



# Project WISA

Appendix, Report 4.3

Reports on tests of green  
technologies for handling storm water – Port Gdynia case study

**Project WISA 2019 - 2022**  
**APPENDIX for Deliverable 4.3**

**Lead Authors:**

Luczkiewicz A., Fudala-Ksiazek S., Kosek K., Byliński H., Szopinska M., Artichowicz W.  
Gdansk University of Technology, Poland

**Co-authors:**

KRINOVA Science Park, Sweden (Lead partner of WISA project)

**Cover photo**

Port of Gdynia, photograph T. Urbaniak

**Contact information:**

[aneta.luczkiewicz@pg.edu.pl](mailto:aneta.luczkiewicz@pg.edu.pl); [sylwia.fudala-ksiazek@pg.edu.pl](mailto:sylwia.fudala-ksiazek@pg.edu.pl); [klaudia.kosek@pg.edu.pl](mailto:klaudia.kosek@pg.edu.pl);  
[hubert.bylinski@pg.edu.pl](mailto:hubert.bylinski@pg.edu.pl); [malgorzata.szopinska@pg.edu.pl](mailto:malgorzata.szopinska@pg.edu.pl); [wojciech.artichowicz@pg.edu.pl](mailto:wojciech.artichowicz@pg.edu.pl)

**APPENDIX FOR DEL. 4.3 - TABLE OF CONTENTS**

<b>No</b>	<b>APPENDIX Chapter</b>	<b>Page</b>
3	Detailed evaluation of stormwater samples chemical characteristic - Port of Gdynia case study	
3.1	Results of real-time rainwater analyses by WISA-ONLINE system	3

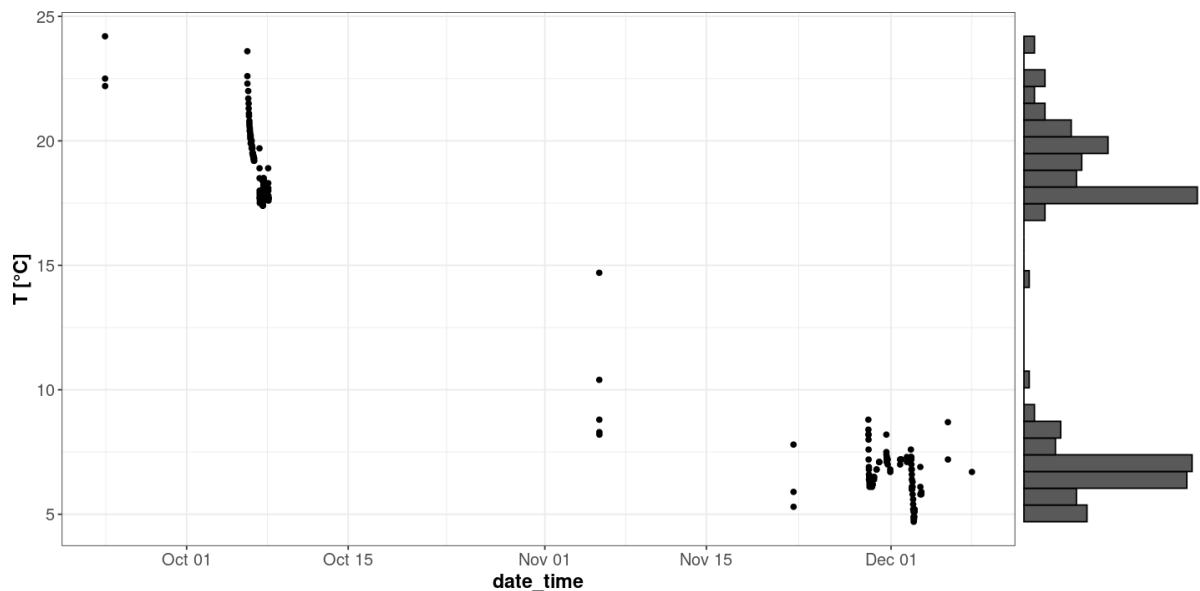
### 3 DETAILED EVALUATION OF STORMWATER SAMPLES CHEMICAL CHARACTERISTIC - PORT OF GDYNIA CASE STUDY

#### 3.2. Results of real-time rainwater analyses by WISA-ONLINE system

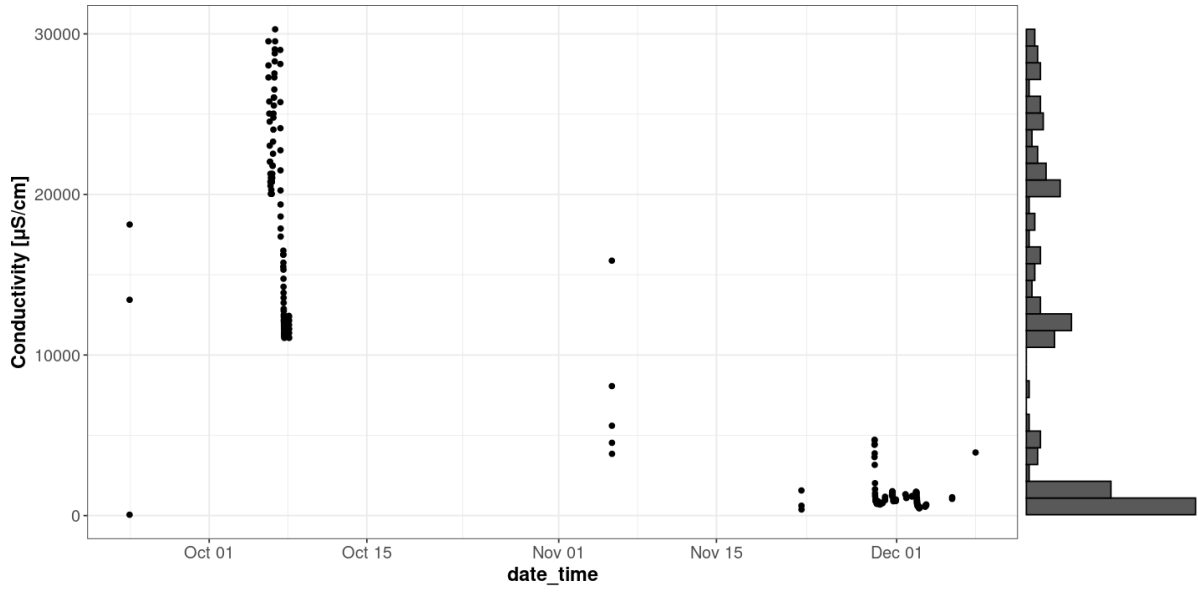
The plots below display the values measured using the automatic probes in year 2021. The plots displayed in A-Figs. 1-6 consist of the point plot displaying each measurement (left part) and the histogram (right part). The histogram displays the frequency of the particular values in the set of measurement. One plot per considered physical or chemical parameter is given. The empty gaps with no data points in the time line are the result of the technical difficulties resulting in the diminishing power supply.

Plots given in A-Fig. 1-7 display the measurements driven at BBM quay, whereas in A-Figs. 8- 11 data for the H/D quay is given. For the parameters that were measured at both sampling points the plots including the data from the both sampling devices are given (A-Figs. 12-14).

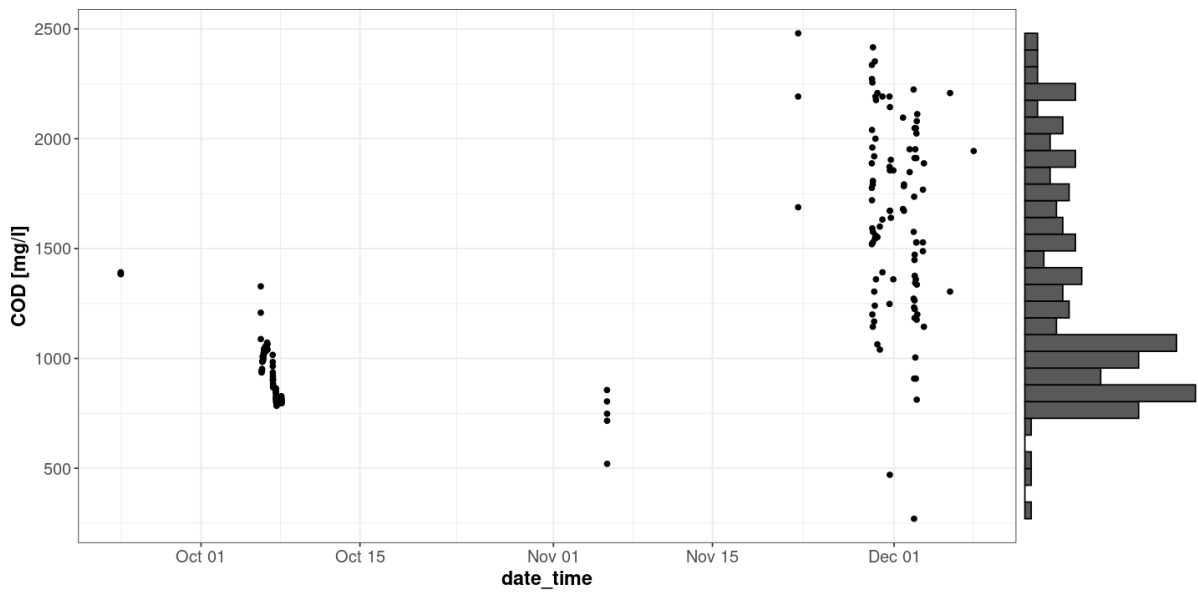
Plots given in A-Fig. 7 and A-Fig. 11, and display the scatterplots for each pair of the monitored variables (lower triangular matrix) as well as histograms (diagonal) and provides linear correlation coefficients for pairs of the variables (upper triangular matrix).



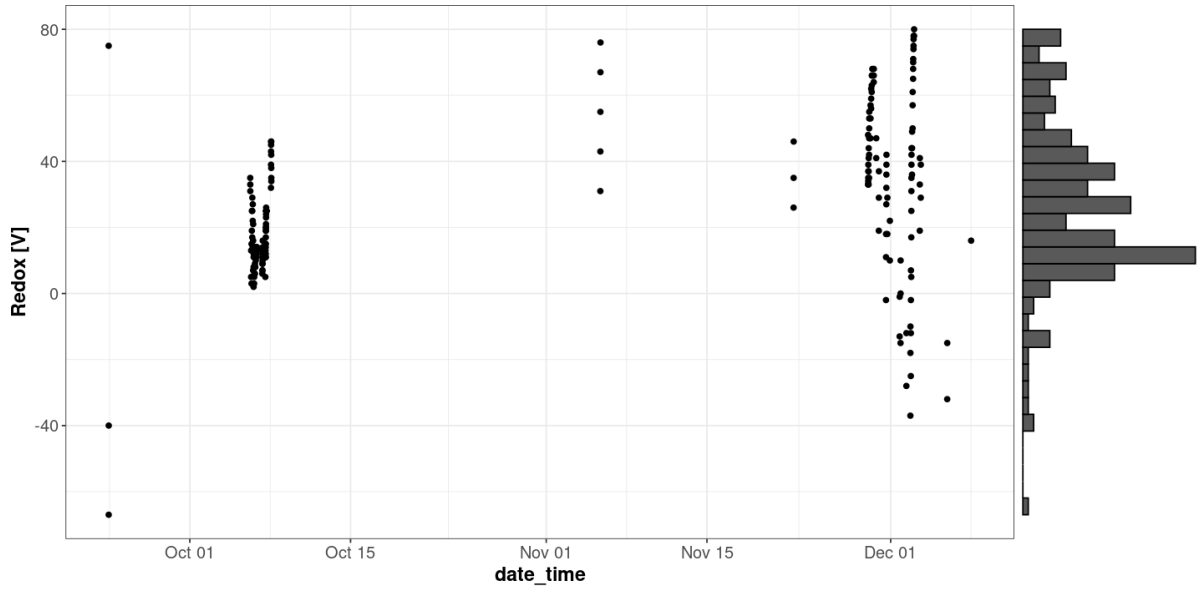
**A-Fig. 1** Temperature measurements at BBM quay collected by automatic measuring device



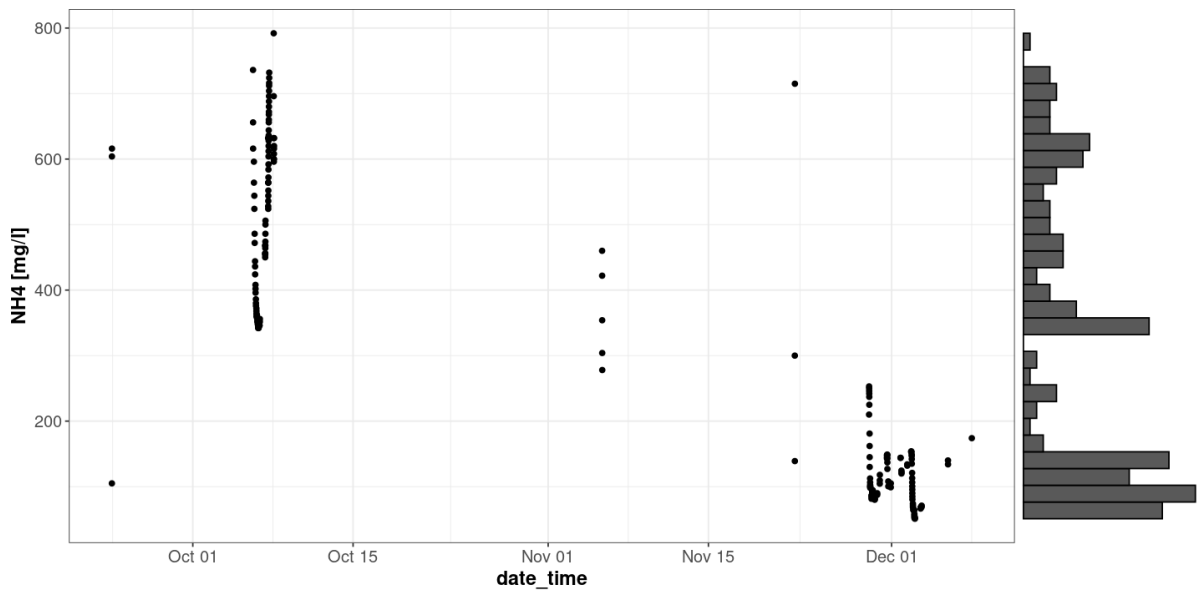
**A-Fig. 2.** Conductivity measurements at BBM quay collected by automatic measuring device



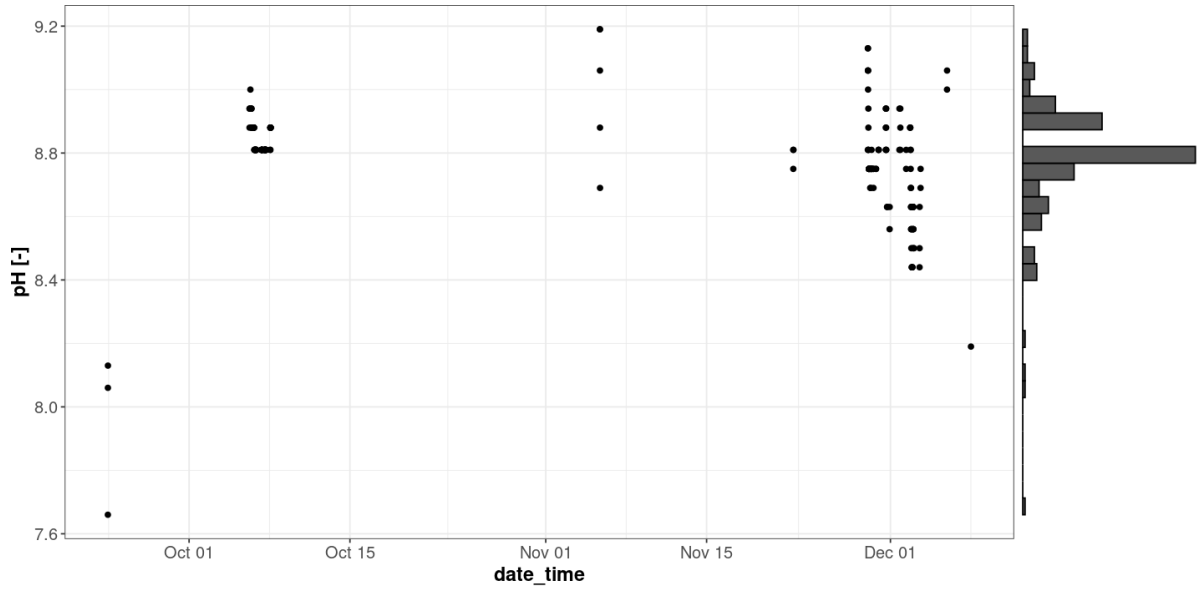
**A-Fig. 3.** Chemical oxygen demand measurements at BBM quay collected by automatic measuring device



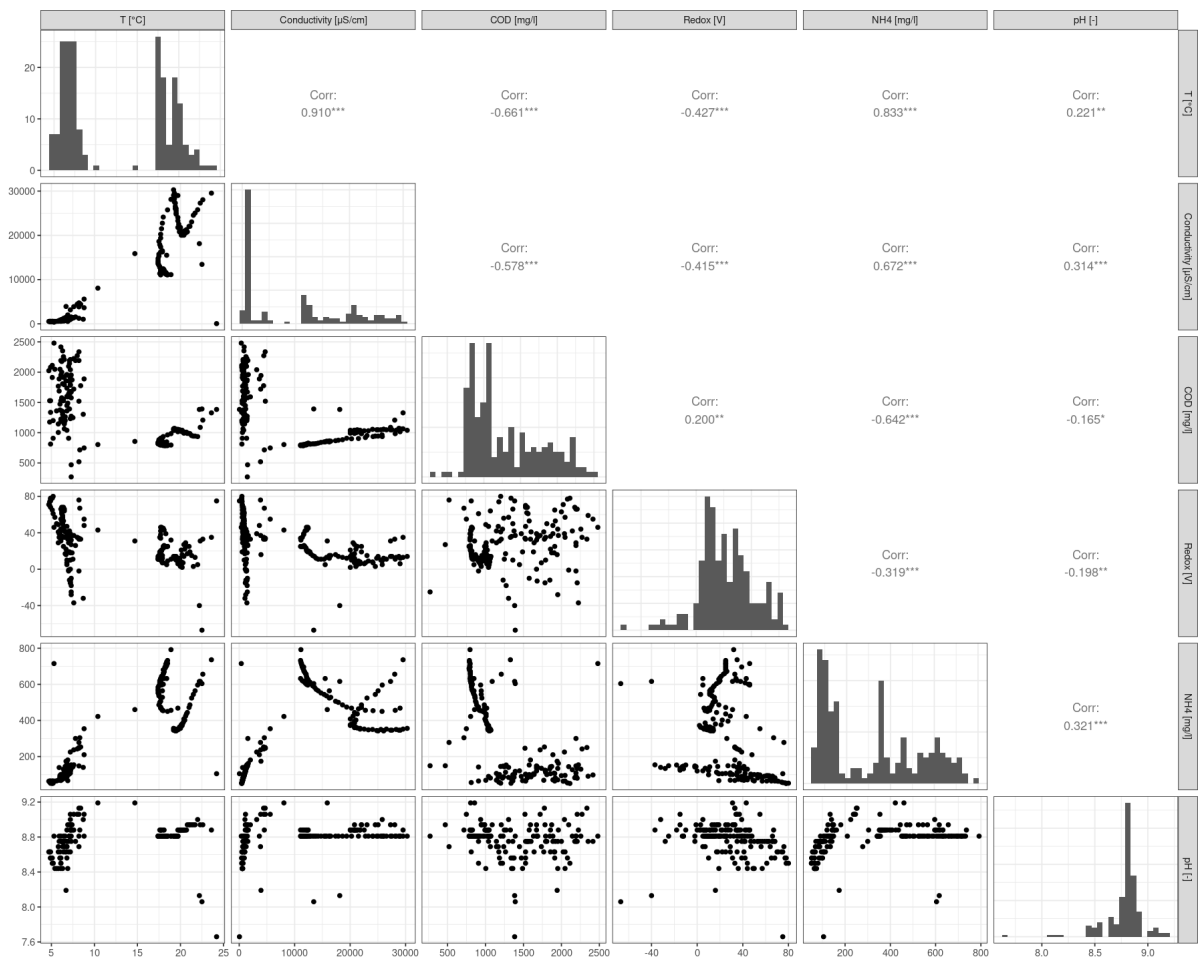
**A-Fig. 4.** Redox measurements at BBM quay collected by automatic measuring device



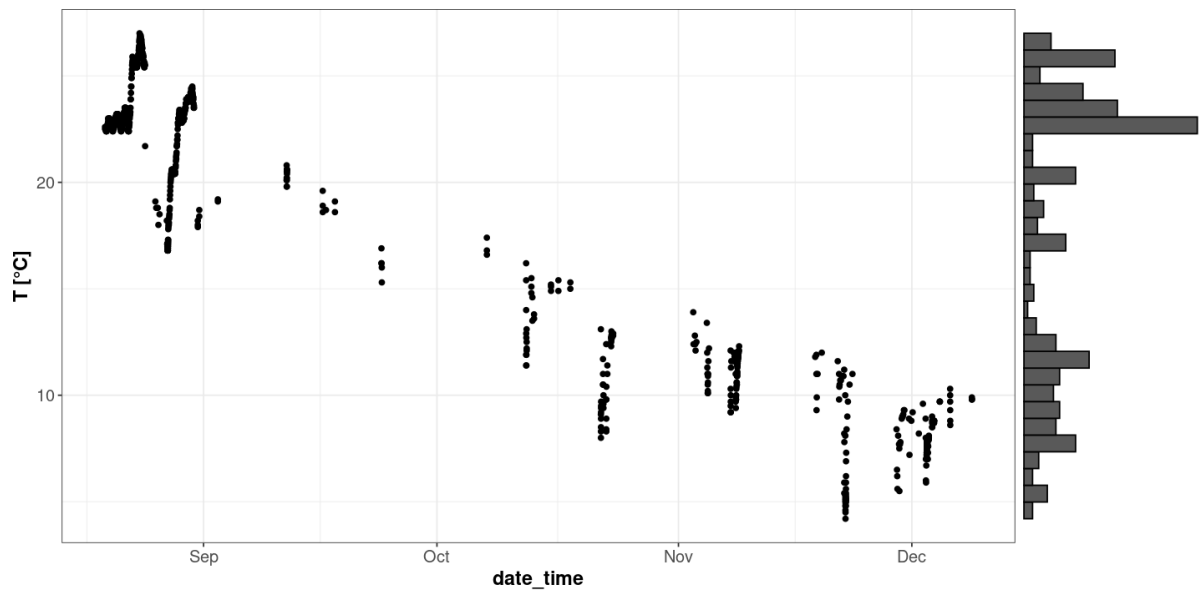
**A-Fig. 5.** Ammonia concentration measurements at BBM quay collected by automatic measuring device



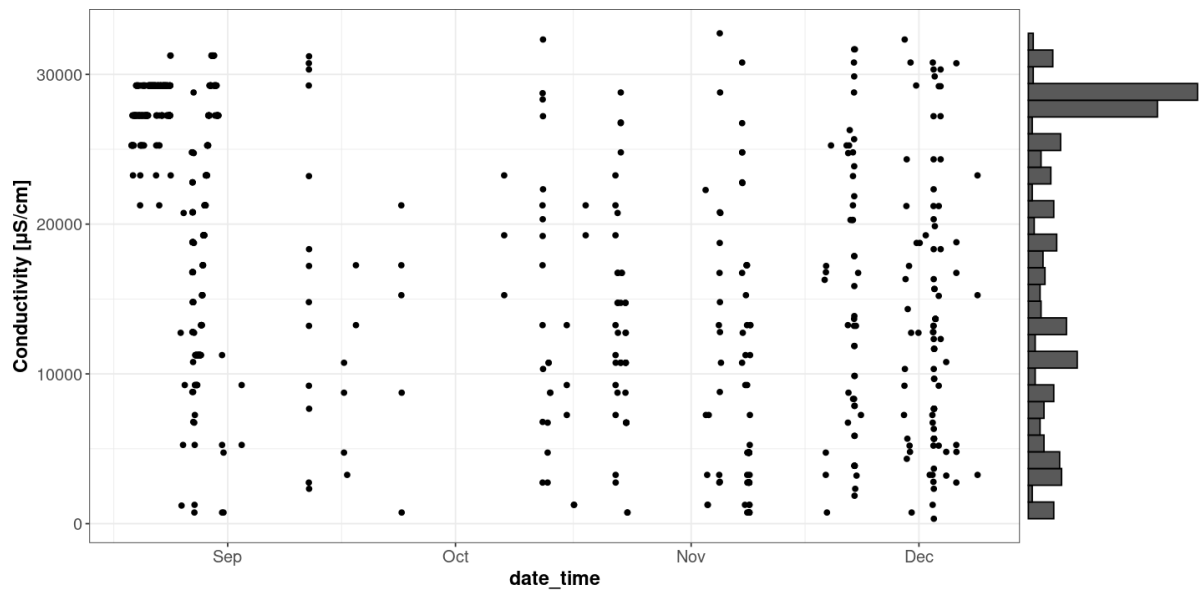
**A-Fig. 6.** pH measurements at BBM quay collected by automatic measuring device



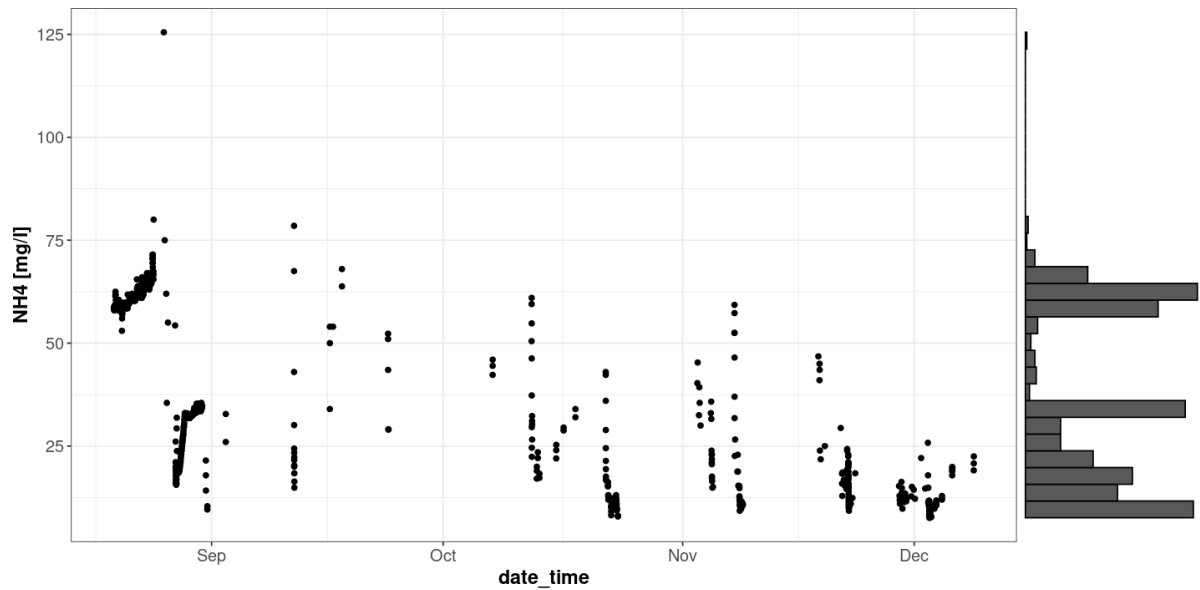
**A-Fig. 7.** Plot summarizing all of the automatic measurements performed by the automatic probes at BBM quay. On diagonal the histograms of the considered parameter are given. The plots in the lower triangle are the scatter plots of the pairs of the parameters.



