup>	5x10 <sup>3</sup> -10 <sup>5</sup>	10 <sup>5</sup> -10 <sup>6</sup>	>10 <sup>6</sup>
	Broj fekalnih koliforma FK/l	<2x10 <sup>2</sup>	2x10 <sup>2</sup> -10 <sup>3</sup>	10 <sup>3</sup> -10 <sup>4</sup>	10 <sup>4</sup> -10 <sup>5</sup>	> 10 <sup>5</sup>
	Broj aerobnih bakterija BK/ml	< 10 <sup>3</sup>	10 <sup>3</sup> -10 <sup>4</sup>	10 <sup>4</sup> -10 <sup>5</sup>	10 <sup>5</sup> -7,5x10 <sup>5</sup>	> 7,5x10 <sup>5</sup>
BIOLOŠKI  E	P-B indeks saprobnosti (S) **	1 0-1,8	1,8-2,3	2,3-2,7	2,7-3,2	3,2-4,0
	Biotički indeks **	< 10	8 - 9	6 - 7	4 - 5	< 4
	Stupanj trofije **		oligotrofan	mezotrofan	umjereno eutrofan	eutrofan

Comparing the data measured at measuring stations in Latvia, the Czech Republic, Slovakia and Croatia with table 17, we observe that:

- There are no phosphates in Croatia, nitrates and nitrites are on the border of I and II water quality, as well as the amount of oxygen and acidity, alkalinity shows the II level of water quality.
- In Slovakia, alkalinity indicates level III of water quality, nitrates level IV, and nitrites level III, the amount of oxygen indicates level II of water quality.
- In the Czech Republic, the alkalinity value indicates the II level of water quality, the amount of oxygen at the I level of quality, nitrates and nitrites at the IV level, and phosphates at the V level of water quality.
- Nitrate and nitrite values have not been measured in Latvia, but alkalinity indicates water quality level II, while the amount of oxygen indicates quality level I.

## Conclusion

By comparing the data collected at the measuring stations, we tried to answer our research questions. We noticed that:

- Croatia is the most southern country, so the air temperature is the highest. Latvia is the most northern country, so the air temperature is the lowest.
- Autumn 2021 was the coldest in Europe and spring 2022 is the coldest part of the year.
- During 2021 and 2022 the air temperature in Europe is the same.
- The pH in the water change is small because there is no pollution. During the whole year pH is between 7 and 8 in every country, which means there is not much pollution. Quality and equality of water is almost the same.
- Oxygen levels depend on the water temperature, there is more oxygen in cold water. 2022 has the biggest oxygen levels because it is the coldest year.
- In the Czech Republic there are higher oxygen levels, because the water is colder and there are probably more plants and a flow of fresh water.

We have confirmed some of our hypotheses and some we have not through our research:

- Air and water temperatures show mutual dependence and change during the year.
- At our measuring points, the temperature of the water does not significantly affect the amount of dissolved oxygen in the water.
- The water of our research stations is of different quality.
- Water pollution is present at some measuring points, which affects other parameters that change water quality.
- The diversity of macrozoobenthos organisms shows that pollution is not permanent.



## LITERATURE AND RESOURCES:

- <https://eur-lex.europa.eu/legal-content/HR/TXT/HTML/?uri=OJ:L:2020:435:FULL&from=EN>
- <https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=uriserv%3AOJ.L.2020.435.01.0001.01.HRV&toc=OJ%3AL%3A2020%3A435%3AFULL>
- <https://hrcak.srce.hr/file/174618>
- [https://narodne-novine.nn.hr/clanci/sluzbeni/1998\\_06\\_77\\_1037.html](https://narodne-novine.nn.hr/clanci/sluzbeni/1998_06_77_1037.html)
- [https://narodne-novine.nn.hr/clanci/sluzbeni/2008\\_04\\_47\\_1593.html](https://narodne-novine.nn.hr/clanci/sluzbeni/2008_04_47_1593.html)
- <https://www.spkc.gov.lv/lv>
- <https://www.vmd.gov.lv/en/valsts-meza-dienests/#jump>
- <https://www.mzp.cz/cz/voda>
- <https://vodarenska.cz/divize-trebic/>
- <https://www.skanska.cz/co-delame/projekty/172137/COV-Trebic-Intenzifikace>
- <http://www.pmo.cz>
- <https://www.bvsas.sk/>
- <https://www.seas.sk/ve-gabcikovo>
- <https://www.vodarne.eu/>
- <https://www.veolia.sk/o-nas/voda>
- <https://www.shmu.sk>
- <https://www.zsvs.sk/>
- <https://www.stvps.sk/>
- <https://www.cleanwateraction.org/>