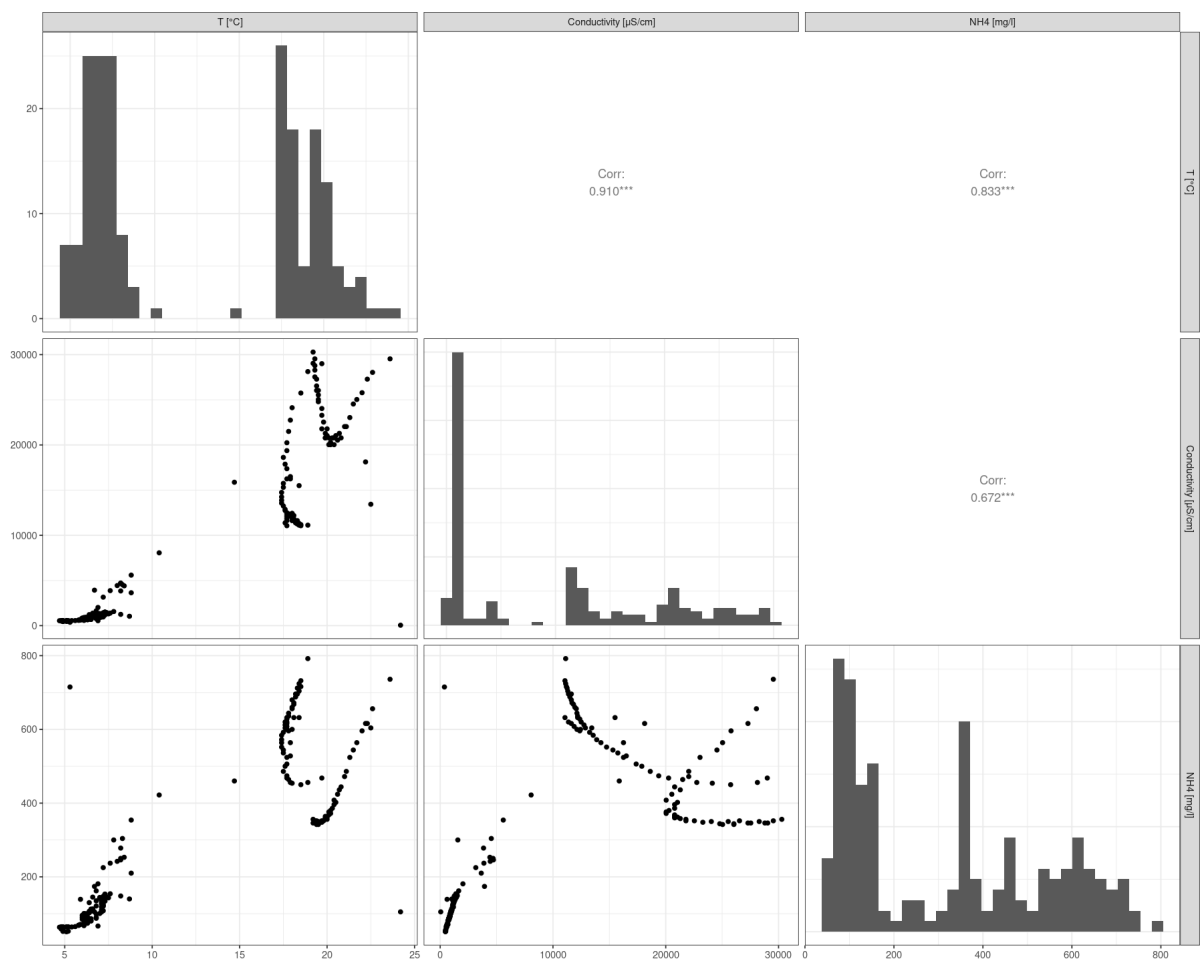
**A-Fig. 8.** Temperature measurements at H/D quay collected by automatic measuring device



**A-Fig. 9.** Conductivity measurements at H/D quay collected by automatic measuring device

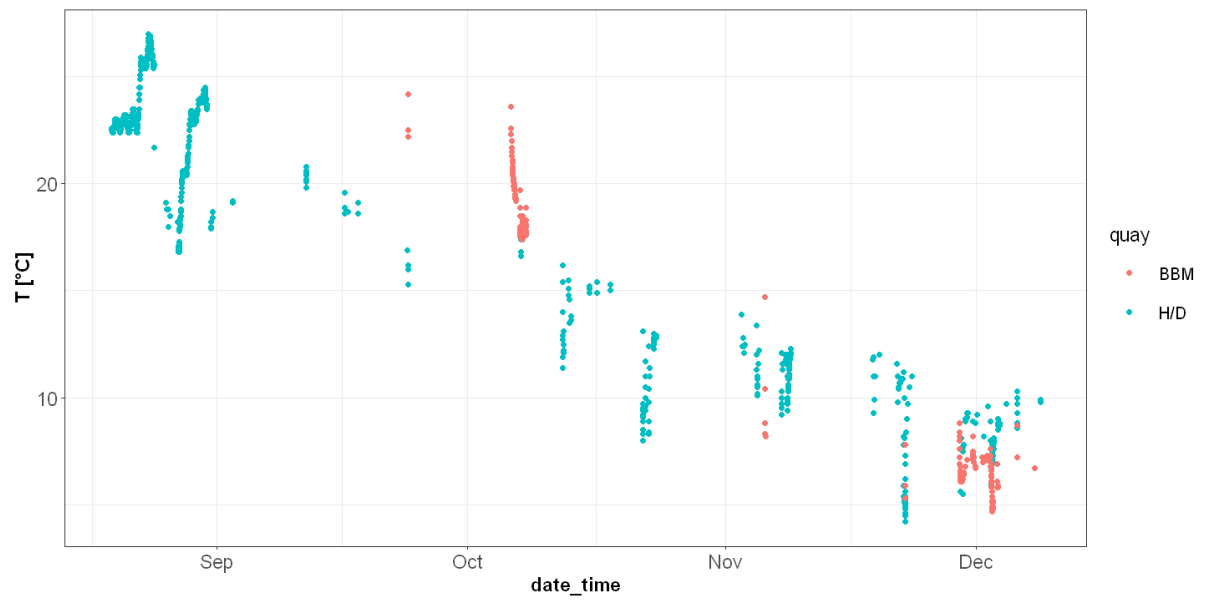


**A-Fig. 10.** Ammonia concentration measurements at H/D quay collected by automatic measuring device

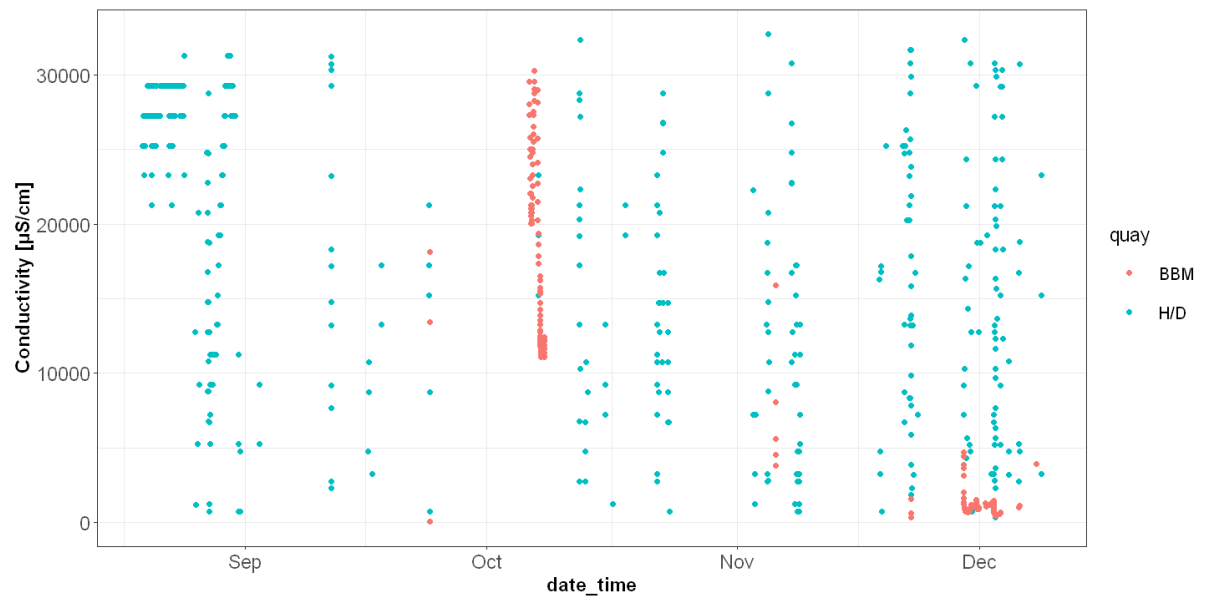


**A-Fig. 11.** Plot summarizing all of the automatic measurements performed by the automatic probes at H/D quay. On diagonal the histograms of the considered parameter are given. The plots in the lower triangle are the scatter plots of the pairs of the parameters.

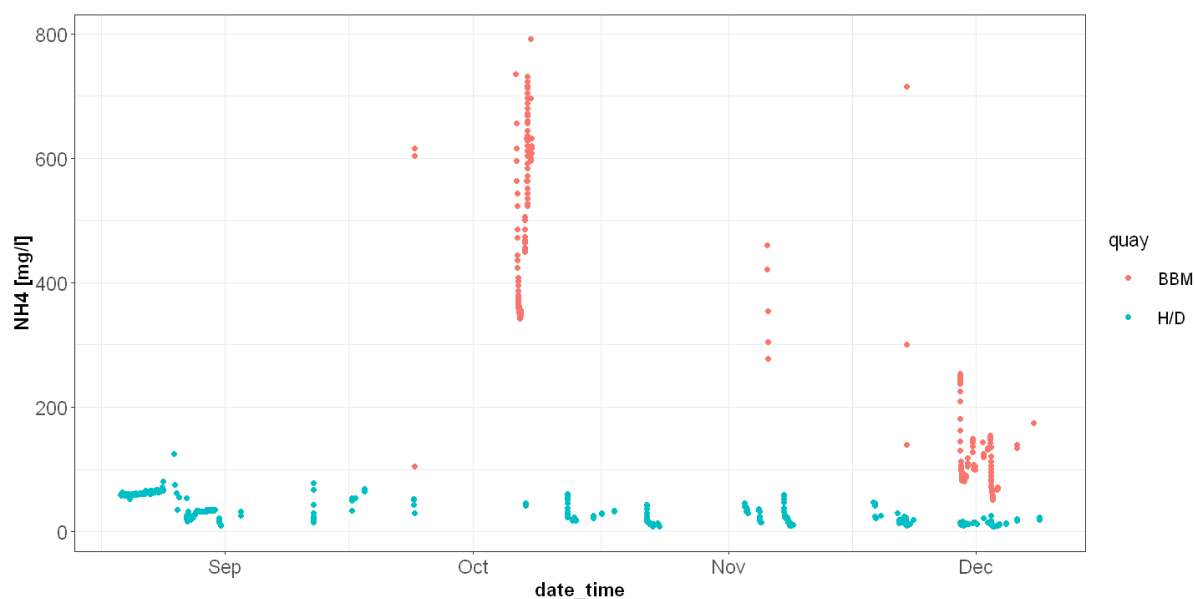




**A-Fig. 12.** Comparison of the temperature [°C] measurements at H/D (blue) and BBM (red) quays.



**A-Fig. 13.** Comparison of the conductivity [µS/cm] measurements at H/D (blue) and BBM (red) quays.



**A-Fig. 14.** Comparison of the ammonia [mg/l] measurements at H/D (blue) and BBM (red) quays.

A data collected by the autosampler devices is displayed and characterized in A-Figs. 15-74 and tables A-Tab. 1-30. For each of the measured parameters the boxplots of the observed data are given as well as the time series of the measurements. Additionally, a conclusive table containing the basic statistical characteristics for a considered chemical parameter of each rainfall episode is given. Also, for each parameter a set of two boxplots in which all the measurements from all episodes in considered quays are given.

A boxplot is a plot displaying the most important statistics characterizing a sample. It displays the median value of the concentration of the given parameter with the horizontal line inside the rectangle. The interquartile range is displayed as the rectangle filled with colour indicating the measurement site (quay BBM in red, H/D in blue). The interquartile range is computed as  $IQR = Q_{0.75} - Q_{0.25}$ , where the  $Q_{0.25}$  and  $Q_{0.75}$  denote the quantiles of order 0.25 and 0.75 respectively. The whiskers (vertical lines at the ends of the rectangles) present the maximal and minimal observed value within the range of the typical observations (based on the sample). The range of the typical observations is considered to be  $[Q_{0.25} - 1.5IQR, Q_{0.75} + 1.5IQR]$ . The values appearing above or below the ends of the whiskers are considered outliers, that means unusual values.

In the plot given in A-Fig. 13. boxplots present the variability of the considered parameter throughout the rainfall episode. That means it includes the values of the parameters obtained from all bottles for which the measurement was performed. The date assigned to the episode is a sample collection date, as it was impossible to collect the exact time and the intensity at the occurrence of the rainfall event. The autosampler device stores the date and time of the sampling bottle becoming full, therefore using sample collection date seems the best approach as the event concluding the whole rainfall episode. It should be noted that the samples were usually collected the next day after the rainfall episode.

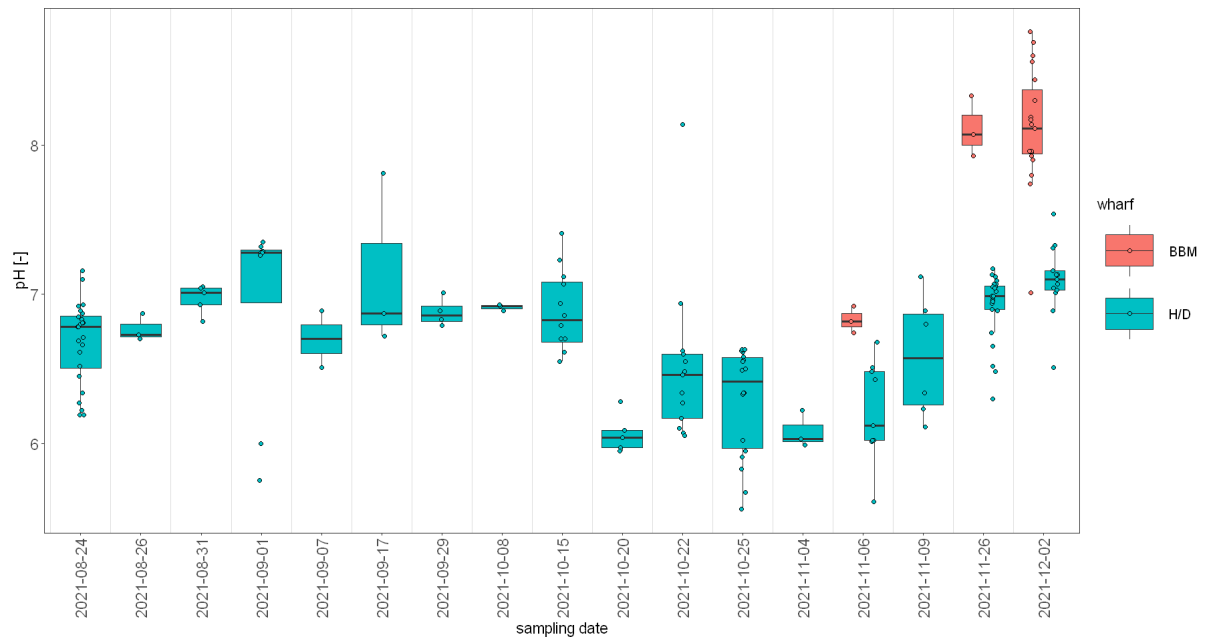
To present most complete information possible, all the measured values are displayed in the form of points covering the boxplot (A-Fig. 15 and 18). Each point given in the plot is a parameter value measured for the content of a single sampling bottle. The vertical position of the point corresponds to the measured value, whereas the horizontal position has no meaning. The horizontal jitter was added to improve the visibility of the points. Each boxplot can be considered a graphical conclusion of the rainfall event expressed in terms of the chemical and physical parameters of the stormwater (A-Fig. 15).

Below boxplots of pH [-] parameter are given (A-Fig. 15). The dates are presented in the format YYYY-MM-DD, where Y denotes a year, M month and D day placeholders.

Additionally, to display the data in most detail also the time series of the measurements were displayed (A-Fig. 16. and 17). However, in case of the following plots no time data is used but the index of the sample bottle. The reason for such proceeding is the fact, that not all parameter were analysed in every sample. The sample bottles were filled subsequently during each rainfall episode and therefore their index can be used as the sample ordering index. The sample collection date for each episode is displayed in the header of the plot, whereas on the horizontal axis the sample bottle index is given. The vertical axis corresponds to the considered value of the physical or chemical parameter. The time series for each quay are given separately. Following plots (A-Fig. 15. and A-Fig. 17) display the variability of the considered parameter during the rainfall episode at quays H/D and BBM.

For each of the considered parameters similar plots and tables were created.

### Statistical characteristics of the pH



**A-Fig. 15.** Boxplots of the measured pH [-] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the pH at H/D quay are equal to 5.56 and 8.14 respectively, whereas at BBM quay those values are equal to 6.74 and 8.76. The medians range from 6.03 to 7.28 at H/D and from 6.82 to 8.11 at BBM.

/

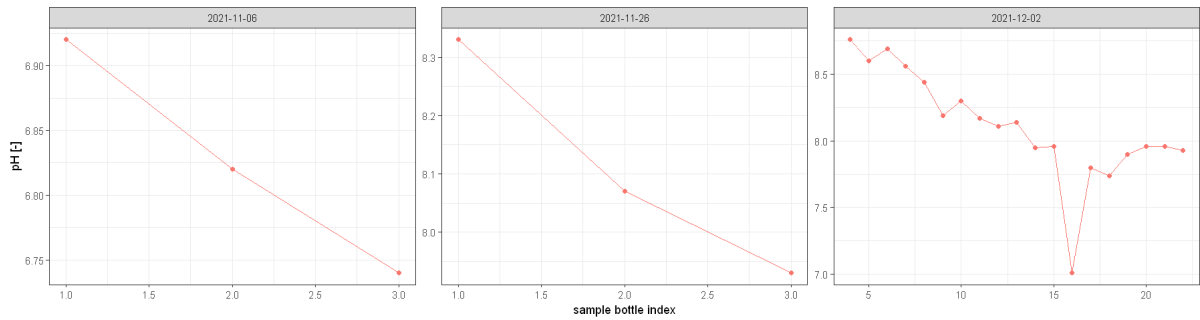


**A-Fig. 16.** pH [-] values in subsequent sampling bottles at H/D quay.

**A-Tab. 1** pH [-] statistical characteristics of the episodes at H/D quay.

sampling date	pH [-]				
	mean	median	std	min	max
<b>2021-08-24</b>	6.682	6.780	0.279	6.19	7.16
<b>2021-08-26</b>	6.767	6.730	0.091	6.70	6.87
<b>2021-08-31</b>	6.970	7.010	0.096	6.82	7.05
<b>2021-09-01</b>	6.941	7.280	0.662	5.75	7.35
<b>2021-09-07</b>	6.700	6.700	0.269	6.51	6.89
<b>2021-09-17</b>	7.133	6.870	0.591	6.72	7.81
<b>2021-09-29</b>	6.880	6.860	0.096	6.79	7.01
<b>2021-10-08</b>	6.913	6.920	0.021	6.89	6.93
<b>2021-10-15</b>	6.883	6.825	0.274	6.55	7.41
<b>2021-10-20</b>	6.066	6.040	0.132	5.95	6.28

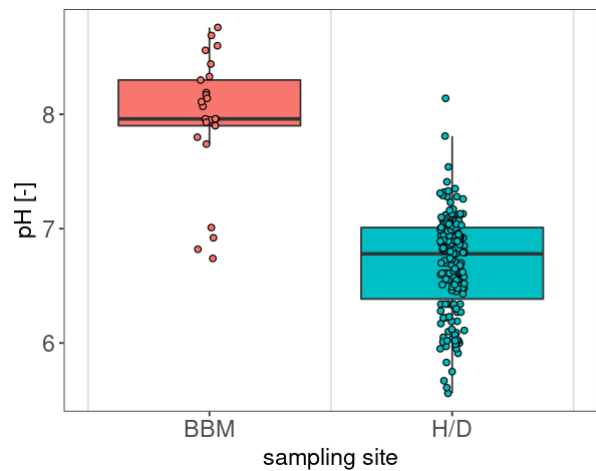
<b>2021-10-22</b>	6.522	6.460	0.551	6.05	8.14
<b>2021-10-25</b>	6.284	6.415	0.361	5.56	6.63
<b>2021-11-04</b>	6.080	6.030	0.123	5.99	6.22
<b>2021-11-06</b>	6.209	6.120	0.338	5.61	6.68
<b>2021-11-09</b>	6.582	6.570	0.409	6.11	7.12
<b>2021-11-26</b>	6.920	6.990	0.223	6.30	7.17
<b>2021-12-02</b>	7.096	7.100	0.242	6.51	7.54



**A-Fig. 17.** pH [-] values in subsequent sampling bottles at BBM quay.

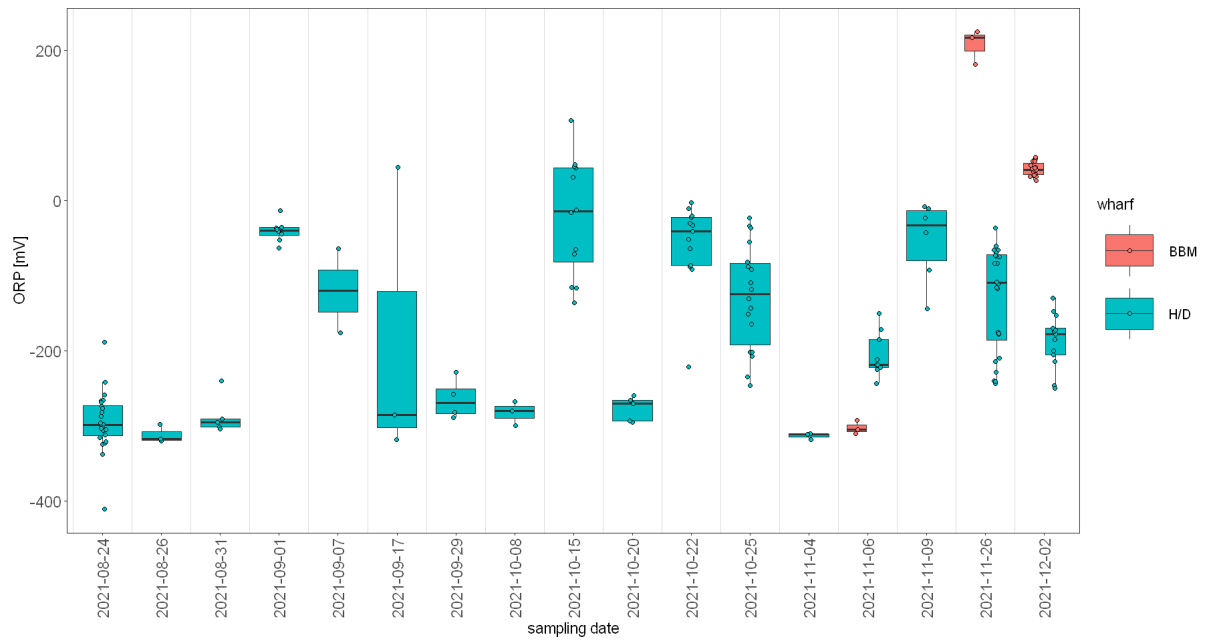
**A-Tab. 2.** pH [-] statistical characteristics of the episodes at BBM quay.

sampling date	pH [-]				
	mean	median	std	min	max
<b>2021-11-06</b>	6.827	6.82	0.090	6.74	6.92
<b>2021-11-26</b>	8.110	8.07	0.203	7.93	8.33
<b>2021-12-02</b>	8.114	8.11	0.406	7.01	8.76



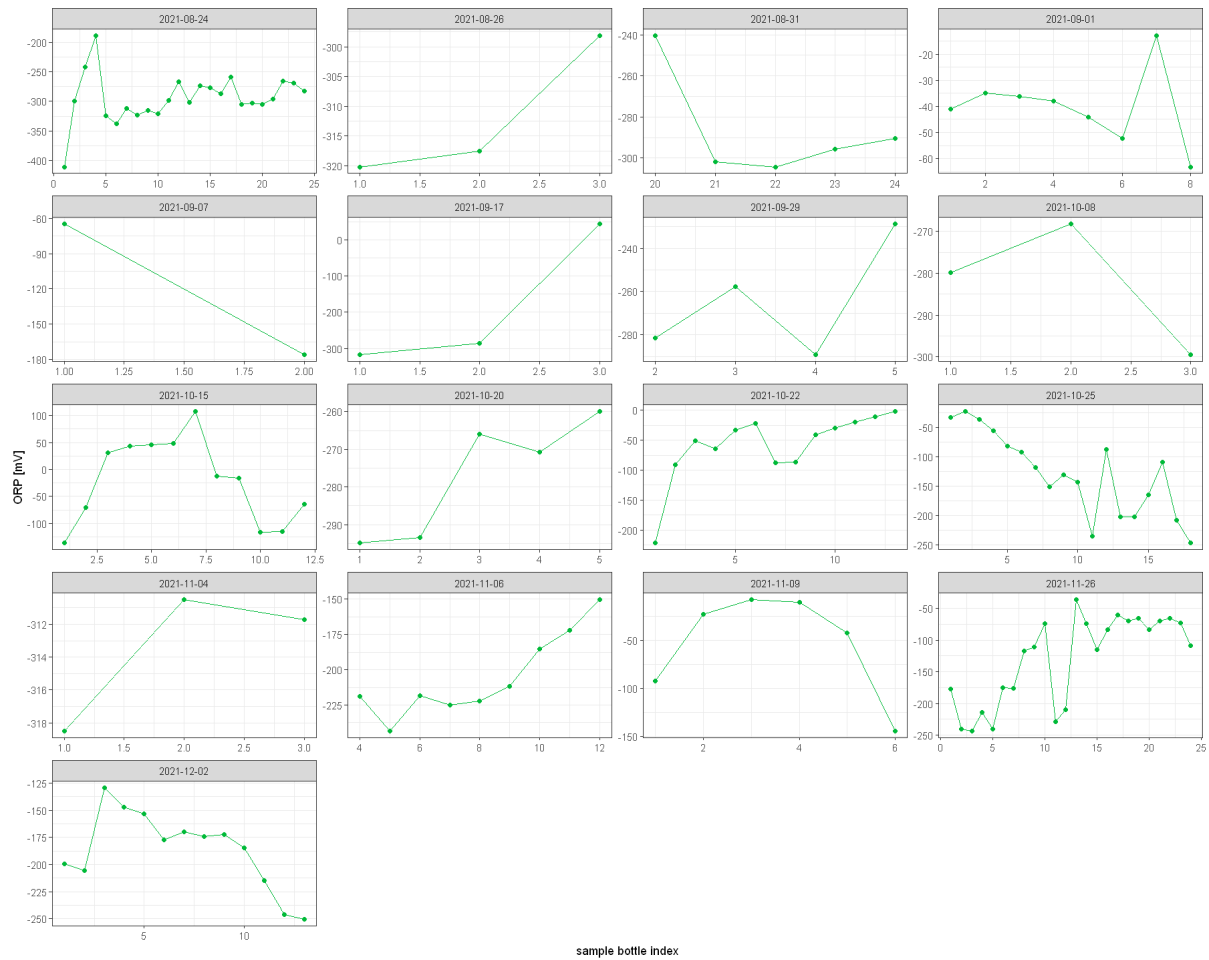
**A-Fig. 18.** Comparison of the pH [-] measurements at BBM and H/D quays.

## Statistical characteristics of the oxidation reduction potential



**A-Fig. 19.** Boxplots of the measured ORP [mV] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the oxidation reduction potential at H/D quay are equal to  $-410.8$  and  $107.3$  respectively, whereas at BBM quay those values are equal to  $-310.8$  and  $225.0$ . The medians range from  $-317.5$  to  $-13.9$  at H/D and from  $-305.2$  to  $217.0$  at BBM.

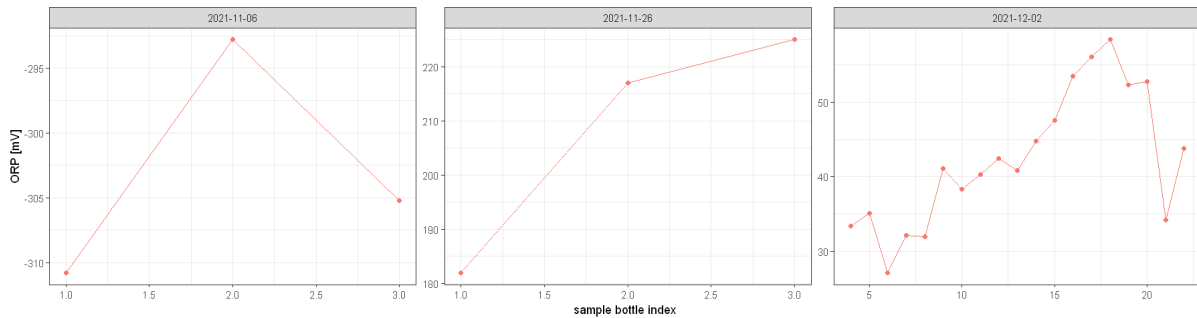


**A-Fig. 20.** ORP [mV] values in subsequent sampling bottles at H/D quay.

**A-Tab. 3.** ORP [mV] statistical characteristics of the episodes at H/D quay.

sampling date	ORP [mV]				
	mean	median	std	min	max
<b>2021-08-24</b>	-294.383	-298.85	40.313	-410.8	-188.8
<b>2021-08-26</b>	-311.933	-317.50	12.056	-320.2	-298.1
<b>2021-08-31</b>	-286.500	-295.60	26.324	-304.3	-240.4
<b>2021-09-01</b>	-40.325	-39.50	14.596	-63.2	-12.8
<b>2021-09-07</b>	-120.300	-120.30	79.196	-176.3	-64.3
<b>2021-09-17</b>	-186.367	-285.80	200.847	-318.1	44.8
<b>2021-09-29</b>	-264.275	-269.60	27.318	-289.3	-228.6
<b>2021-10-08</b>	-282.467	-279.80	15.869	-299.5	-268.1
<b>2021-10-15</b>	-21.267	-13.90	78.896	-136.3	107.3
<b>2021-10-20</b>	-276.980	-270.70	16.134	-294.9	-260.0
<b>2021-10-22</b>	-58.485	-40.60	57.399	-221.6	-2.2

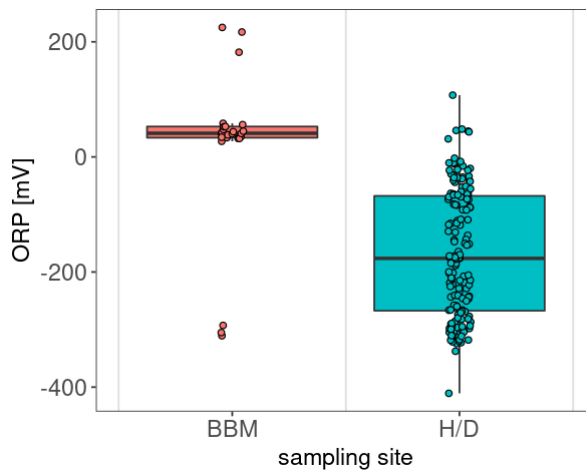
<b>2021-10-25</b>	-128.839	-124.70	70.194	-246.4	-23.2
<b>2021-11-04</b>	-313.567	-311.70	4.314	-318.5	-310.5
<b>2021-11-06</b>	-205.256	-218.40	29.729	-243.4	-150.3
<b>2021-11-09</b>	-53.450	-32.90	54.235	-144.3	-8.0
<b>2021-11-26</b>	-129.807	-109.65	69.580	-243.7	-36.1
<b>2021-12-02</b>	-186.500	-177.40	35.994	-250.3	-129.3



**A-Fig. 21.** ORP [mV] values in subsequent sampling bottles at BBM quay.

**A-Tab. 4.** ORP [mV] statistical characteristics of the episodes at BBM quay.

sampling date	ORP [mV]				
	mean	median	std	min	max
<b>2021-11-06</b>	-302.933	-305.2	9.212	-310.8	-292.8
<b>2021-11-26</b>	207.967	217.0	22.926	181.9	225.0
<b>2021-12-02</b>	42.432	41.1	9.077	27.1	58.4

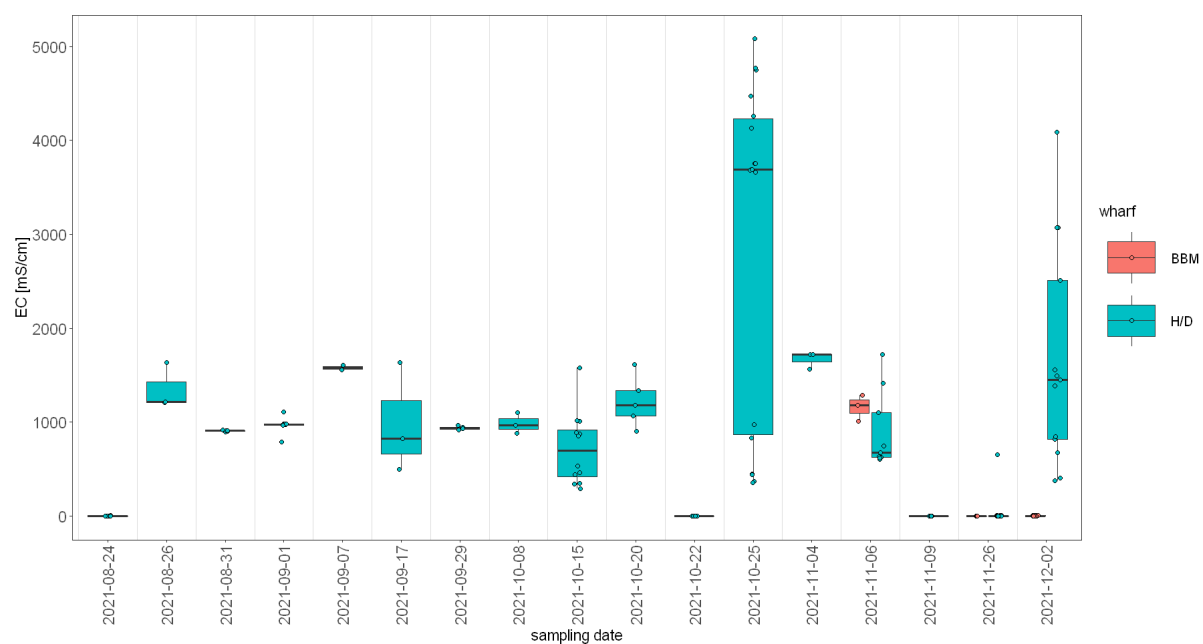


**A-Fig. 22.** Comparison of the ORP [mV] measurements at BBM and H/D quays.

In A-Fig. 22. it can be noticed that statistically oxidation reduction potential at BBM quay is significantly higher than at H/D quay.

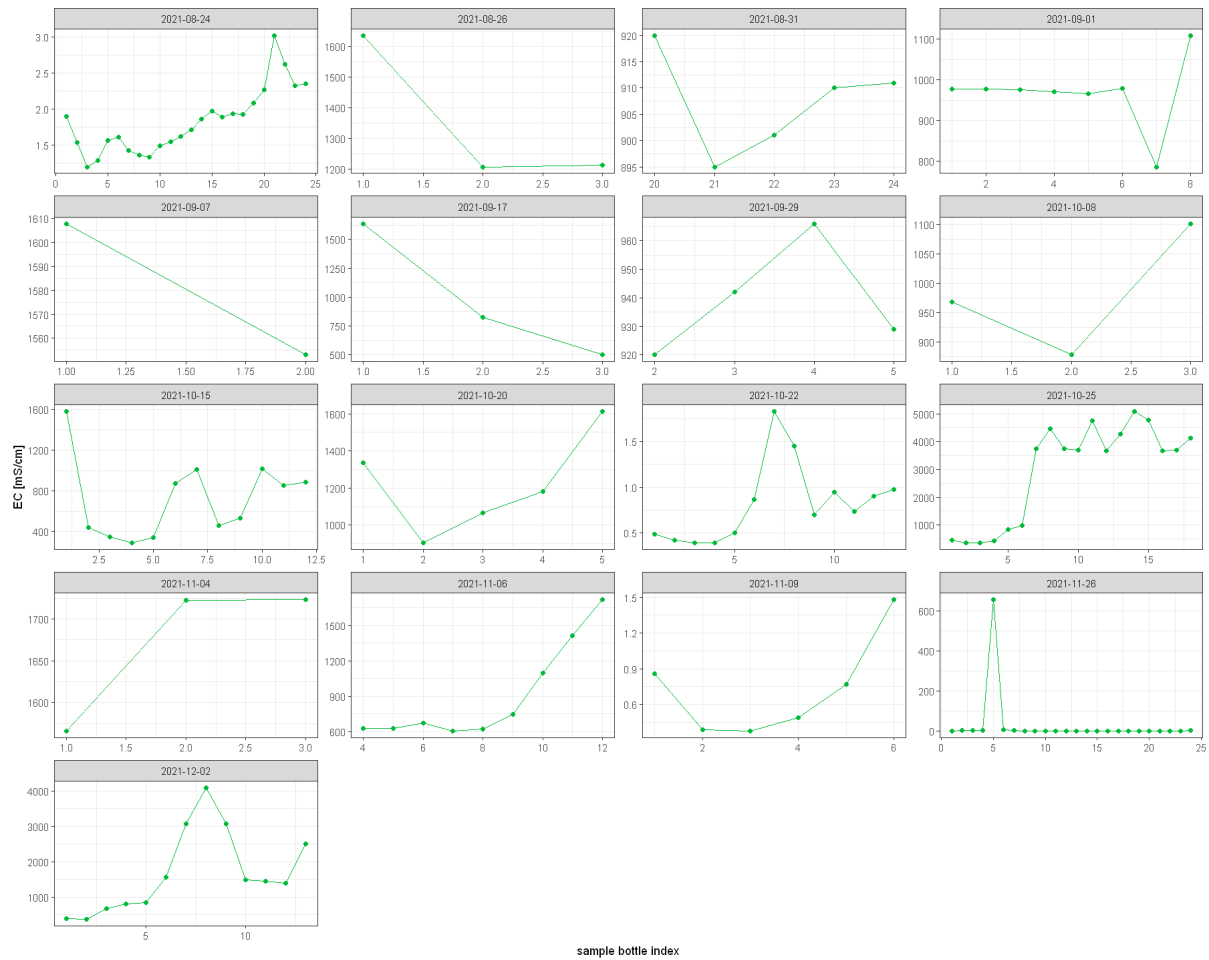


Statistical characteristics of the electrical conductivity.



**A-Fig. 23.** Boxplots of the measured EC [mS/cm] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

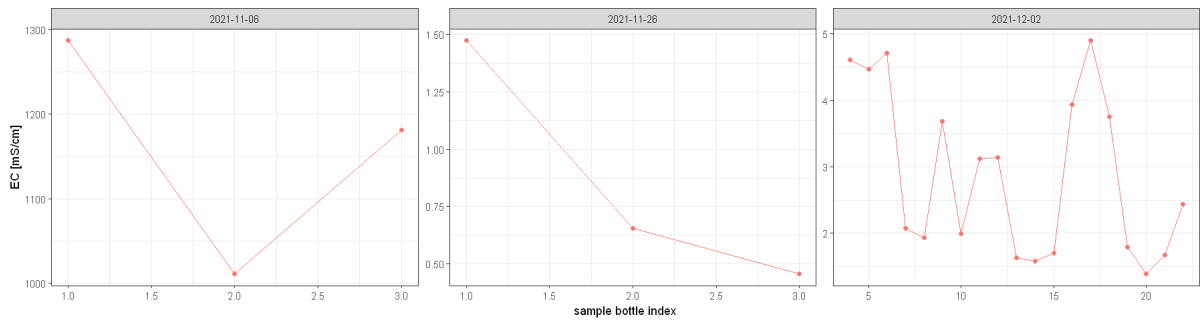
Minimum and maximum observed values of the electrical conductivity at H/D quay are equal to 0.356 mS/cm and 5080 mS/cm respectively, whereas at BBM quay those values are equal to 0.456 mS/cm and 1287 mS/cm. The medians range from 0.627 mS/cm to 3690 mS/cm at H/D and from 0.655 mS/cm to 1181 mS/cm at BBM.



**A-Fig. 24.** EC [mS/cm] values in subsequent sampling bottles at H/D quay.

**A-Tab. 5.** EC [mS/cm] statistical characteristics of the episodes at H/D quay.

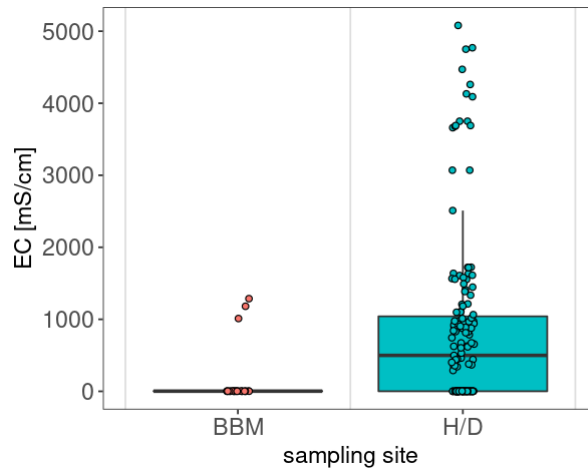
sampling date	EC [mS/cm]				
	mean	median	std	min	max
<b>2021-08-24</b>	1.824	1.7825	0.450	1.195	3.020
<b>2021-08-26</b>	1352.667	1214.0	245.392	1208.0	1636.0
<b>2021-08-31</b>	907.400	910.0	9.659	895.0	920.0
<b>2021-09-01</b>	967.500	976.0	87.311	786.0	1109.0
<b>2021-09-07</b>	1580.500	1580.5	38.891	1553.0	1608.0
<b>2021-09-17</b>	987.000	824.0	586.734	499.0	1638.0
<b>2021-09-29</b>	939.250	935.5	19.990	920.0	966.0
<b>2021-10-08</b>	982.667	968.0	112.718	878.0	1102.0
<b>2021-10-15</b>	720.333	693.0	384.685	290.0	1580.0
<b>2021-10-20</b>	1219.800	1183.0	270.249	904.0	1612.0
<b>2021-10-22</b>	0.816	0.7350	0.429	0.392	1.826
<b>2021-10-25</b>	2949.722	3690.0	1786.919	355.0	5080.0
<b>2021-11-04</b>	1670.333	1722.0	90.357	1566.0	1723.0
<b>2021-11-06</b>	902.111	672.0	412.604	604.0	1718.0
<b>2021-11-09</b>	0.727	0.6270	0.420	0.377	1.480
<b>2021-11-26</b>	28.905	0.7620	133.582	0.356	656.0
<b>2021-12-02</b>	1671.692	1447.0	1167.035	379.0	4090.0



**A-Fig. 25.** EC [mS/cm] values in subsequent sampling bottles at BBM quay.

**A-Tab. 6.** EC [mS/cm] statistical characteristics of the episodes at BBM quay.

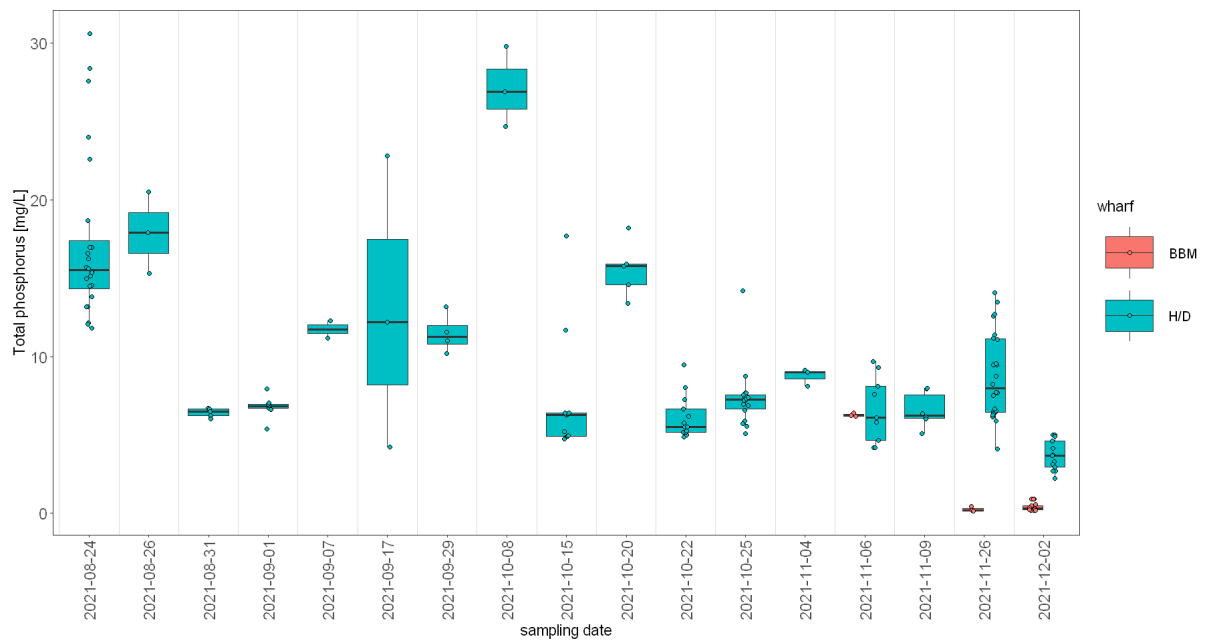
sampling date	EC [mS/cm]				
	mean	median	std	min	max
<b>2021-11-06</b>	1159.667	1181.000	139.231	1011.0	1287.0
<b>2021-11-26</b>	0.862	0.655	0.540	0.456	1.474
<b>2021-12-02</b>	2.871	2.440	1.239	1.388	4.900



**A-Fig. 26.** Comparison of the EC [mS/cm] measurements at BBM and H/D quays.

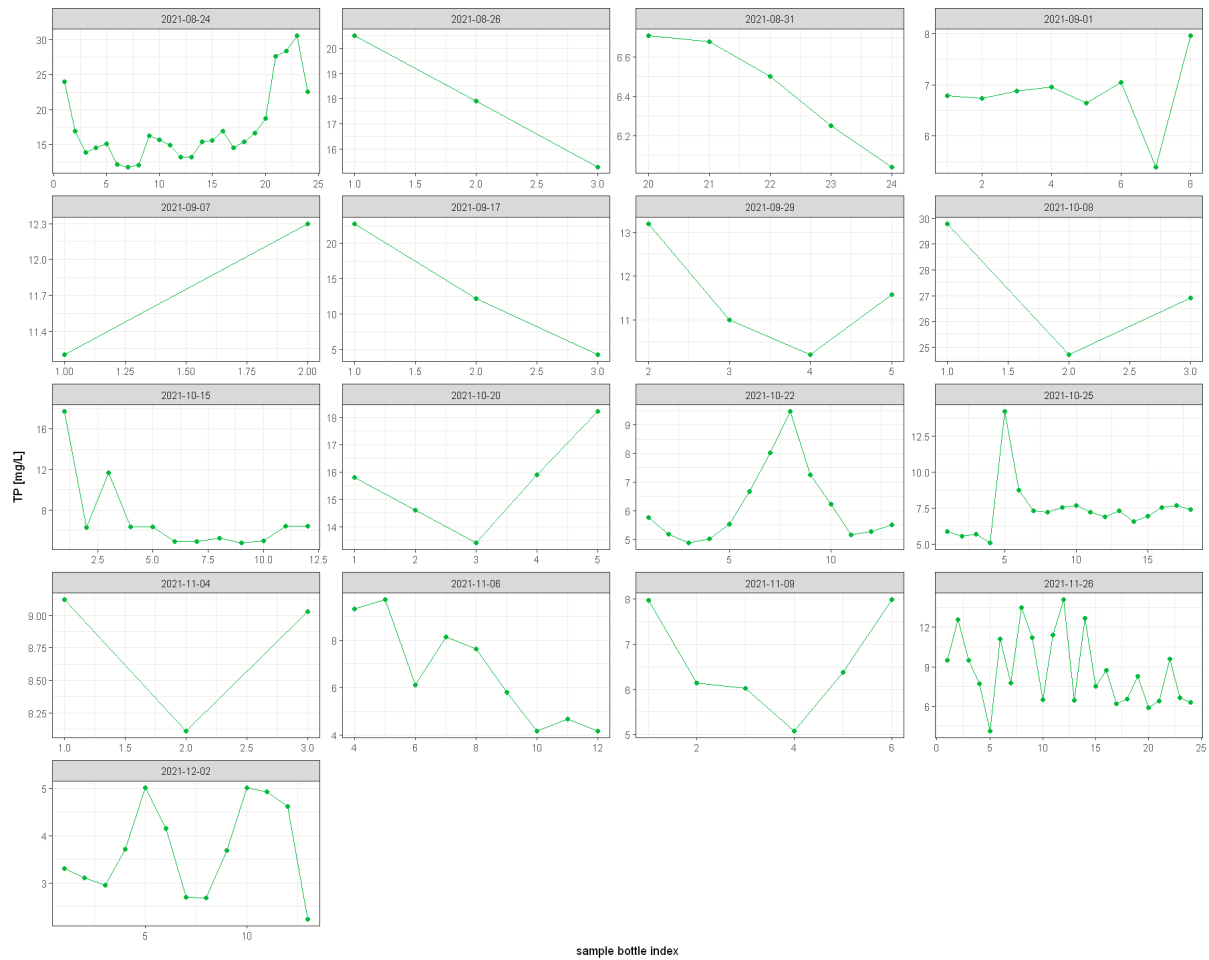
In A-Fig. 26. it can be noticed that statistically the electrical conductivity at the considered quays differs significantly. The values at H/D quay tend to have much wider range of variability.

### Statistical characteristics of the total phosphorus (TP)



**A-Fig. 27.** Boxplots of the measured values of the total phosphorus [mg/L] for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the total phosphorus at H/D quay are equal to 2.24 mg/L and 30.6 mg/L respectively, whereas at BBM quay those values are equal to 0.154 mg/L and 6.4 mg/L. The medians range from 3.68 mg/L to 26.9 mg/L at H/D and from 0.181 mg/L to 6.4 mg/L at BBM.

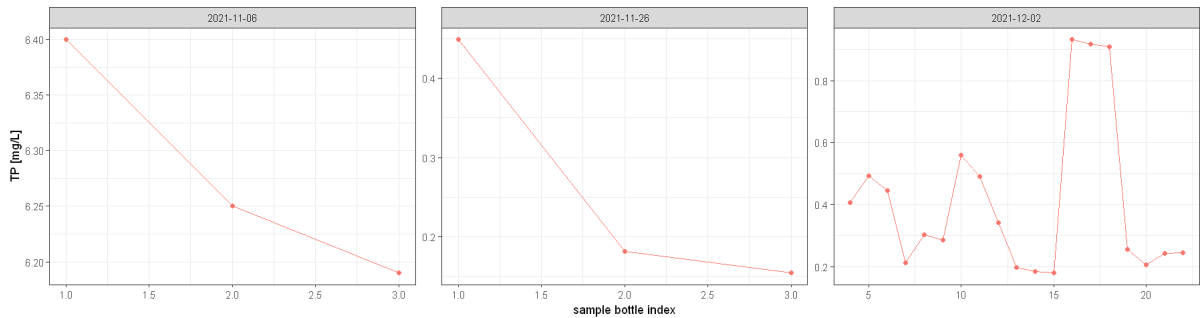


**A-Fig. 28.** Total phosphorus [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 7.** Total phosphorus [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	Total phosphorus [mg/l]				
	mean	median	std	min	max
<b>2021-08-24</b>	17.341	15.530	5.319	11.82	30.60
<b>2021-08-26</b>	17.900	17.900	2.600	15.30	20.50
<b>2021-08-31</b>	6.436	6.500	0.287	6.04	6.71
<b>2021-09-01</b>	6.800	6.835	0.700	5.40	7.96
<b>2021-09-07</b>	11.750	11.750	0.778	11.20	12.30
<b>2021-09-17</b>	13.073	12.200	9.321	4.22	22.80
<b>2021-09-29</b>	11.492	11.285	1.269	10.20	13.20
<b>2021-10-08</b>	27.133	26.900	2.558	24.70	29.80
<b>2021-10-15</b>	7.162	6.305	3.808	4.75	17.70
<b>2021-10-20</b>	15.580	15.800	1.784	13.40	18.20
<b>2021-10-22</b>	6.145	5.520	1.371	4.87	9.46

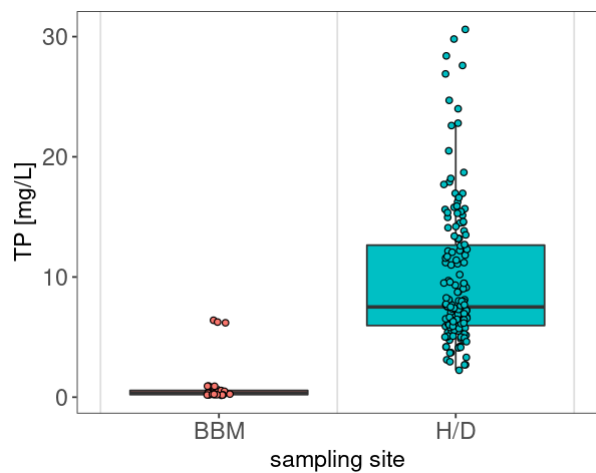
<b>2021-10-25</b>	7.366	7.265	1.929	5.09	14.20
<b>2021-11-04</b>	8.753	9.030	0.559	8.11	9.12
<b>2021-11-06</b>	6.638	6.120	2.138	4.18	9.70
<b>2021-11-09</b>	6.592	6.255	1.155	5.08	7.98
<b>2021-11-26</b>	8.750	8.005	2.750	4.10	14.10
<b>2021-12-02</b>	3.701	3.680	0.966	2.24	5.01



**A-Fig. 29.** Total phosphorus [mg/L] values in subsequent sampling bottles at BBM quay.

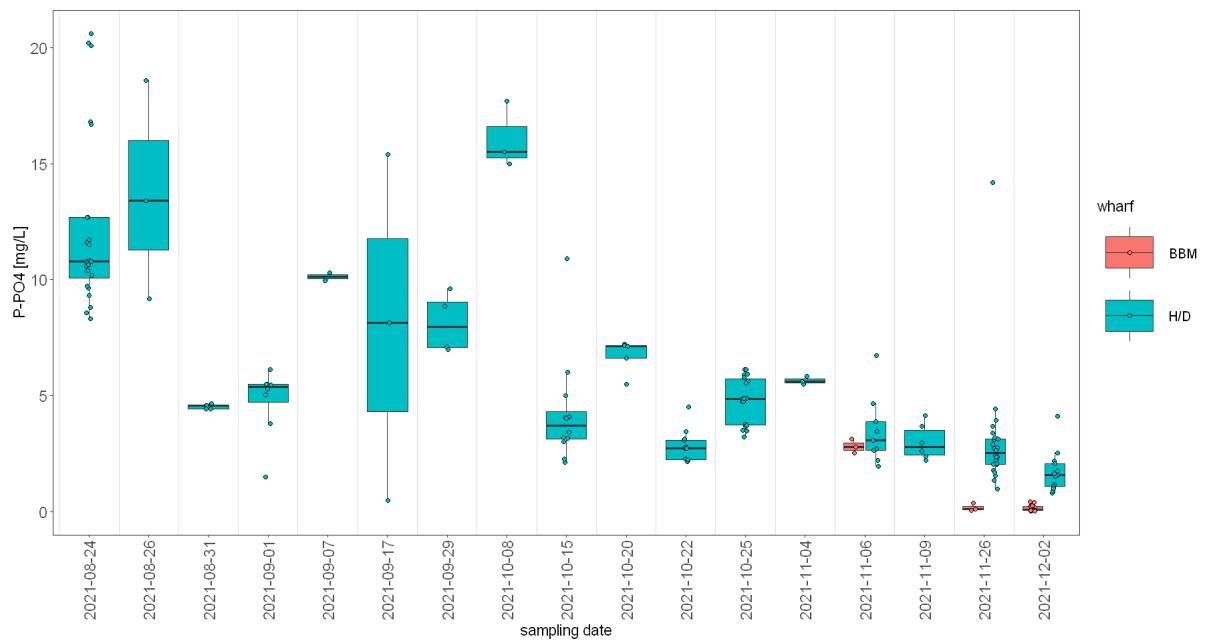
**A-Tab. 8.** Total phosphorus [mg/L] statistical characteristics of the episodes at BBM quay.

sampling date	Total phosphorus [mg/l]				
	mean	median	std	min	max
<b>2021-11-06</b>	6.280	6.250	0.108	6.190	6.400
<b>2021-11-26</b>	0.261	0.181	0.163	0.154	0.449
<b>2021-12-02</b>	0.411	0.303	0.253	0.180	0.932



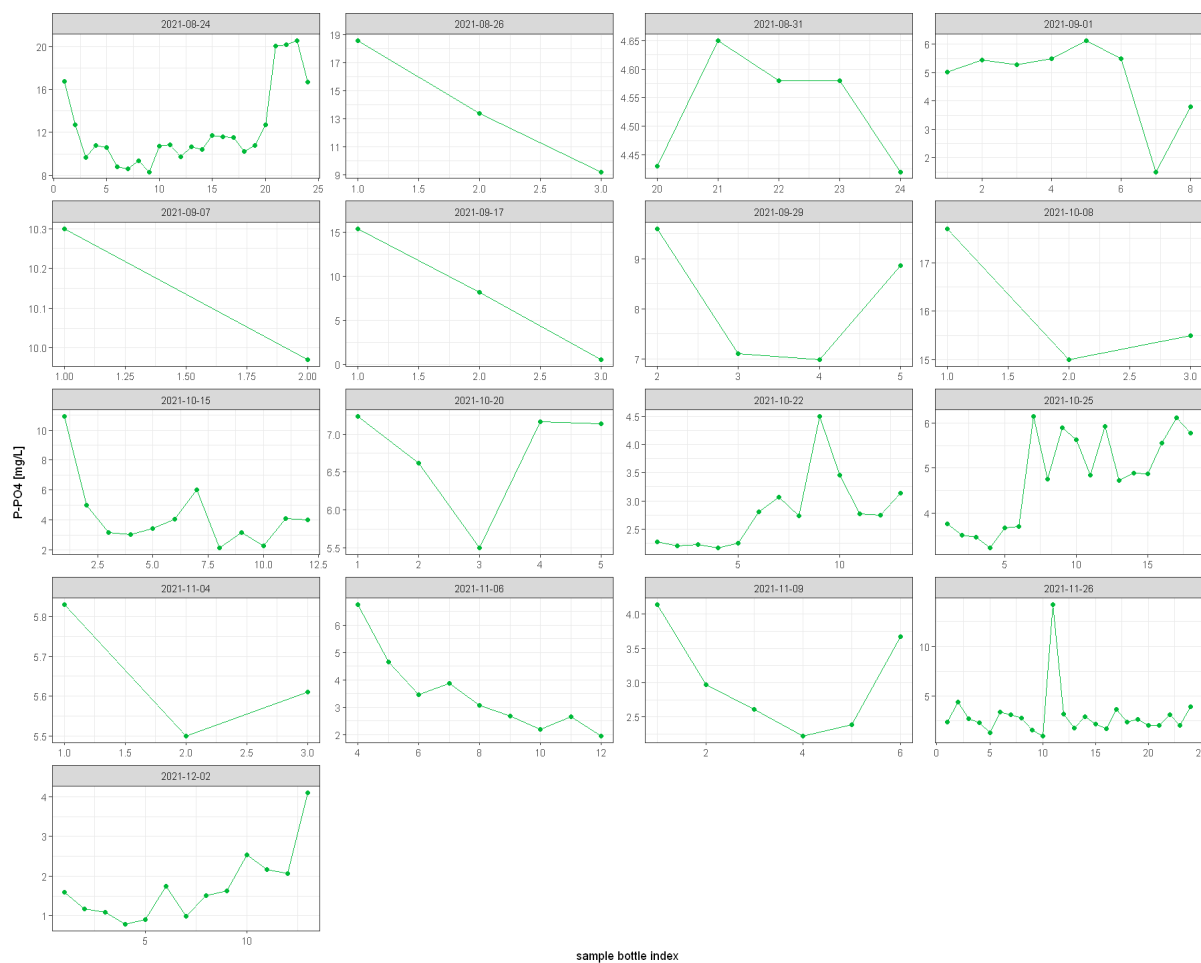
**A-Fig. 30.** Comparison of the total phosphorus [mg/L] measurements at BBM and H/D quays.

## Statistical characteristics of the P-PO<sub>4</sub>



**A-Fig. 31** Boxplots of the measured P-PO<sub>4</sub> [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the P-PO<sub>4</sub> at H/D quay are equal to 0.473 mg/L and 20.6 mg/L respectively, whereas at BBM quay those values are equal to 0.026 mg/L and 3.12 mg/L. The medians range from 1.59 mg/L to 15.5 mg/L at H/D and from 0.08 mg/L to 2.78 mg/L at BBM.



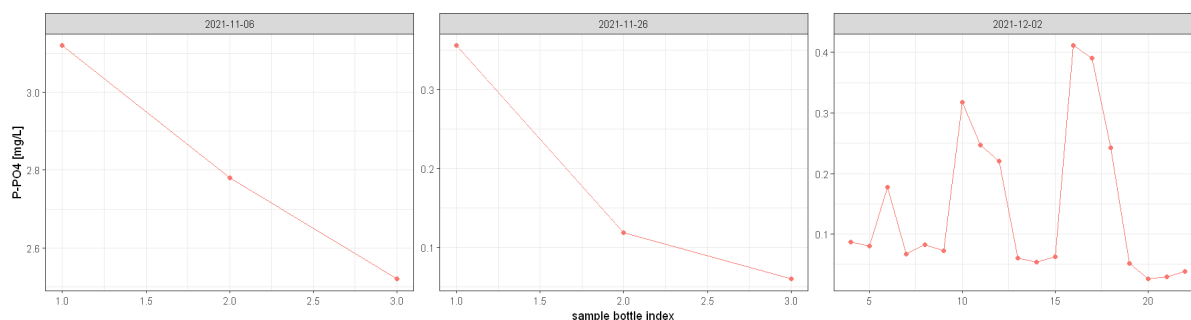
**A-Fig. 32.** P-PO<sub>4</sub> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 9.** P-PO<sub>4</sub> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	P-PO <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	12.248	10.800	3.736	8.310	20.60
<b>2021-08-26</b>	13.730	13.400	4.714	9.190	18.60
<b>2021-08-31</b>	4.532	4.580	0.102	4.420	4.65
<b>2021-09-01</b>	4.769	5.365	1.480	1.500	6.13
<b>2021-09-07</b>	10.135	10.135	0.233	9.970	10.30
<b>2021-09-17</b>	8.001	8.130	7.464	0.473	15.40
<b>2021-09-29</b>	8.135	7.980	1.301	6.980	9.60
<b>2021-10-08</b>	16.067	15.500	1.436	15.000	17.70
<b>2021-10-15</b>	4.270	3.715	2.354	2.130	10.90
<b>2021-10-20</b>	6.730	7.140	0.729	5.500	7.23
<b>2021-10-22</b>	2.793	2.740	0.659	2.160	4.50



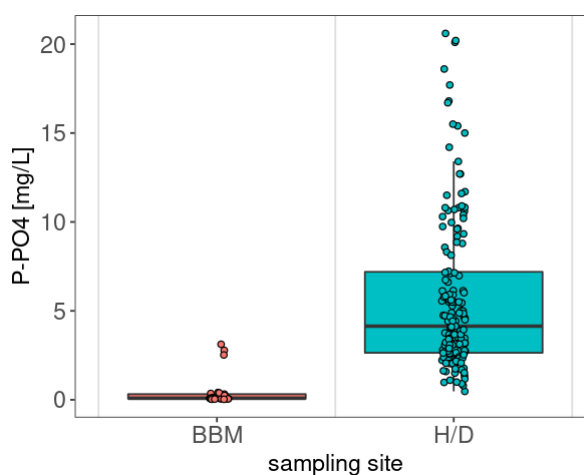
<b>2021-10-25</b>	4.805	4.865	1.018	3.230	6.14
<b>2021-11-04</b>	5.647	5.610	0.168	5.500	5.83
<b>2021-11-06</b>	3.479	3.080	1.485	1.950	6.74
<b>2021-11-09</b>	3.000	2.790	0.759	2.220	4.14
<b>2021-11-26</b>	3.036	2.520	2.520	0.976	14.20
<b>2021-12-02</b>	1.716	1.590	0.888	0.794	4.10



**A-Fig. 33.** P-PO<sub>4</sub> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 10.** P-PO<sub>4</sub> [mg/L] statistical characteristics of the episodes at BBM quay.

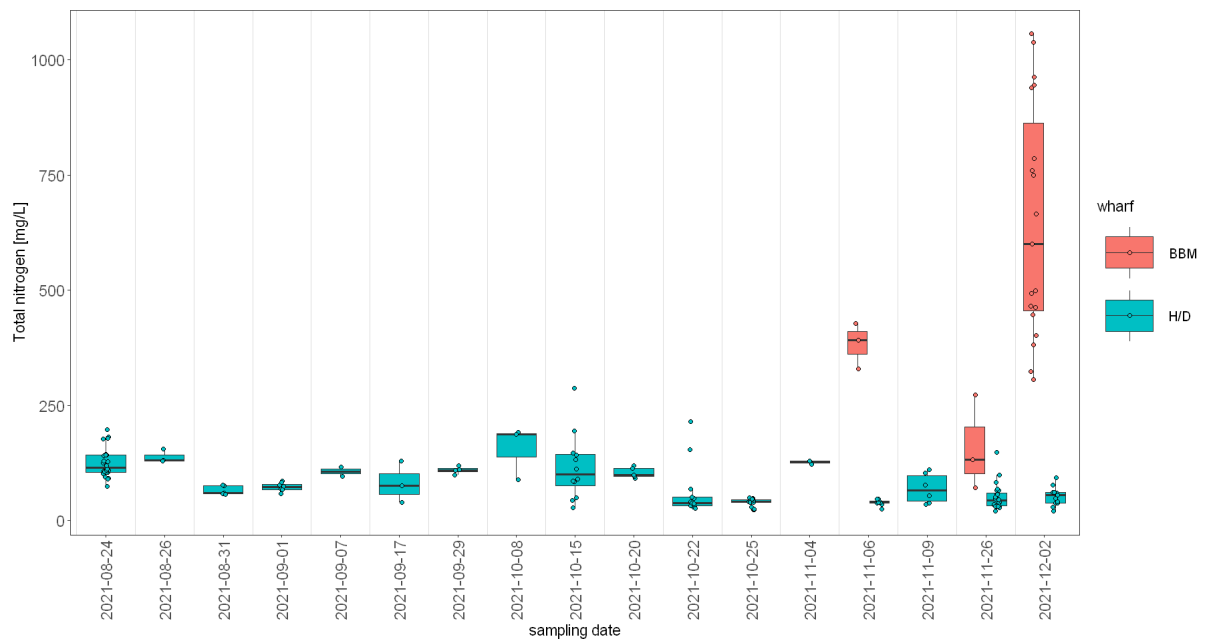
sampling date	P-PO <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	2.807	2.780	0.301	2.520	3.120
<b>2021-11-26</b>	0.178	0.119	0.157	0.060	0.356
<b>2021-12-02</b>	0.143	0.080	0.125	0.026	0.411



**A-Fig. 34** Comparison of the P-PO<sub>4</sub> [mg/L] measurements at BBM and H/D quays.

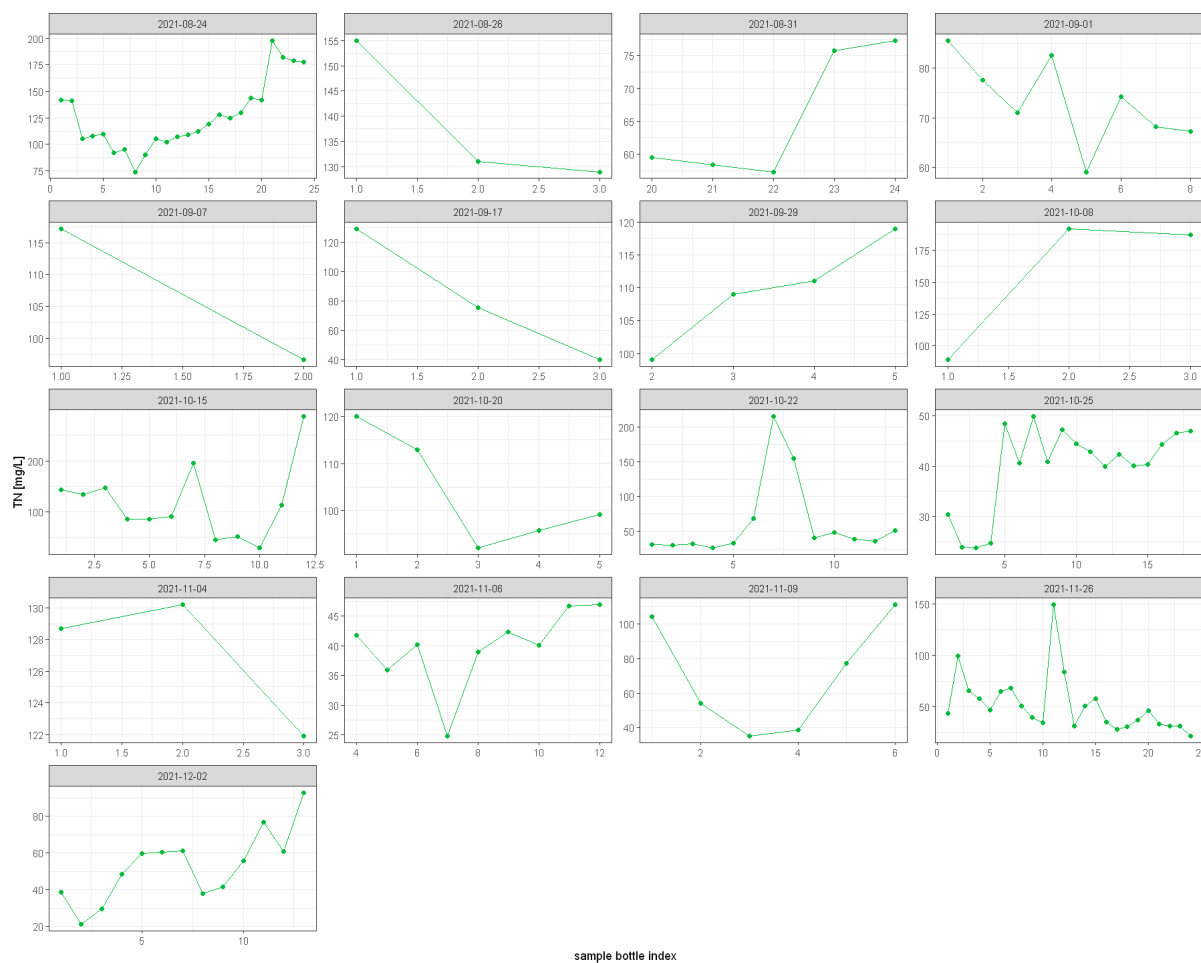
In A-Fig. 34 it can be noticed that the concentration of P-PO<sub>4</sub> at considered quays has different characteristics. The P-PO<sub>4</sub> values at BBM are significantly lower than at H/D quay.

Statistical characteristics of the concentration of the total nitrogen (TN).



**A-Fig. 35.** Boxplots of the measured values of the total nitrogen [mg/L] for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the total nitrogen at H/D quay are equal to 21.2 mg/L and 287 mg/L respectively, whereas at BBM quay those values are equal to 72.1 mg/L and 1056 mg/L. The medians range from 38.6 mg/L to 187 mg/L at H/D and from 133.2 mg/L to 600 mg/L at BBM.

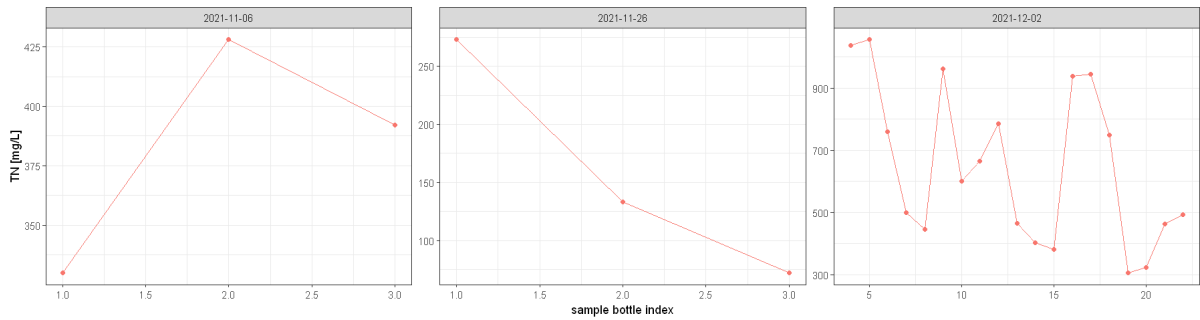


**A-Fig. 36.** Total nitrogen [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 11.** Total nitrogen [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	Total nitrogen [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	125.729	115.50	32.253	74.1	198.0
<b>2021-08-26</b>	138.333	131.00	14.468	129.0	155.0
<b>2021-08-31</b>	65.640	59.50	9.960	57.3	77.3
<b>2021-09-01</b>	73.200	72.60	8.668	59.1	85.6
<b>2021-09-07</b>	106.900	106.90	14.566	96.6	117.2
<b>2021-09-17</b>	81.567	75.60	45.147	39.7	129.4
<b>2021-09-29</b>	109.500	110.00	8.226	99.0	119.0
<b>2021-10-08</b>	156.000	187.00	58.078	89.0	192.0
<b>2021-10-15</b>	116.700	101.00	72.118	28.3	287.0
<b>2021-10-20</b>	103.960	99.10	11.978	92.0	120.0
<b>2021-10-22</b>	62.008	38.60	56.825	26.4	214.5

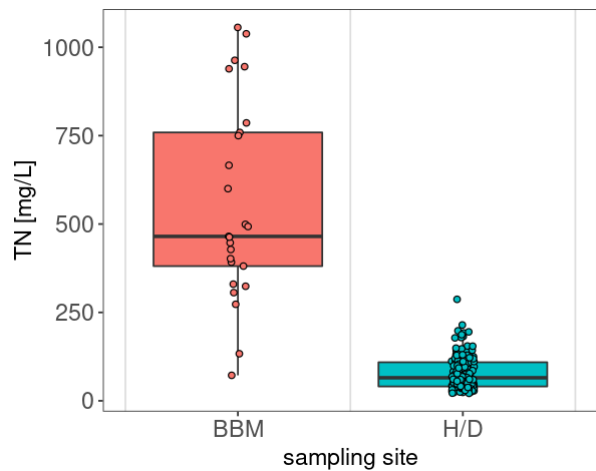
<b>2021-10-25</b>	39.850	41.55	8.436	23.8	49.8
<b>2021-11-04</b>	126.933	128.70	4.423	121.9	130.2
<b>2021-11-06</b>	39.733	40.20	6.610	24.8	46.9
<b>2021-11-09</b>	70.050	65.65	32.652	35.2	111.0
<b>2021-11-26</b>	51.650	44.85	27.981	21.7	149.0
<b>2021-12-02</b>	52.615	55.50	19.454	21.2	92.8



**A-Fig. 37.** Total nitrogen [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 12.** Total nitrogen [mg/L] statistical characteristics of the episodes at BBM quay.

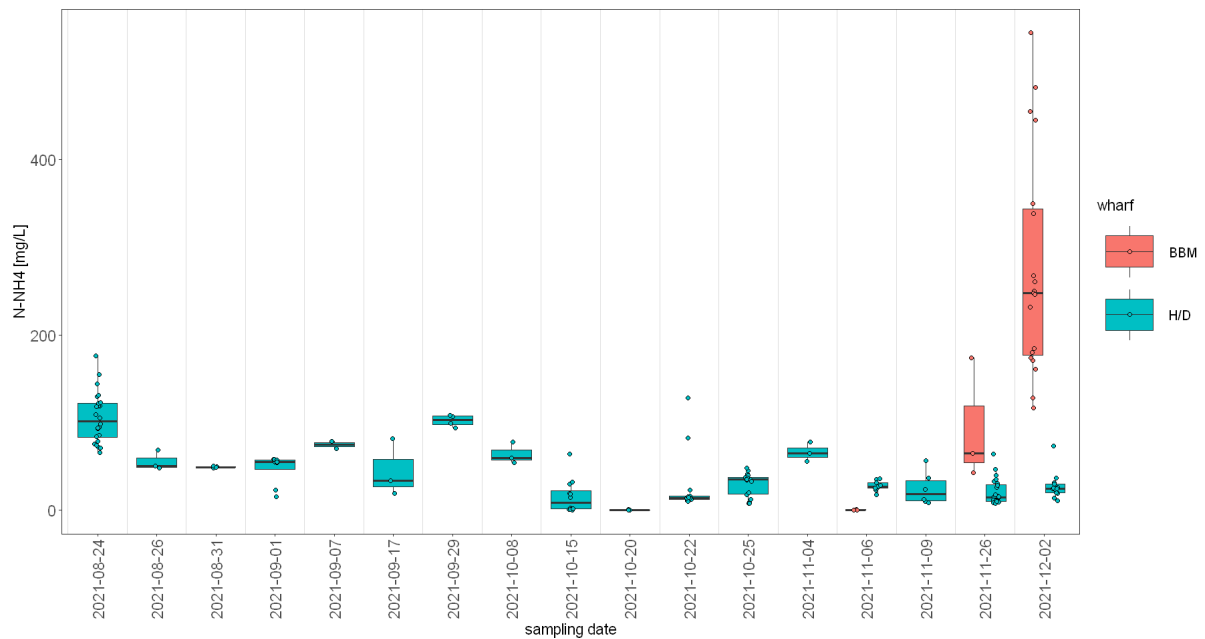
sampling date	Total nitrogen [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	383.333	392.0	49.571	330.0	428
<b>2021-11-26</b>	159.433	133.2	102.987	72.1	273
<b>2021-12-02</b>	646.421	600.0	252.005	306.0	1056



**A-Fig. 38.** Comparison of the total nitrogen [mg/L] measurements at BBM and H/D quays.

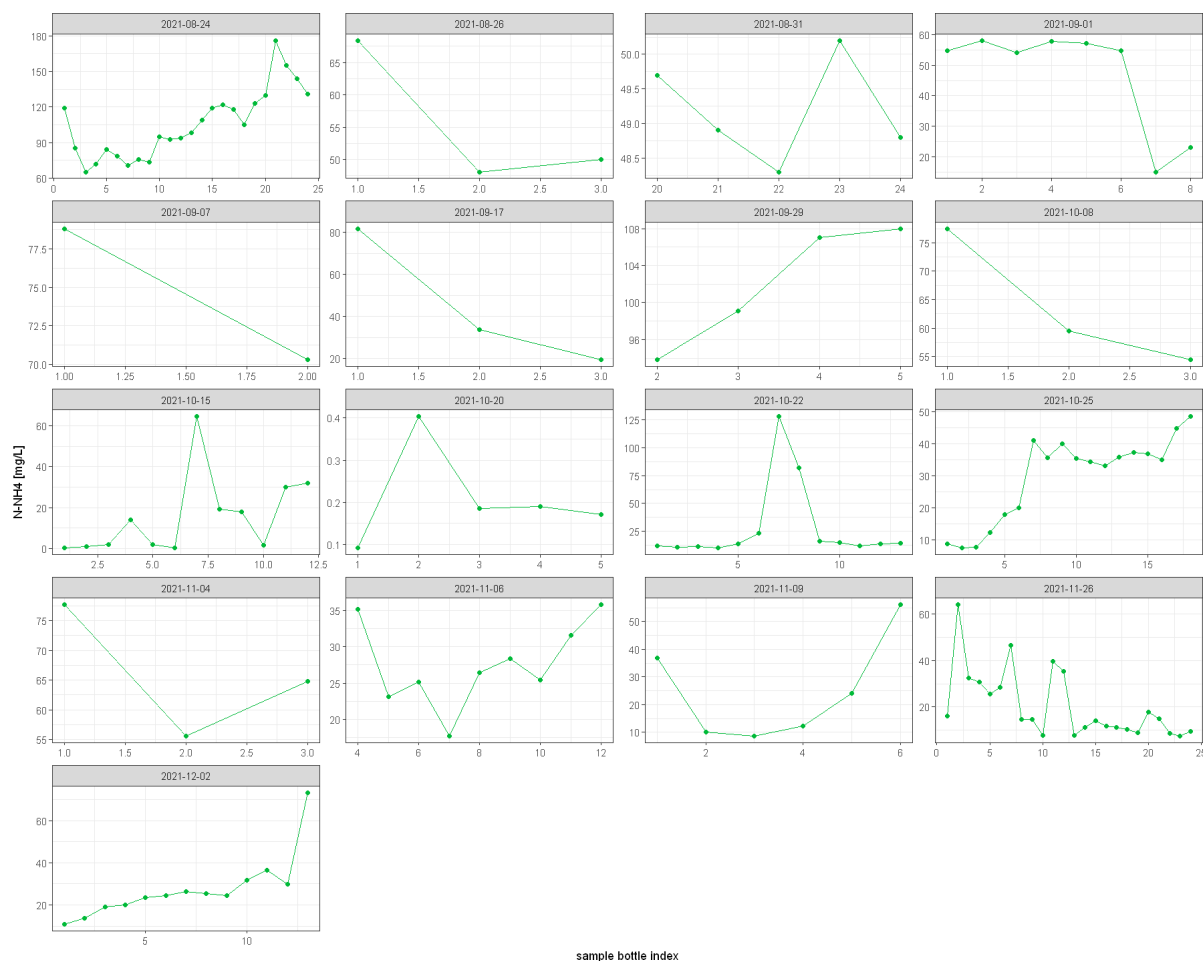
A-Fig. 38 presents the boxplots of total nitrogen concentration measurements at considered quays. The values at BBM are higher and have wide range in comparison to values observed at H/D.

Statistical characteristics of the concentration of the ammonia (N-NH<sub>4</sub>)



**A-Fig. 39.** Boxplots of the measured N-NH<sub>4</sub> values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the N-NH<sub>4</sub> at H/D quay are equal to 0.092 mg/L and 176 mg/L respectively, whereas at BBM quay those values are equal to 0.12 mg/L and 545 mg/L. The medians range from 0.186 mg/L to 103.05 mg/L at H/D and from 0.27 mg/L to 247.5 mg/L at BBM.

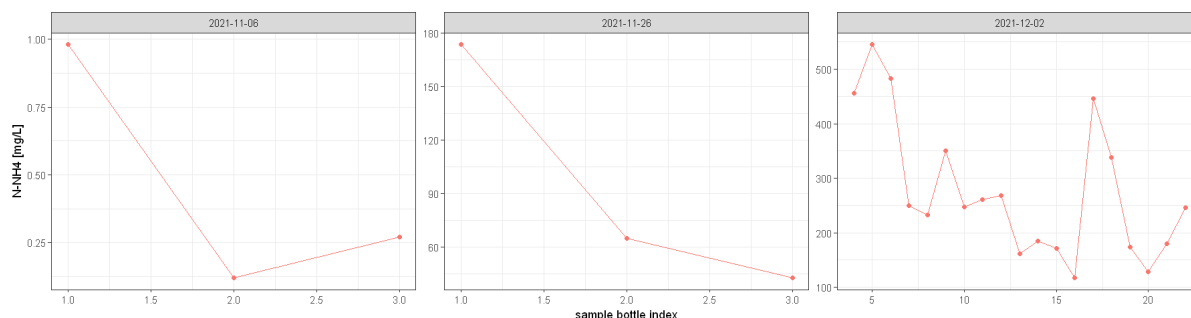


**A-Fig. 40.** N-NH<sub>4</sub> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 13.** N-NH<sub>4</sub> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	N-NH <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	105.708	101.700	28.828	65.400	176.000
<b>2021-08-26</b>	55.500	50.000	11.212	48.100	68.400
<b>2021-08-31</b>	49.180	48.900	0.760	48.300	50.200
<b>2021-09-01</b>	46.850	54.700	17.388	15.000	58.100
<b>2021-09-07</b>	74.550	74.550	6.010	70.300	78.800
<b>2021-09-17</b>	44.933	33.700	32.729	19.300	81.800
<b>2021-09-29</b>	101.975	103.050	6.749	93.800	108.000
<b>2021-10-08</b>	63.800	59.500	12.135	54.400	77.500
<b>2021-10-15</b>	15.423	8.075	19.368	0.306	64.400
<b>2021-10-20</b>	0.209	0.186	0.116	0.092	0.403
<b>2021-10-22</b>	27.842	13.800	35.678	9.950	128.000

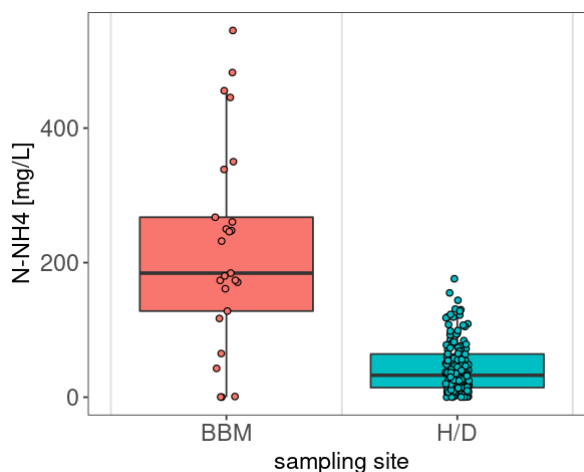
<b>2021-10-25</b>	29.539	35.150	13.345	7.500	48.400
<b>2021-11-04</b>	66.033	64.800	11.102	55.600	77.700
<b>2021-11-06</b>	27.633	26.400	5.835	17.700	35.800
<b>2021-11-09</b>	24.675	18.100	18.758	8.650	56.100
<b>2021-11-26</b>	20.388	14.650	14.584	7.520	64.000
<b>2021-12-02</b>	27.615	24.500	15.358	10.900	73.200



**A-Fig. 41.** N-NH<sub>4</sub> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 14.** N-NH<sub>4</sub> [mg/L] statistical characteristics of the episodes at BBM quay.

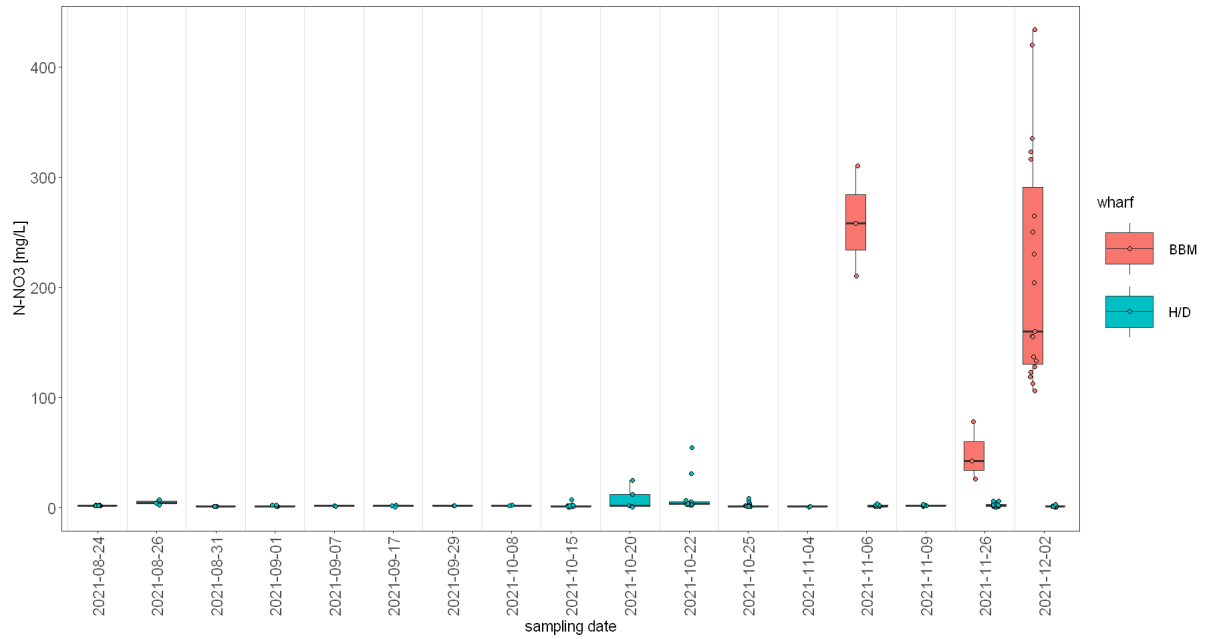
sampling date	N-NH <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	0.457	0.27	0.459	0.12	0.98
<b>2021-11-26</b>	93.767	64.90	70.015	42.80	173.60
<b>2021-12-02</b>	275.574	247.50	126.801	117.00	545.00



**A-Fig. 42.** Comparison of the N-NH<sub>4</sub> [mg/L] measurements at BBM and H/D quays.

According to A-Fig. 42 it can be concluded that N-NH<sub>4</sub> concentrations at BBM and H/D quays differ significantly. N-NH<sub>4</sub> concentrations at BBM are greater as well as their range in comparison to the values collected at H/D quay.

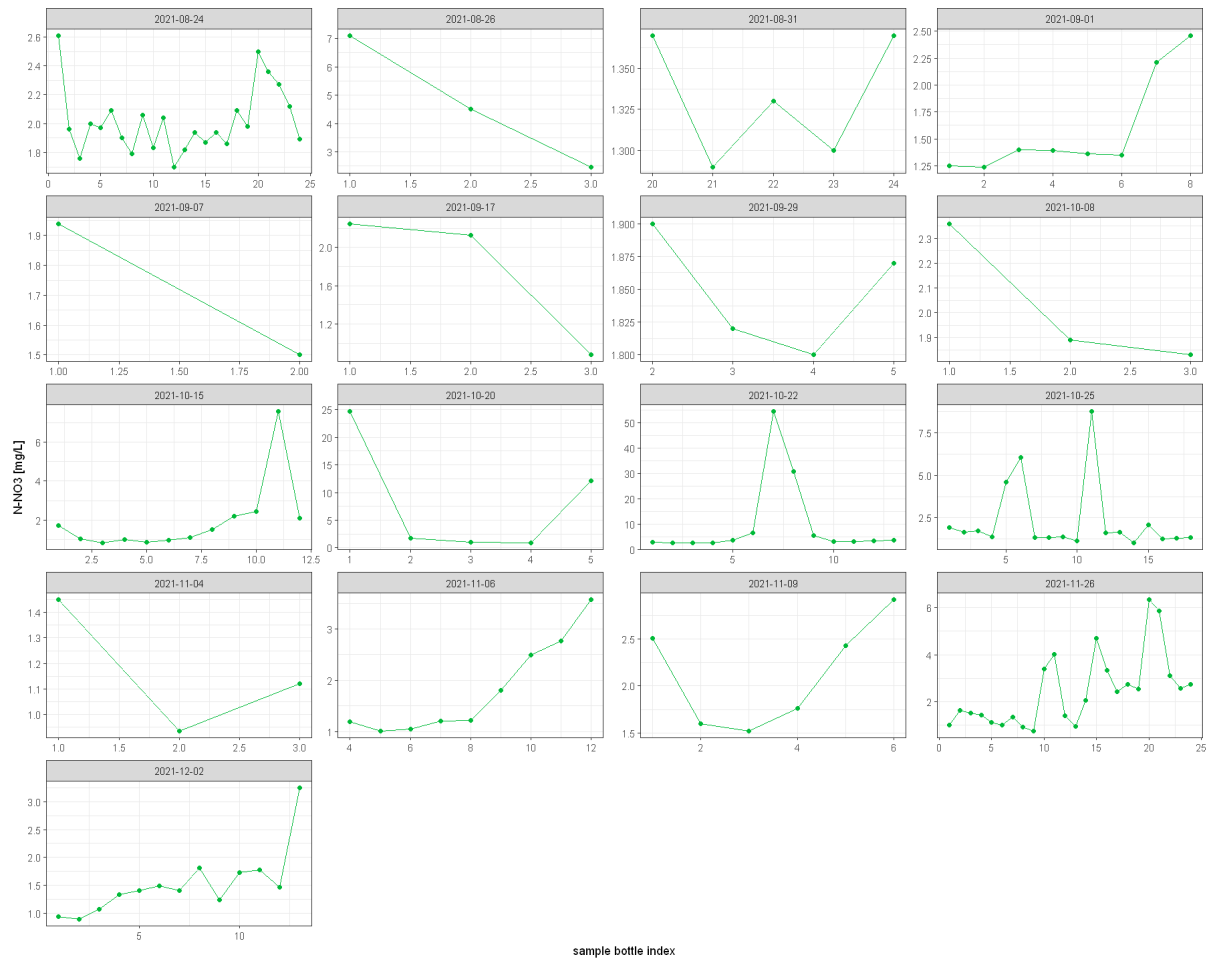
Statistical characteristics of the concentration of the N-NO<sub>3</sub>



**A-Fig. 43.** Boxplots of the measured N-NO<sub>3</sub> [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the N-NO<sub>3</sub> at H/D quay are equal to 0.74 mg/L and 54.5 mg/L respectively, whereas at BBM quay those values are equal to 25.8 mg/L and 433.5 mg/L. The medians range from 1.12 mg/L to 4.51 mg/L at H/D and from 42.6 mg/L to 258 mg/L at BBM.



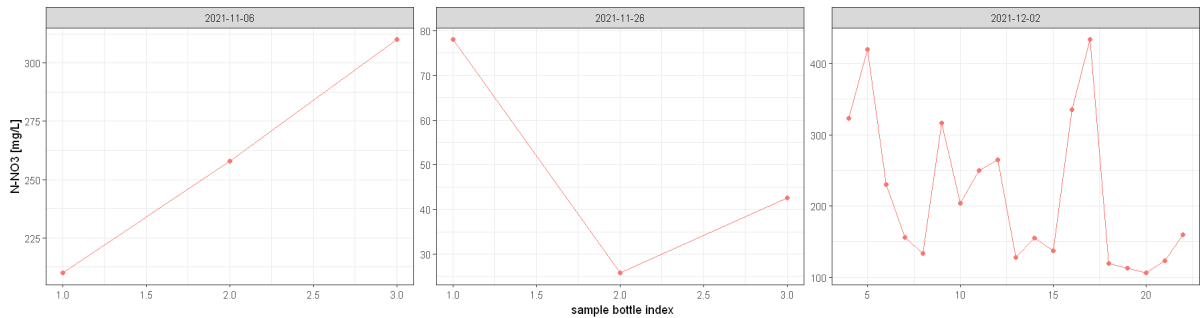


**A-Fig. 44.** N-NO<sub>3</sub> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 15.** N-NO<sub>3</sub> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	N-NO <sub>3</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	2.015	1.965	0.226	1.700	2.61
<b>2021-08-26</b>	4.693	4.510	2.320	2.470	7.10
<b>2021-08-31</b>	1.332	1.330	0.038	1.290	1.37
<b>2021-09-01</b>	1.582	1.375	0.473	1.240	2.46
<b>2021-09-07</b>	1.720	1.720	0.311	1.500	1.94
<b>2021-09-17</b>	1.753	2.130	0.760	0.878	2.25
<b>2021-09-29</b>	1.848	1.845	0.046	1.800	1.90
<b>2021-10-08</b>	2.027	1.890	0.290	1.830	2.36
<b>2021-10-15</b>	1.936	1.310	1.865	0.815	7.58
<b>2021-10-20</b>	8.075	1.760	10.374	0.884	24.60
<b>2021-10-22</b>	9.600	3.420	15.504	2.530	54.50

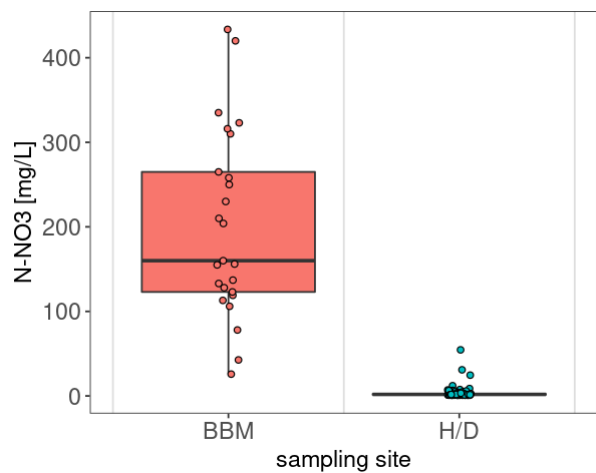
<b>2021-10-25</b>	2.309	1.510	2.057	1.020	8.74
<b>2021-11-04</b>	1.168	1.120	0.261	0.935	1.45
<b>2021-11-06</b>	1.811	1.220	0.920	1.010	3.57
<b>2021-11-09</b>	2.123	2.095	0.574	1.520	2.92
<b>2021-11-26</b>	2.449	2.245	1.552	0.740	6.35
<b>2021-12-02</b>	1.524	1.410	0.596	0.892	3.25



**A-Fig. 45.** N-NO<sub>3</sub> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 16.** N-NO<sub>3</sub> [mg/L] statistical characteristics of the episodes at BBM quay.

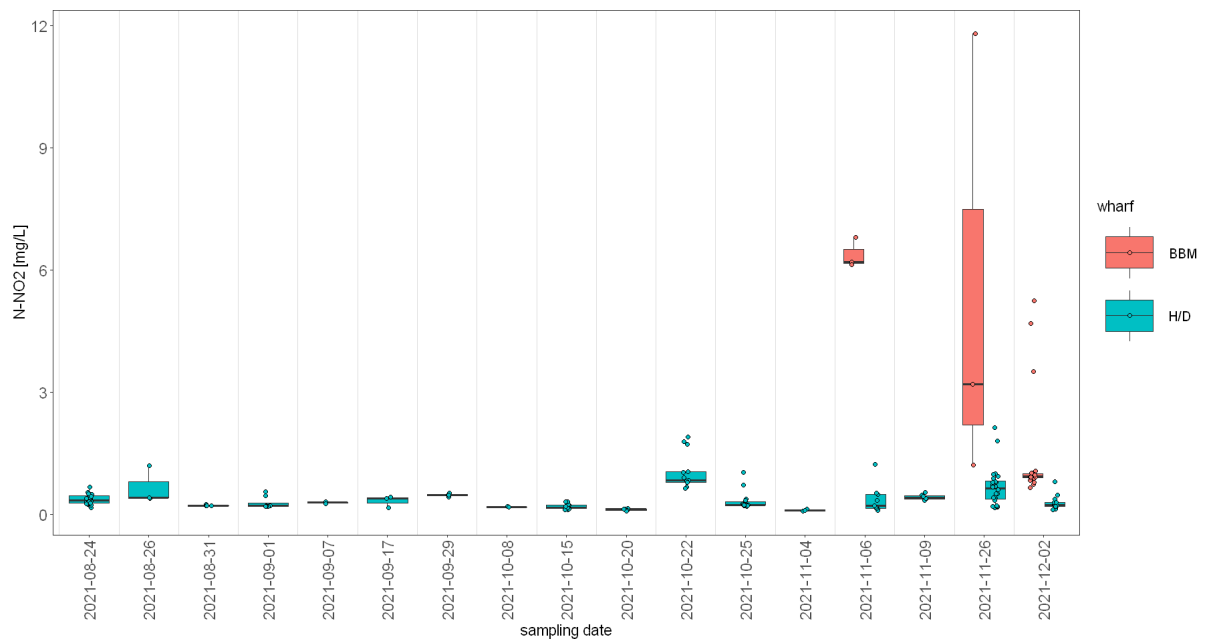
sampling date	N-NO <sub>3</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	259.333	258.0	50.013	210.0	310.0
<b>2021-11-26</b>	48.800	42.6	26.647	25.8	78.0
<b>2021-12-02</b>	216.132	160.0	105.548	106.0	433.5



**A-Fig. 46.** Comparison of the N-NO<sub>3</sub> [mg/L] measurements at BBM and H/D quays.

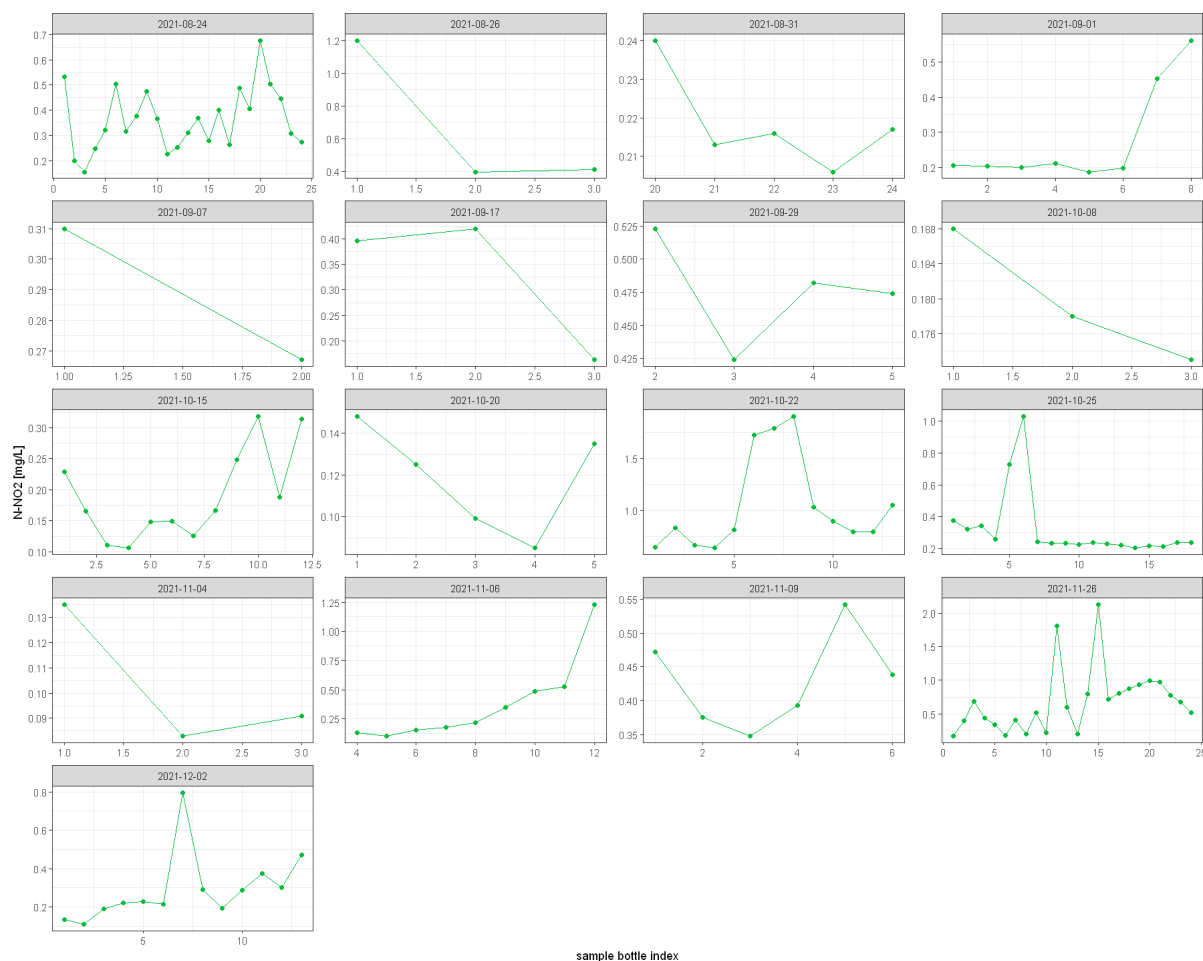
A-Fig. 46. displays that the concentrations of N-NO<sub>3</sub> at quays BBM and H/D differ significantly. On average values observed at BBM are of orders of magnitude greater than those observed at H/D quay.

## Statistical characteristics of the concentration of the N-NO<sub>2</sub>



**A-Fig. 47.** Boxplots of the measured N-NO<sub>2</sub> [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the N-NO<sub>2</sub> at H/D quay are equal to 0.083 mg/L and 2.13 mg/L respectively, whereas at BBM quay those values are equal to 0.66 mg/L and 11.8 mg/L. The medians range from 0.091 mg/L to 0.829 mg/L at H/D and from 0.934 mg/L to 6.2 mg/L at BBM.

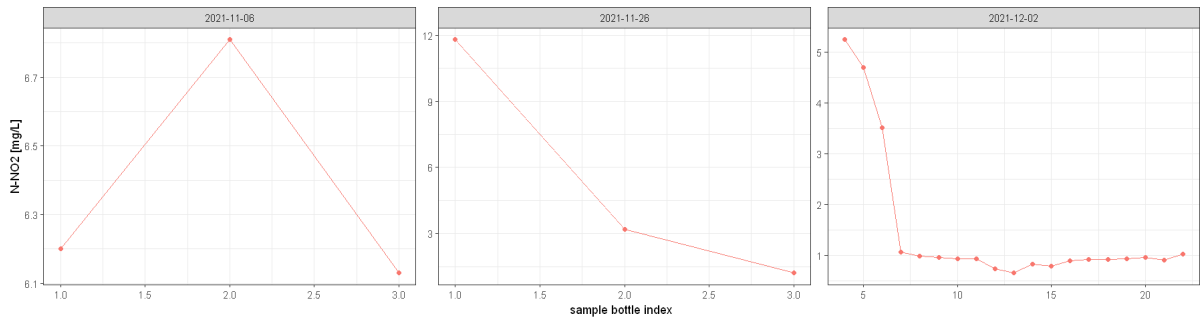


**A-Fig. 48.** N-NO<sub>2</sub> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 17.** N-NO<sub>2</sub> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	N-NO <sub>2</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	0.363	0.3440	0.123	0.157	0.676
<b>2021-08-26</b>	0.669	0.4110	0.460	0.397	1.200
<b>2021-08-31</b>	0.218	0.2160	0.013	0.206	0.240
<b>2021-09-01</b>	0.278	0.2055	0.144	0.188	0.561
<b>2021-09-07</b>	0.288	0.2885	0.030	0.267	0.310
<b>2021-09-17</b>	0.326	0.3960	0.142	0.163	0.420
<b>2021-09-29</b>	0.476	0.4780	0.041	0.424	0.523
<b>2021-10-08</b>	0.180	0.1780	0.008	0.173	0.188
<b>2021-10-15</b>	0.189	0.1660	0.073	0.106	0.318
<b>2021-10-20</b>	0.118	0.1250	0.026	0.085	0.148
<b>2021-10-22</b>	1.043	0.8290	0.453	0.639	1.900

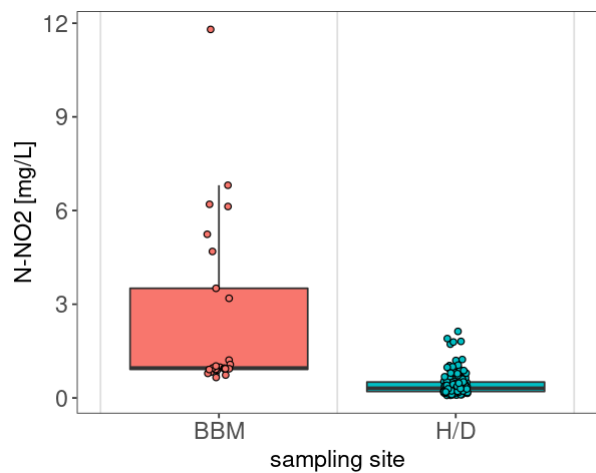
<b>2021-10-25</b>	0.320	0.2355	0.215	0.202	1.030
<b>2021-11-04</b>	0.103	0.0910	0.028	0.083	0.135
<b>2021-11-06</b>	0.375	0.2150	0.356	0.103	1.230
<b>2021-11-09</b>	0.428	0.4160	0.071	0.348	0.542
<b>2021-11-26</b>	0.681	0.6395	0.480	0.168	2.130
<b>2021-12-02</b>	0.293	0.2260	0.180	0.110	0.796



**A-Fig. 49.** N-NO<sub>2</sub> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 18.** N-NO<sub>2</sub> [mg/L] statistical characteristics of the episodes at BBM quay.

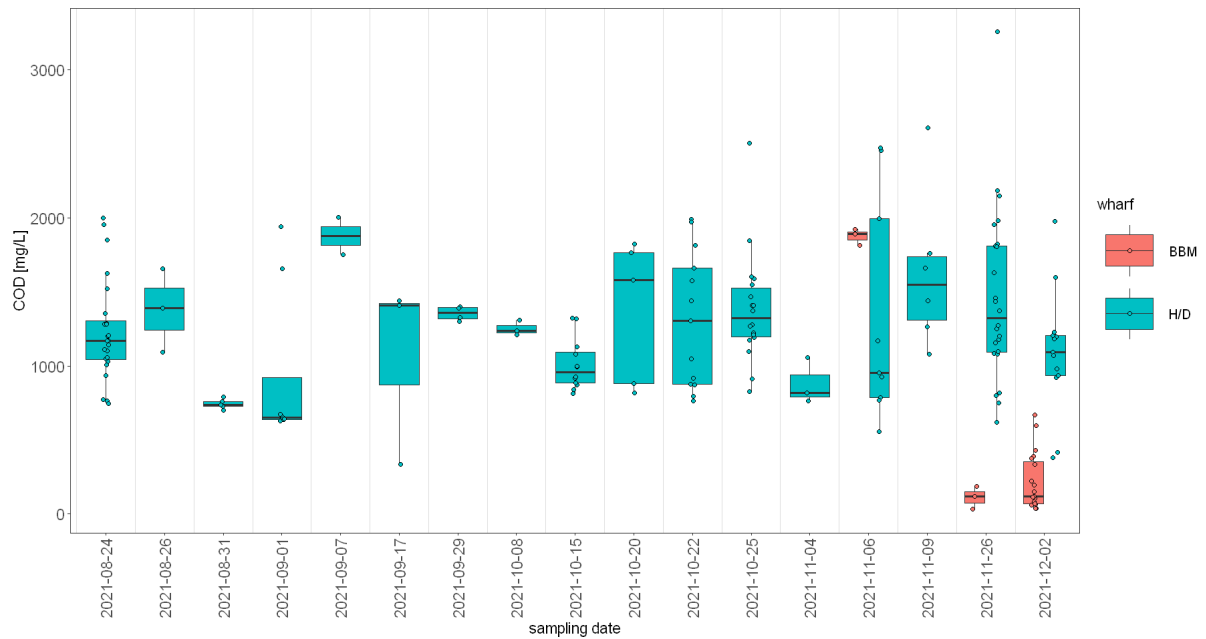
sampling date	N-NO <sub>2</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	6.380	6.200	0.374	6.130	6.81
<b>2021-11-26</b>	5.400	3.190	5.630	1.210	11.80
<b>2021-12-02</b>	1.466	0.934	1.376	0.655	5.24



**A-Fig. 5.** Comparison of the N-NO<sub>2</sub> [mg/L] measurements at BBM and H/D quays.

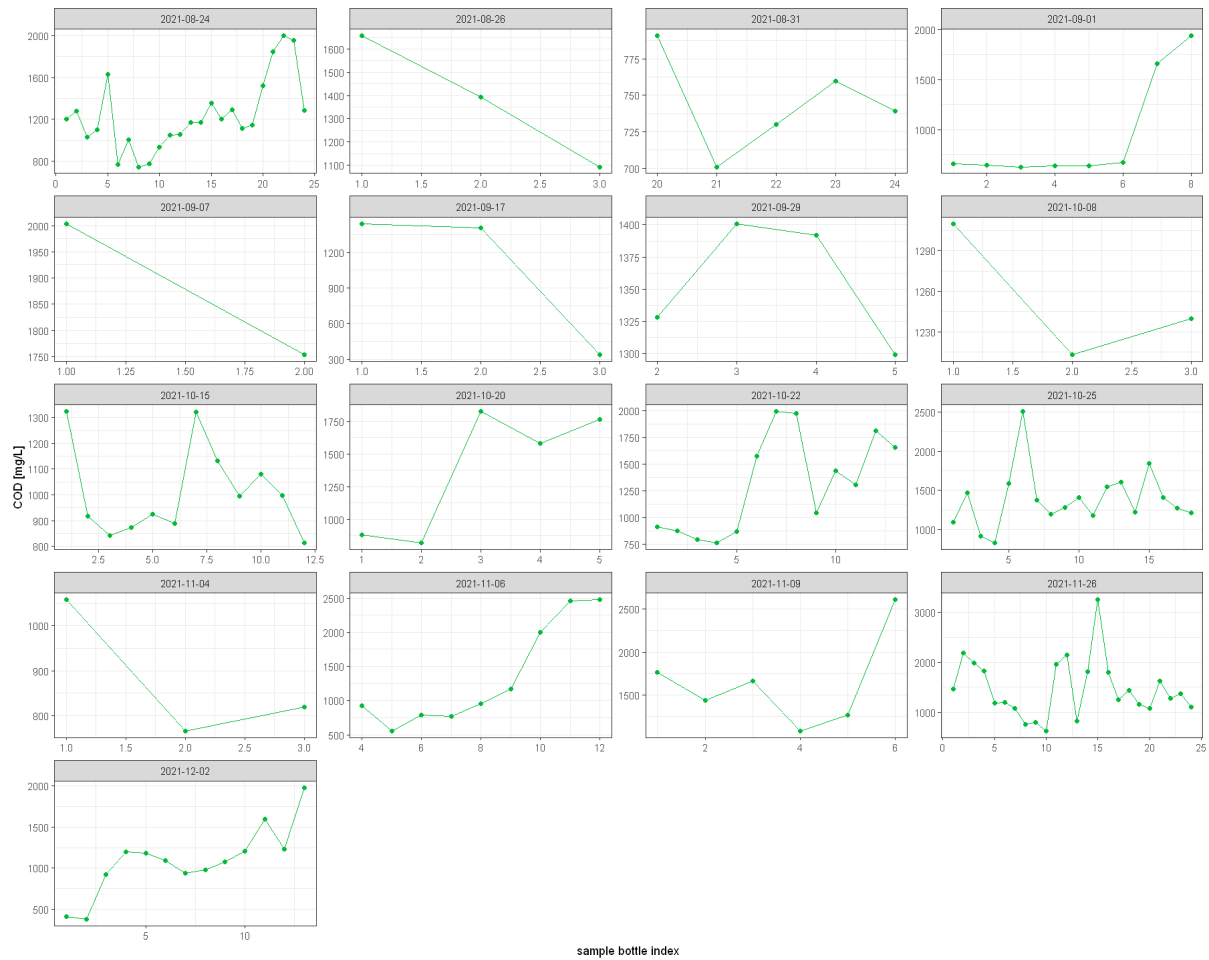
Based on the A-Fig. 50. it can be concluded that the concentrations of N-NO<sub>2</sub> at BBM quay are significantly greater than at quay H/D. Also, they have a greater dispersion. However, unlike in case of N-NO<sub>3</sub> the values are of similar magnitude.

Statistical characteristics of the concentration of the chemical oxygen demand (COD)



**A-Fig. 51.** Boxplots of the measured chemical oxygen demand (COD) [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the COD at H/D quay are equal to 336 mg/L and 3257 mg/L respectively, whereas at BBM quay those values are equal to 34.3 mg/L and 1923 mg/L. The medians range from 650 mg/L to 1878.5 mg/L at H/D and from 118 mg/L to 1891 mg/L at BBM.

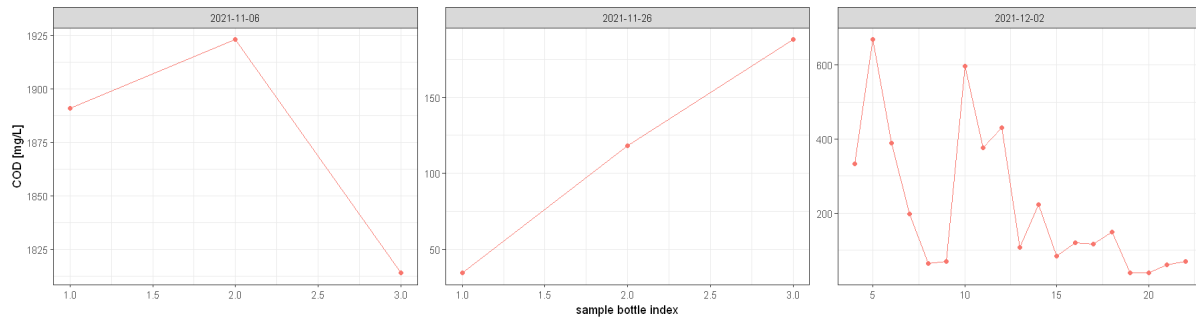


**A-Fig. 52.** COD [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 19.** COD [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	COD [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	1234.708	1170.5	343.895	745	2002
<b>2021-08-26</b>	1381.333	1393.0	282.681	1093	1658
<b>2021-08-31</b>	744.200	739.0	33.670	701	791
<b>2021-09-01</b>	935.125	650.0	538.673	629	1940
<b>2021-09-07</b>	1878.500	1878.5	177.484	1753	2004
<b>2021-09-17</b>	1062.000	1408.0	628.964	336	1442
<b>2021-09-29</b>	1355.000	1360.0	49.497	1299	1401
<b>2021-10-08</b>	1254.333	1240.0	50.063	1213	1310
<b>2021-10-15</b>	1008.583	959.5	173.504	813	1323
<b>2021-10-20</b>	1374.600	1582.0	487.638	820	1824
<b>2021-10-22</b>	1310.769	1306.0	459.924	764	1993

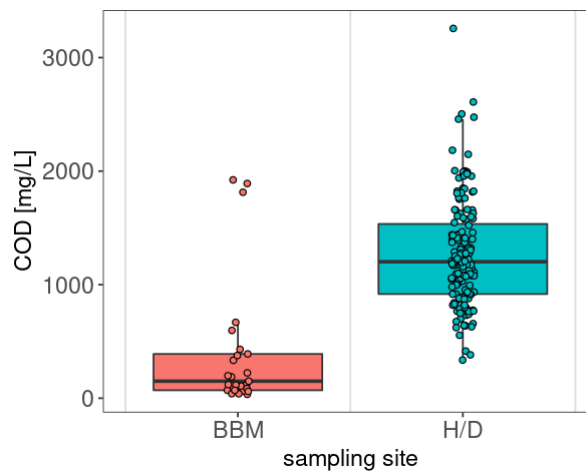
<b>2021-10-25</b>	1385.444	1325.0	372.982	829	2504
<b>2021-11-04</b>	881.333	820.0	155.362	766	1058
<b>2021-11-06</b>	1343.333	954.0	755.172	555	2475
<b>2021-11-09</b>	1636.500	1551.0	538.026	1081	2609
<b>2021-11-26</b>	1465.750	1323.5	587.582	622	3257
<b>2021-12-02</b>	1091.692	1095.0	420.097	382	1976



**A-Fig. 53.** Chemical oxygen demand [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 20.** COD [mg/L] statistical characteristics of the episodes at BBM quay.

sampling date	COD [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	1876.000	1891	56.027	1814.0	1923
<b>2021-11-26</b>	113.433	118	76.952	34.3	188
<b>2021-12-02</b>	217.737	120	192.984	39.0	668

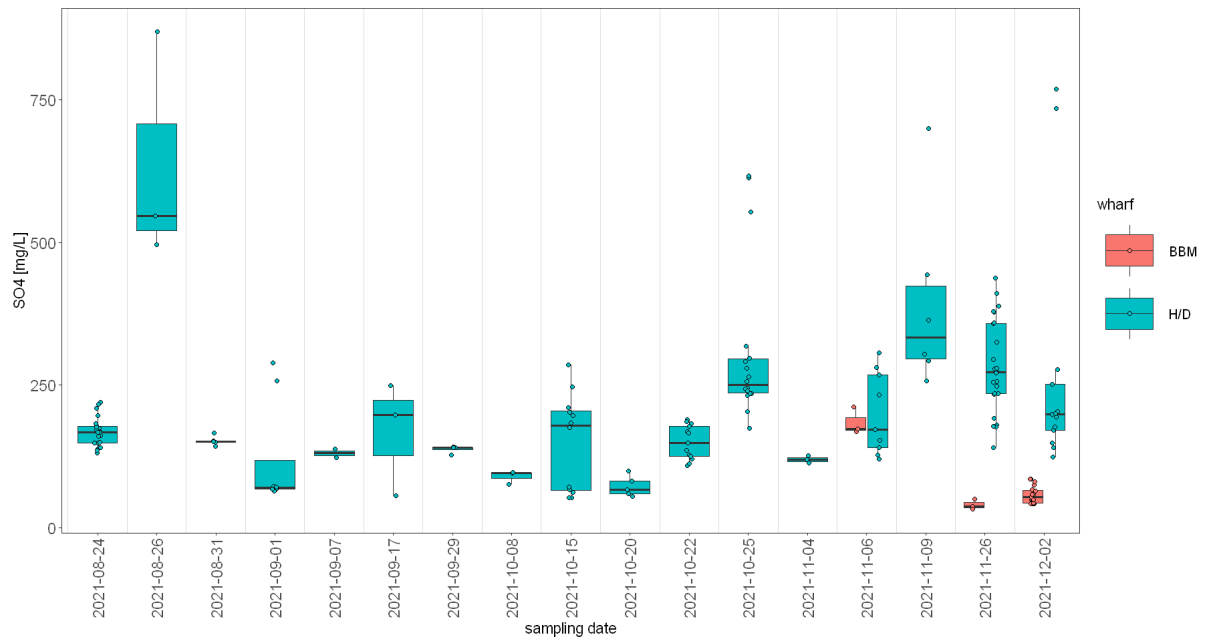


**A-Fig. 54.** Comparison of the COD [mg/L] measurements at BBM and H/D quays.

A-Fig. 54. shows that the COD levels at BBM and H/D quays differ significantly. Observed COD values at BBM are lower and less dispersed than those observed at H/D quay.

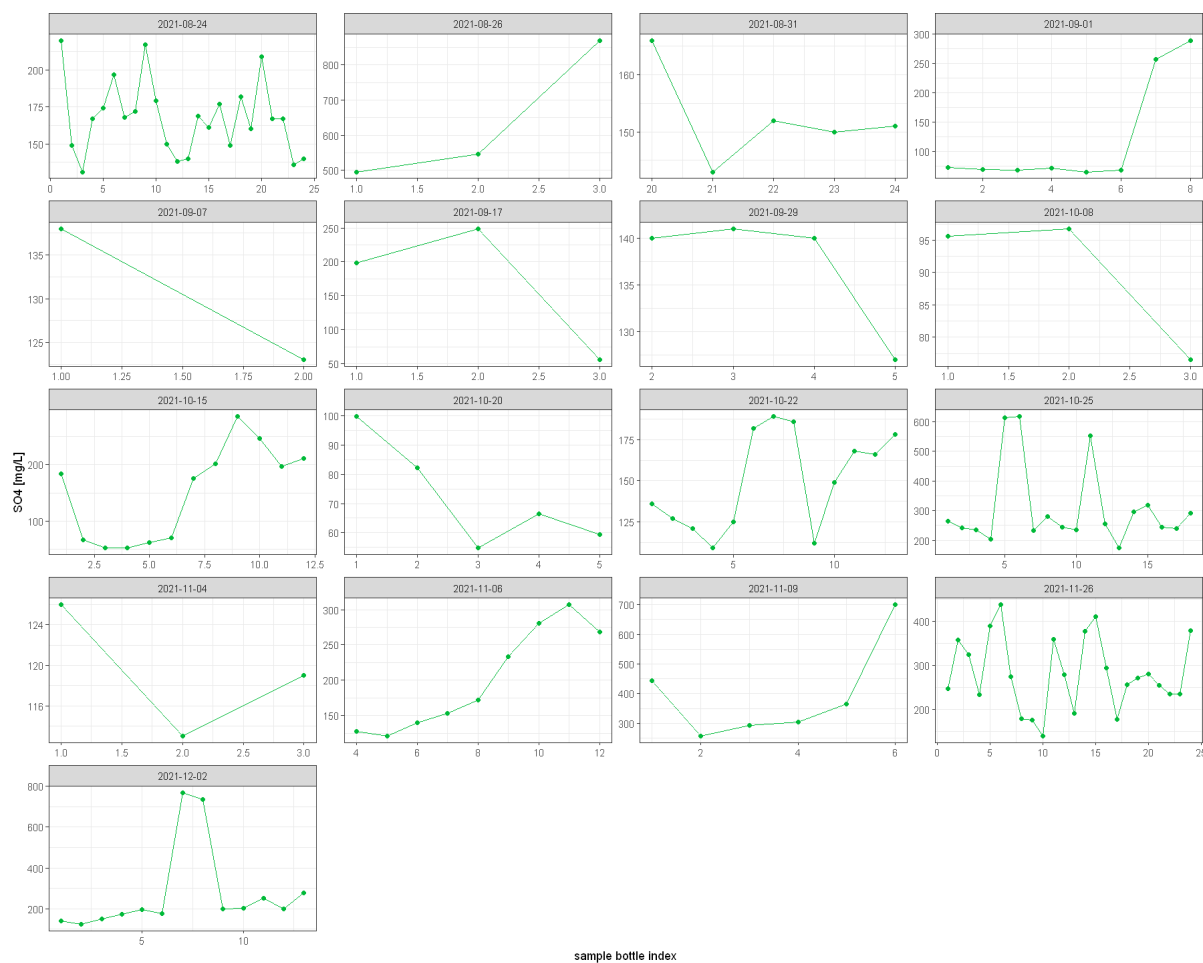


Statistical characteristics of the concentration of the SO<sub>4</sub>



**A-Fig. 55.** Boxplots of the measured SO<sub>4</sub> [mg/l] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the SO<sub>4</sub> at H/D quay are equal to 52.6 mg/L and 869 mg/L respectively, whereas at BBM quay those values are equal to 32.9 mg/L and 212 mg/L. The medians range from 66.4 mg/L to 546 mg/L at H/D and from 37.7 mg/L to 173 mg/L at BBM.

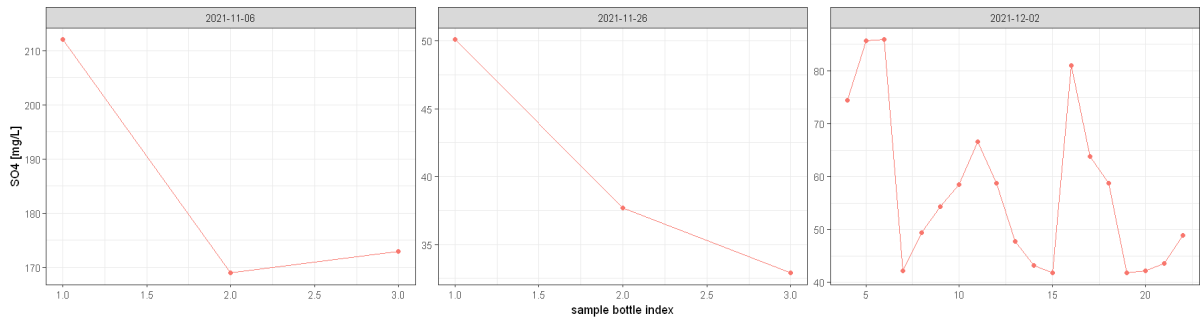


**A-Fig. 56.** SO<sub>4</sub> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 21.** SO<sub>4</sub> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	SO <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	167.458	167.0	24.754	131.0	220.0
<b>2021-08-26</b>	637.000	546.0	202.467	496.0	869.0
<b>2021-08-31</b>	152.400	151.0	8.385	143.0	166.0
<b>2021-09-01</b>	119.738	70.0	95.010	64.8	289.0
<b>2021-09-07</b>	130.500	130.5	10.607	123.0	138.0
<b>2021-09-17</b>	167.567	198.0	100.179	55.7	249.0
<b>2021-09-29</b>	137.000	140.0	6.683	127.0	141.0
<b>2021-10-08</b>	89.633	95.6	11.390	76.5	96.8
<b>2021-10-15</b>	150.542	179.5	84.116	52.6	285.0
<b>2021-10-20</b>	72.460	66.4	18.417	54.8	99.7
<b>2021-10-22</b>	149.846	149.0	29.611	109.0	189.0

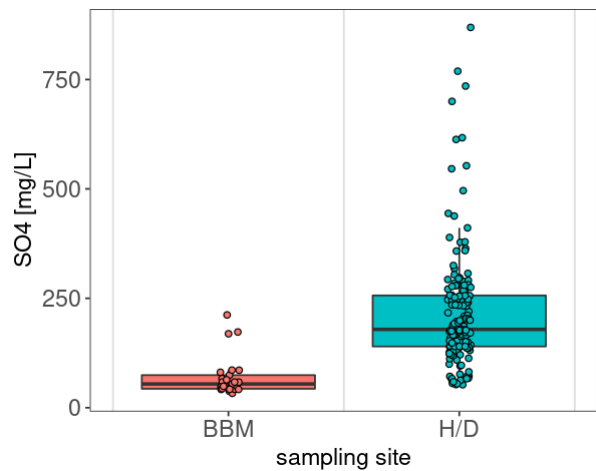
<b>2021-10-25</b>	307.722	250.5	136.530	174.0	617.0
<b>2021-11-04</b>	119.333	119.0	6.506	113.0	126.0
<b>2021-11-06</b>	200.333	172.0	72.232	121.0	307.0
<b>2021-11-09</b>	393.667	334.0	163.771	257.0	700.0
<b>2021-11-26</b>	281.958	273.0	82.026	140.0	438.0
<b>2021-12-02</b>	276.077	199.0	215.421	124.0	769.0



**A-Fig. 57.** SO<sub>4</sub> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 22.** SO<sub>4</sub> [mg/L] statistical characteristics of the episodes at BBM quay.

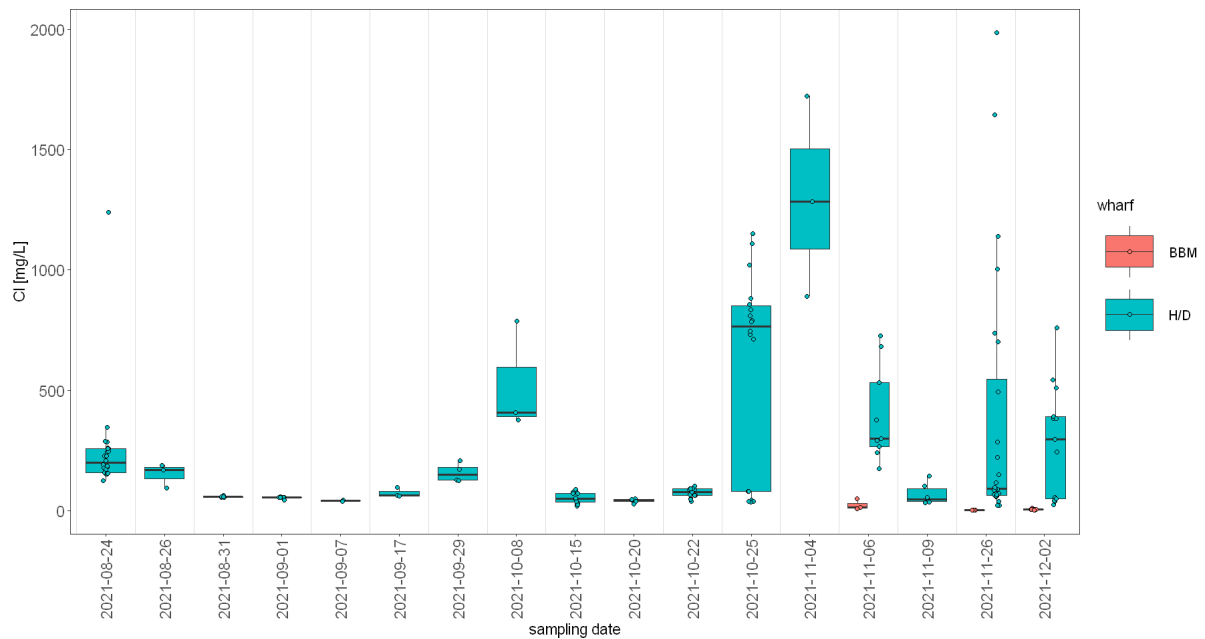
sampling date	SO <sub>4</sub> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	184.667	173.0	23.756	169.0	212.0
<b>2021-11-26</b>	40.233	37.7	8.875	32.9	50.1
<b>2021-12-02</b>	57.289	54.3	15.227	41.8	85.9



**A-Fig. 58.** Comparison of the SO<sub>4</sub> [mg/L] measurements at BBM and H/D quays.

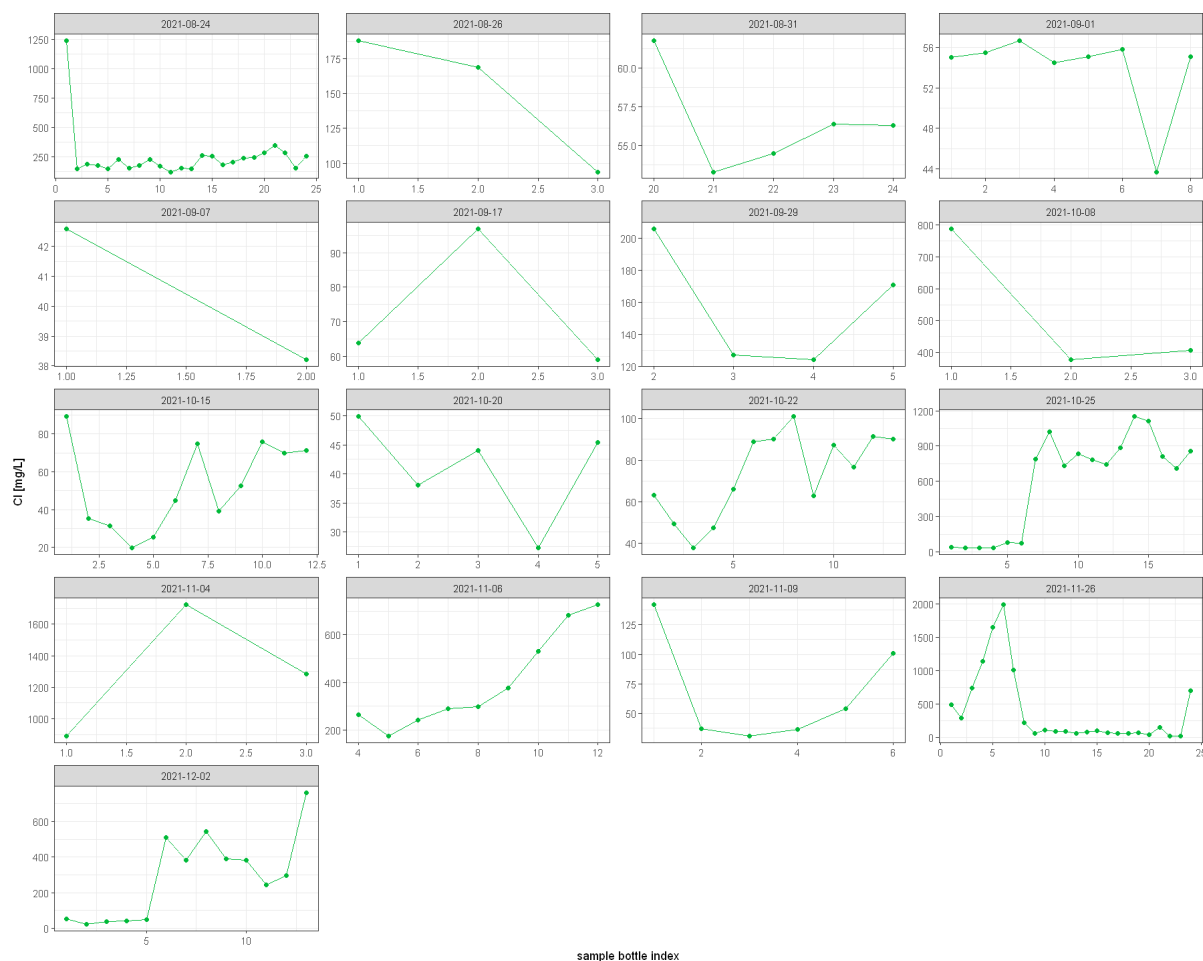
A-Fig. 58. shows that SO<sub>4</sub> concentrations at H/D quay are significantly greater than concentrations at BBM quay.

### Statistical characteristics of the concentration of the Cl<sup>-</sup>



**A-Fig. 59.** Boxplots of the measured Cl<sup>-</sup> [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the Cl<sup>-</sup> at H/D quay are equal to 19.7 mg/L and 1986 mg/L respectively, whereas at BBM quay those values are equal to 2.11 mg/L and 48.4 mg/L. The medians range from 40.4 mg/L to 1284 mg/L at H/D and from 2.41 mg/L to 11.8 mg/L at BBM.

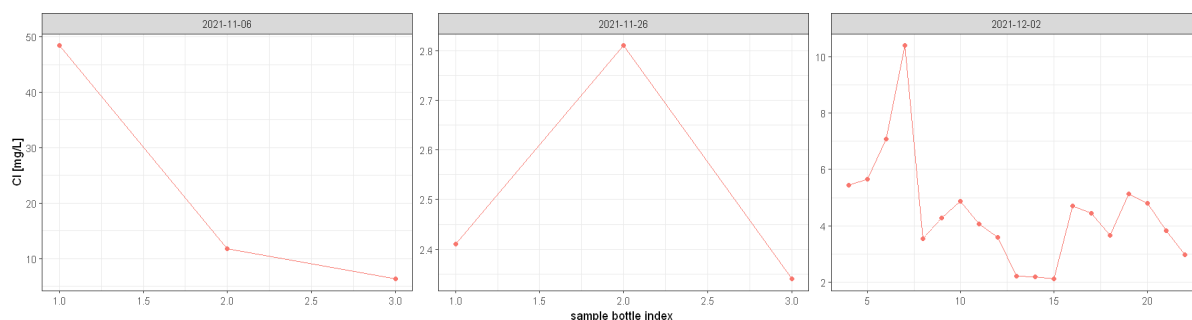


**A-Fig. 60.** Cl<sup>-</sup> [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 23.** Cl<sup>-</sup> [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	Cl <sup>-</sup> [mg/L]				
	mean	median	std	min	max
<b>2021-08-24</b>	251.429	198.7	218.012	124.0	1241.0
<b>2021-08-26</b>	150.200	168.8	49.778	93.8	188.0
<b>2021-08-31</b>	56.460	56.3	3.255	53.3	61.8
<b>2021-09-01</b>	53.925	55.1	4.183	43.7	56.7
<b>2021-09-07</b>	40.400	40.4	3.111	38.2	42.6
<b>2021-09-17</b>	73.233	63.8	20.728	58.9	97.0
<b>2021-09-29</b>	157.000	149.0	39.098	124.0	206.0
<b>2021-10-08</b>	523.667	406.0	229.378	377.0	788.0
<b>2021-10-15</b>	52.383	48.7	23.006	19.7	89.1
<b>2021-10-20</b>	40.940	44.1	8.761	27.2	49.9
<b>2021-10-22</b>	73.223	76.7	20.217	37.6	101.0

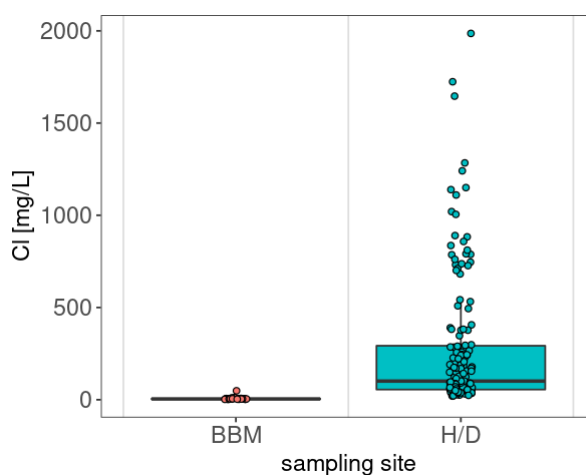
<b>2021-10-25</b>	597.178	766.0	413.714	35.6	1150.0
<b>2021-11-04</b>	1299.333	1284.0	417.211	890.0	1724.0
<b>2021-11-06</b>	398.667	298.0	200.236	175.0	727.0
<b>2021-11-09</b>	66.950	45.7	44.876	30.9	142.0
<b>2021-11-26</b>	387.229	91.9	546.337	21.3	1986.0
<b>2021-12-02</b>	285.646	295.0	236.467	23.7	761.0



**A-Fig. 61.** Cl<sup>-</sup> [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 24.** Cl<sup>-</sup> [mg/L] statistical characteristics of the episodes at BBM quay.

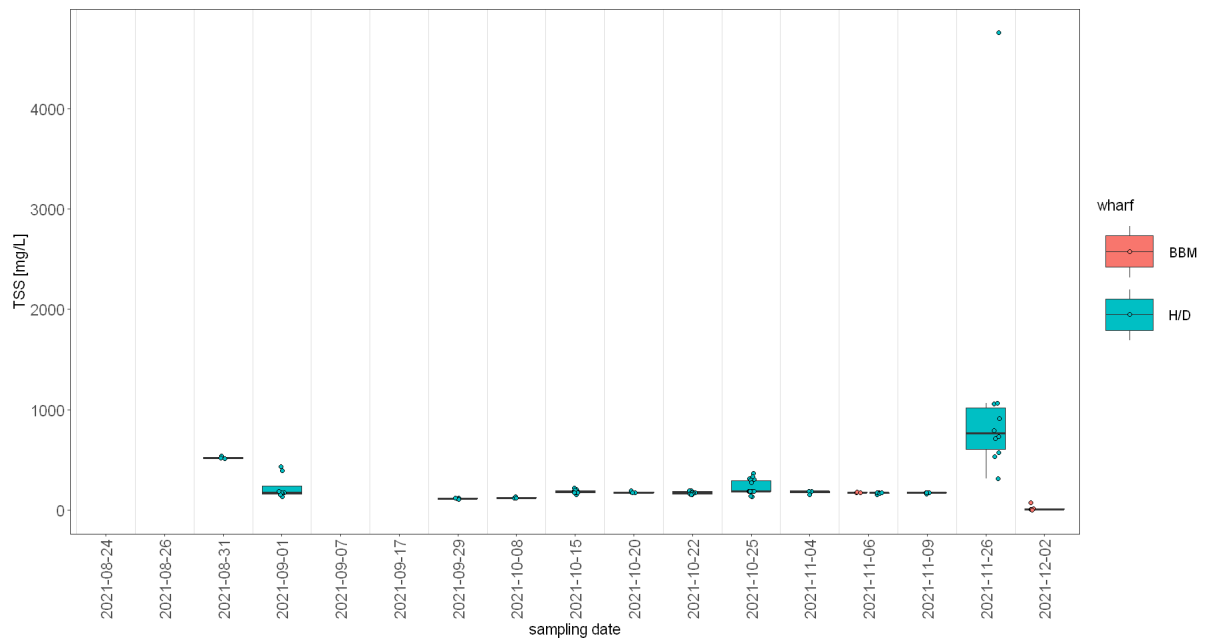
sampling date	Cl <sup>-</sup> [mg/L]				
	mean	median	std	min	max
<b>2021-11-06</b>	22.177	11.80	22.874	6.33	48.40
<b>2021-11-26</b>	2.520	2.41	0.254	2.34	2.81
<b>2021-12-02</b>	4.473	4.28	1.917	2.11	10.40



**A-Fig. 62.** Comparison of the Cl<sup>-</sup> [mg/L] measurements at BBM and H/D quays.

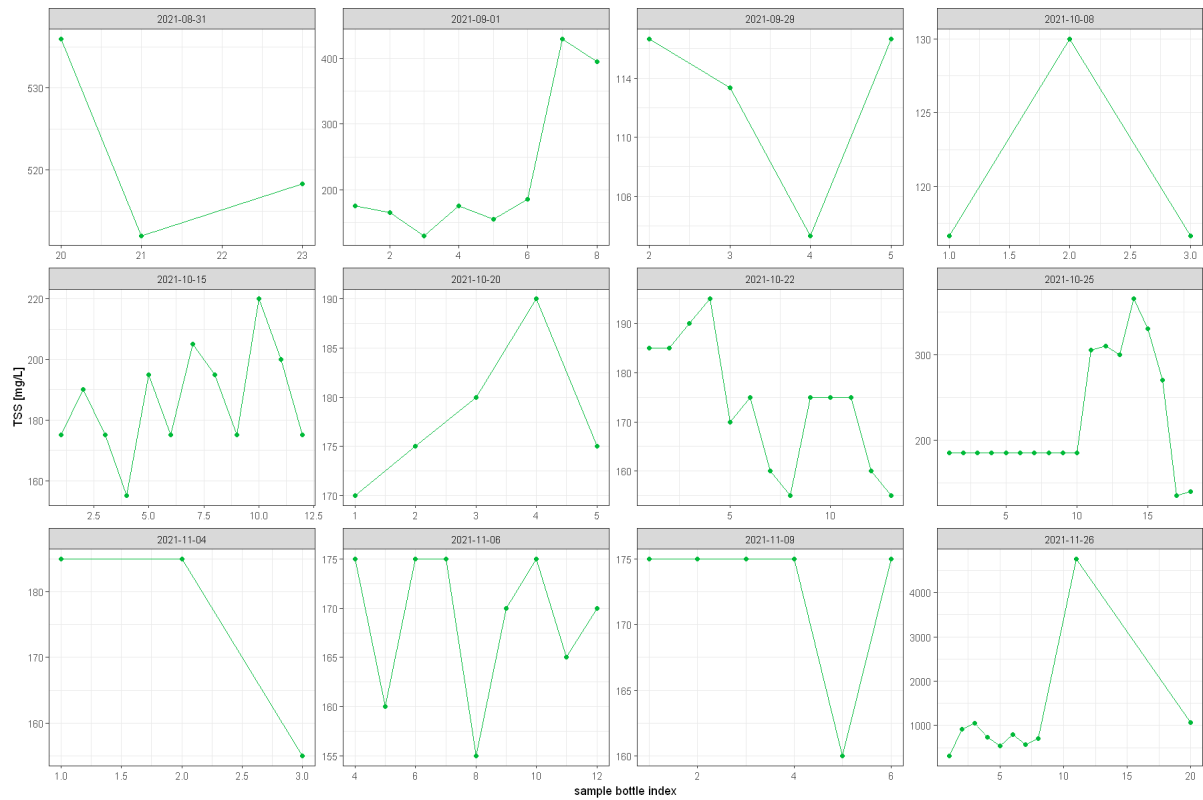
A-Fig. 62 displays that Cl<sup>-</sup> concentrations at BBM are significantly lower and less dispersed than at H/D. The difference is of orders of magnitude.

Statistical characteristics of the concentration of the total suspended solids (TSS)



**A-Fig. 63.** Boxplots of the measured values of the total suspended solids (TSS) [mg/L] for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

Minimum and maximum observed values of the total suspended solids at H/D quay are equal to 103 mg/L and 4755 mg/L (extreme outlier) respectively, whereas at BBM quay those values are equal to 1 mg/L and 180 mg/L. The medians range from 115 mg/L to 763 mg/L at H/D and from 9.5 mg/L to 175 mg/L at BBM.

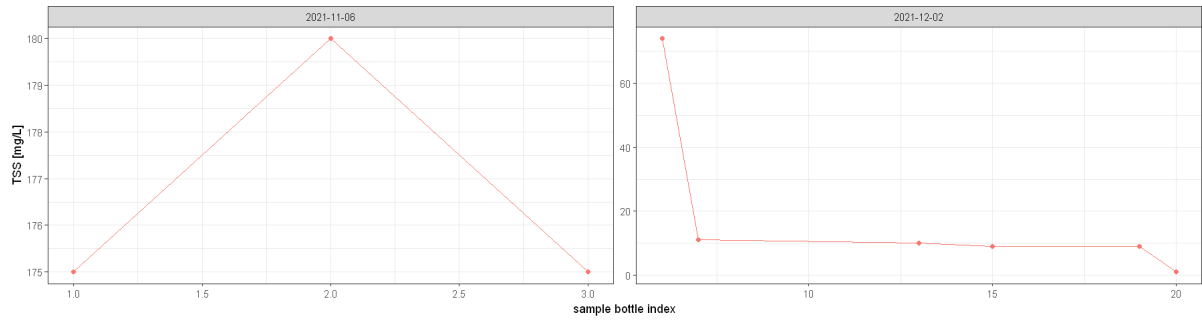


**A-Fig. 64.** Total suspended solids [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 25.** TSS [mg/L] statistical characteristics of the episodes at H/D quay.

sampling date	TSS [mg/L]				
	mean	median	std	min	max
<b>2021-08-31</b>	522.11	518.3	12.438	512.0	536.0
<b>2021-09-01</b>	226.25	175.0	116.519	130.0	430.0
<b>2021-09-29</b>	112.50	115.0	6.310	103.3	116.7
<b>2021-10-08</b>	121.111	116.7	7.698	116.7	130.0
<b>2021-10-15</b>	186.250	182.5	17.726	155.0	220.0
<b>2021-10-20</b>	178.000	175.0	7.583	170.0	190.0
<b>2021-10-22</b>	173.462	175.0	13.131	155.0	195.0
<b>2021-10-25</b>	222.500	185.0	69.921	135.0	365.0
<b>2021-11-04</b>	175.000	185.0	17.321	155.0	185.0
<b>2021-11-06</b>	168.889	170.0	7.407	155.0	175.0
<b>2021-11-09</b>	172.50	175.0	6.124	160.0	175.0
<b>2021-11-26</b>	1144.00	762.5	1290.021	315.0	4755.0

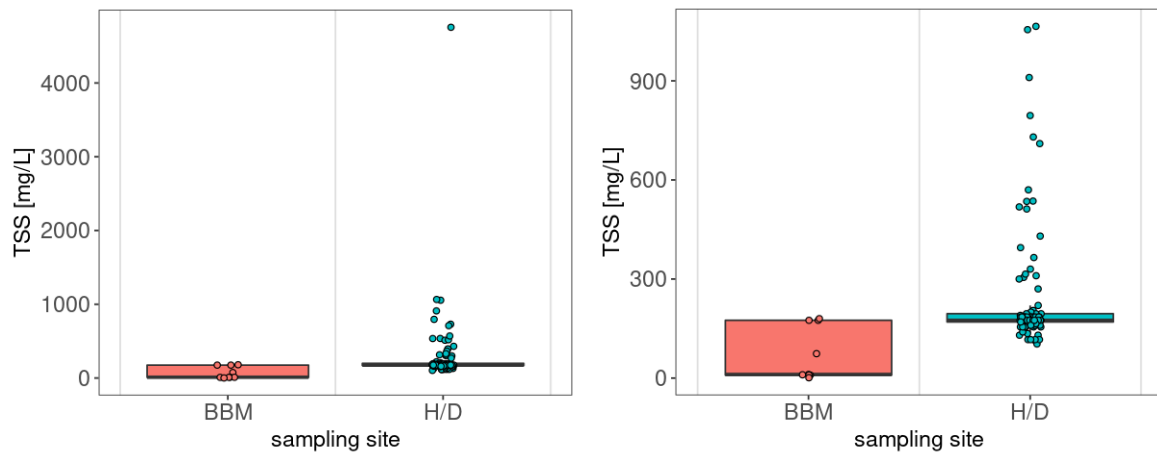




**A-Fig. 65.** Total suspended solids [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 26.** TSS [mg/L] statistical characteristics of the episodes at BBM quay.

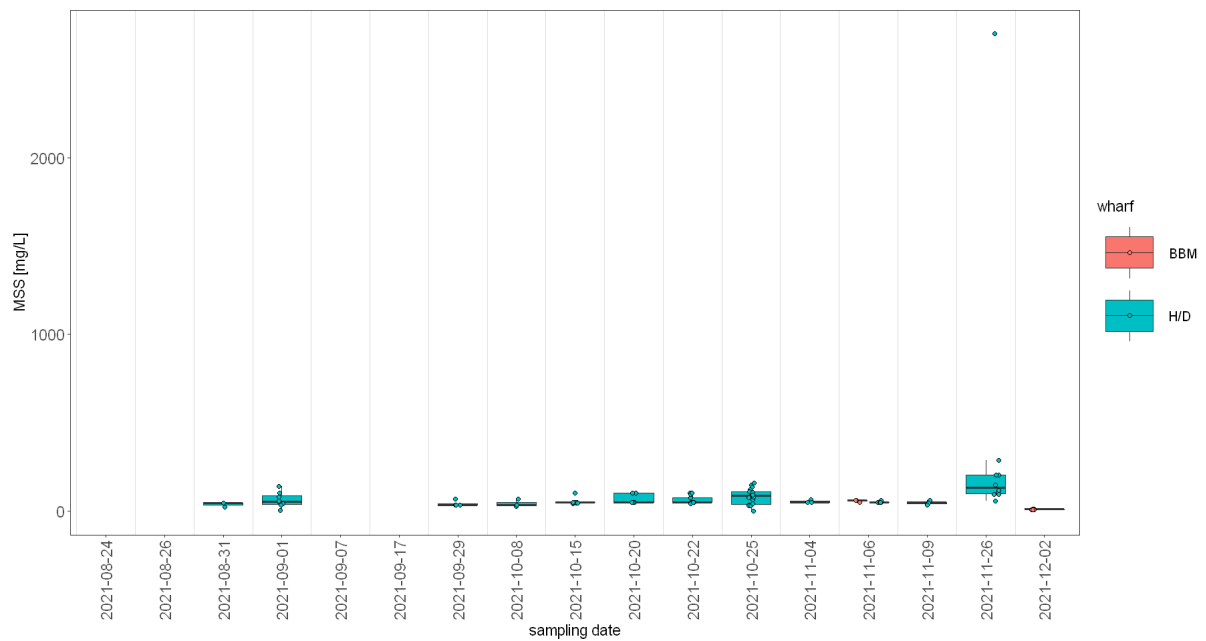
sampling date	TSS [mg/L]				
	mean	median	std	min	max
2021-11-06	176.667	175.0	2.887	175	180
2021-12-02	19.000	9.5	27.181	1	74



**A-Fig. 66.** Comparison of the TSS [mg/L] measurements at BBM and H/D quays.

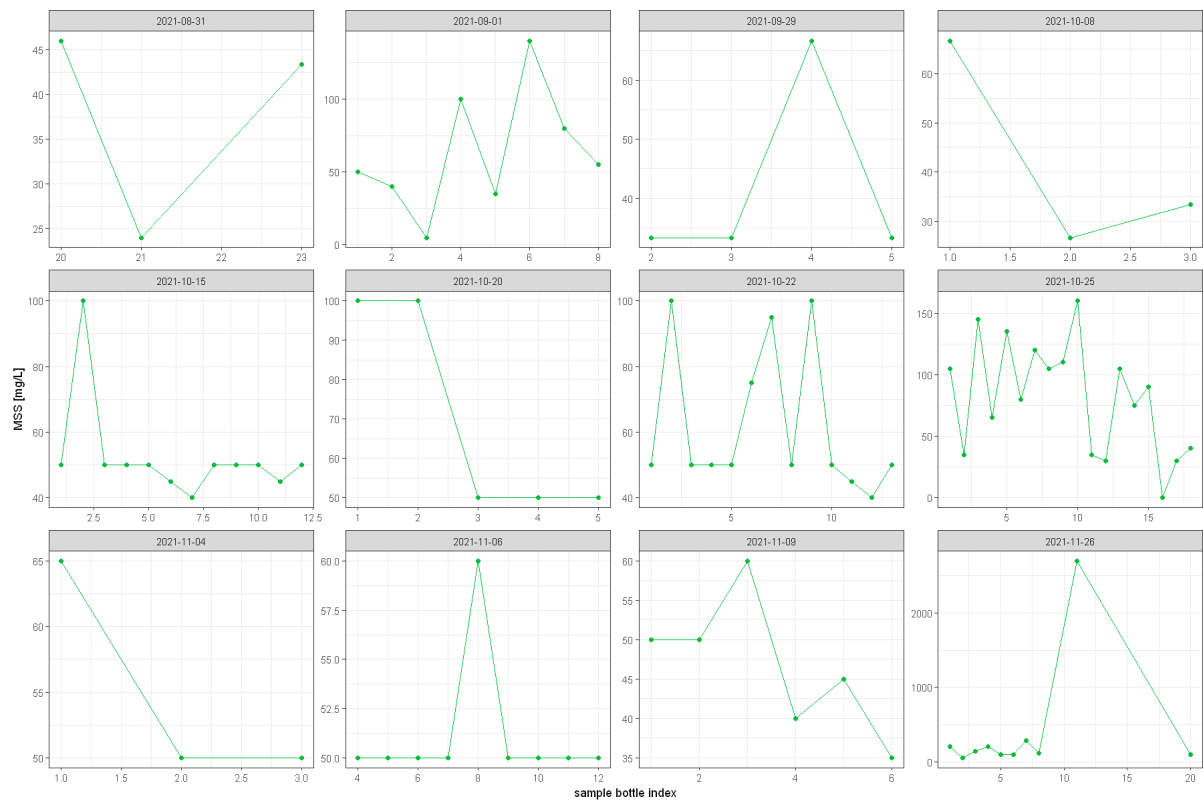
In A-Fig. 66. the left plot includes an extreme outlier registered at H/D quay. The plot on the right has this outlier removed for the purpose of better visualization. Based on the A-Fig. 4.67 it can be concluded that the TSS concentrations at H/D are significantly greater than at BBM.

Statistical characteristics of the mineral suspended solids (MSS)



**A-Fig. 67.** Boxplots of the measured values of the mineral suspended solids [mg/L] for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

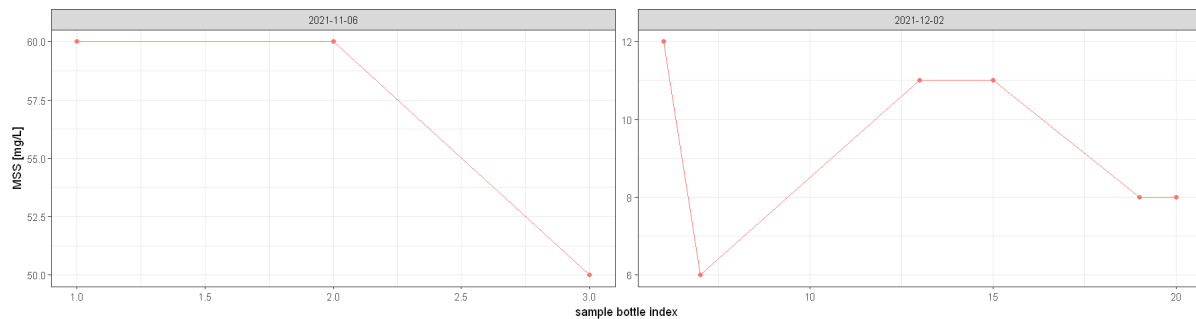
Minimum and maximum observed values of the MSS at H/D quay are equal to 0 mg/L and 2700 mg/L respectively, whereas at BBM quay those values are equal to 6 mg/L and 60 mg/L. The medians range from 33.3 mg/L to 130 mg/L at H/D and from 9.5 mg/L to 60 mg/L at BBM.



**A-Fig. 68.** Mineral suspended solids [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 27.** MSS [mg/L] statistical characteristics of the episodes at H/D quay.

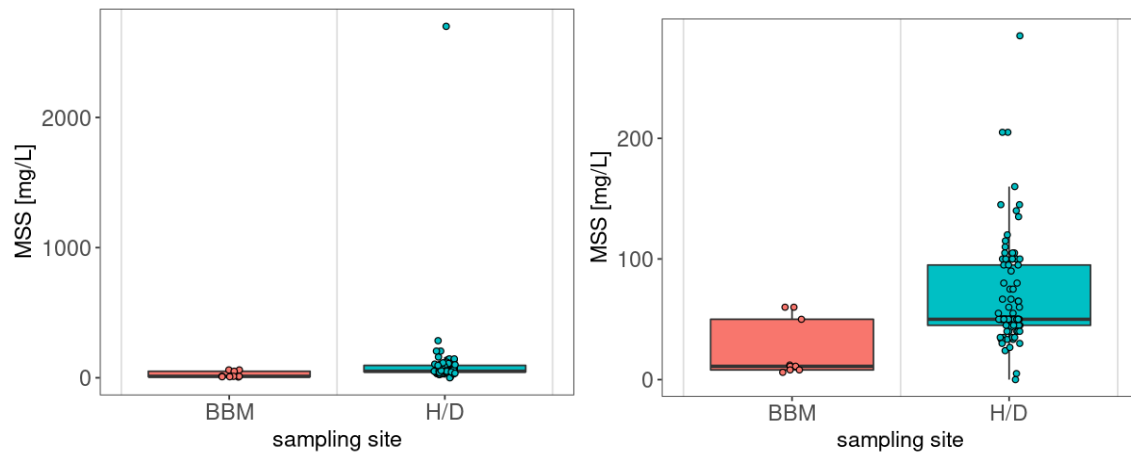
sampling date	MSS [mg/L]				
	mean	median	std	min	max
2021-08-31	37.78	43.33	12.006	24.0	46.0
2021-09-01	63.13	52.50	42.252	5.0	140.0
2021-09-29	41.7	33.33	16.667	33.3	66.7
2021-10-08	42.2	33.33	21.430	26.7	66.7
2021-10-15	52.5	50.00	15.300	40.0	100.0
2021-10-20	70.0	50.00	27.386	50.0	100.0
2021-10-22	61.92	50.00	22.224	40.0	100.0
2021-10-25	81.39	85.00	45.627	0.0	160.0
2021-11-04	55.00	50.00	8.660	50.0	65.0
2021-11-06	51.11	50.00	3.333	50.0	60.0
2021-11-09	46.67	47.50	8.756	35.0	60.0
2021-11-26	400.00	130.00	811.076	55.0	2700.0



**A-Fig. 69.** Mineral suspended solids [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 28.** MSS [mg/L] statistical characteristics of the episodes at BBM quay.

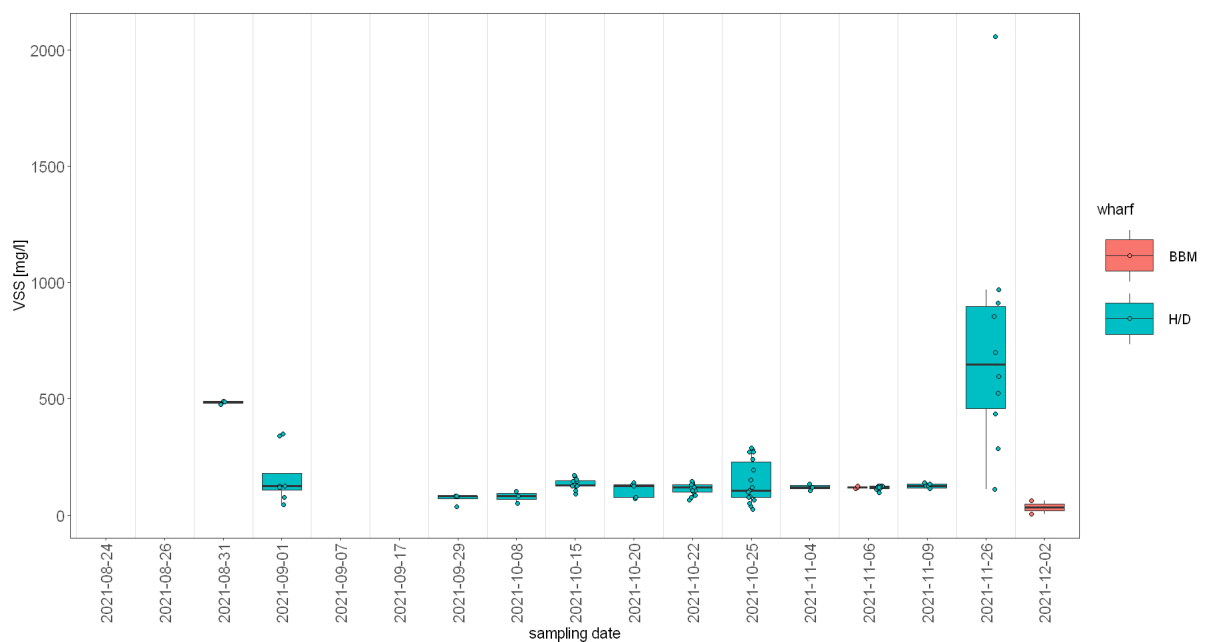
sampling date	MSS [mg/L]				
	mean	median	std	min	max
2021-11-06	56.667	60.0	5.774	50	60
2021-12-02	9.333	9.5	2.338	6	12



**A-Fig. 4.72.** Comparison of the MSS [mg/L] measurements at BBM and H/D quays.

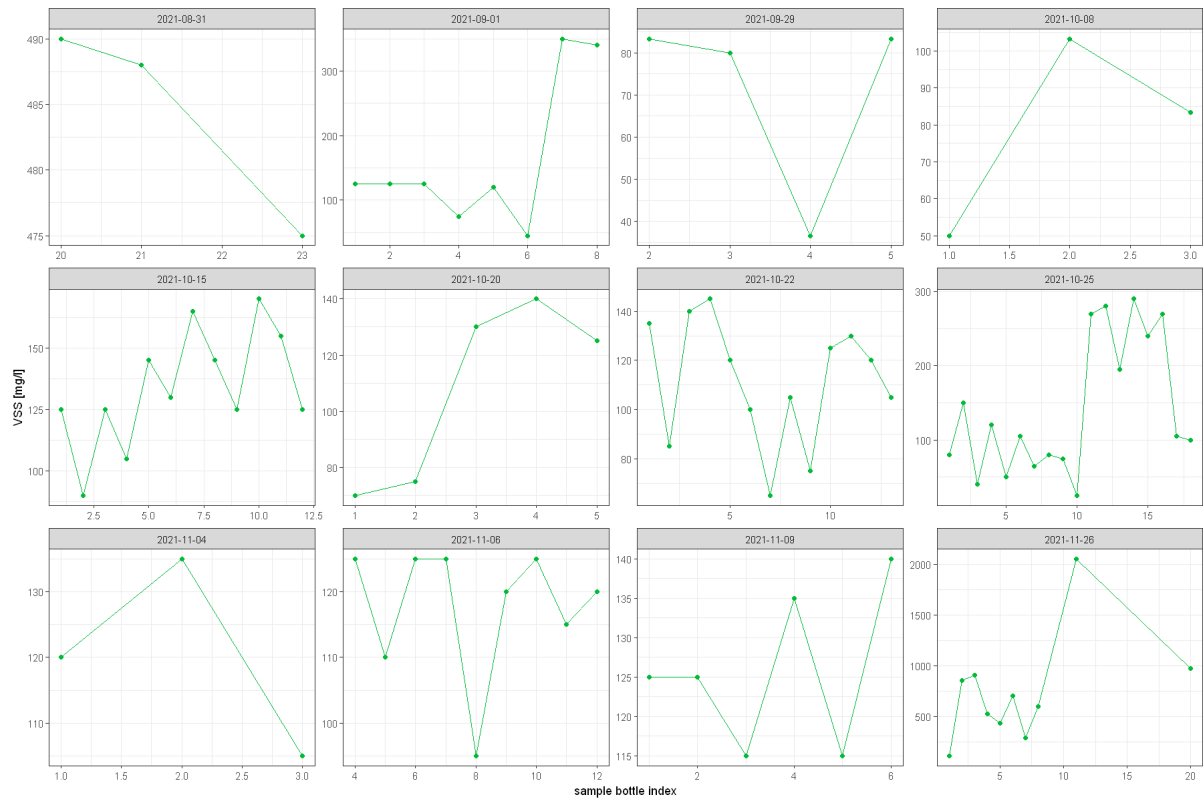
In A-Fig. 70, the left plot includes an extreme outlier registered at H/D quay. The plot on the right has this outlier removed for the purpose of better visualization. Based on the A-Fig. 4.72 it can be concluded that the MSS concentrations at H/D are significantly greater than at BBM.

Statistical characteristics of the violated suspended solids (VSS)



**A-Fig. 71.** Boxplots of the measured VSS [mg/L] values for data grouped by the sampling date. All measured points are displayed as well. Colour indicates the quay at which the sample collection was made.

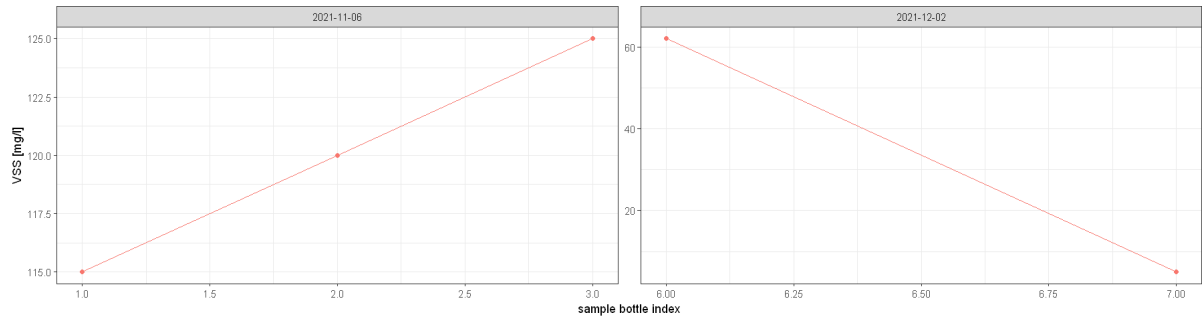
Minimum and maximum observed values of the VSS at H/D quay are equal to 25 mg/L and 2055 mg/L respectively, whereas at BBM quay those values are equal to 5 mg/L and 125 mg/L. The medians range from 81.7 mg/L to 647.5 mg/L at H/D and from 33.5 mg/L to 120 mg/L at BBM.



**A-Fig. 72.** VSS [mg/L] values in subsequent sampling bottles at H/D quay.

**A-Tab. 29.** VSS [mg/L] statistical characteristics of the episodes at H/D quay.

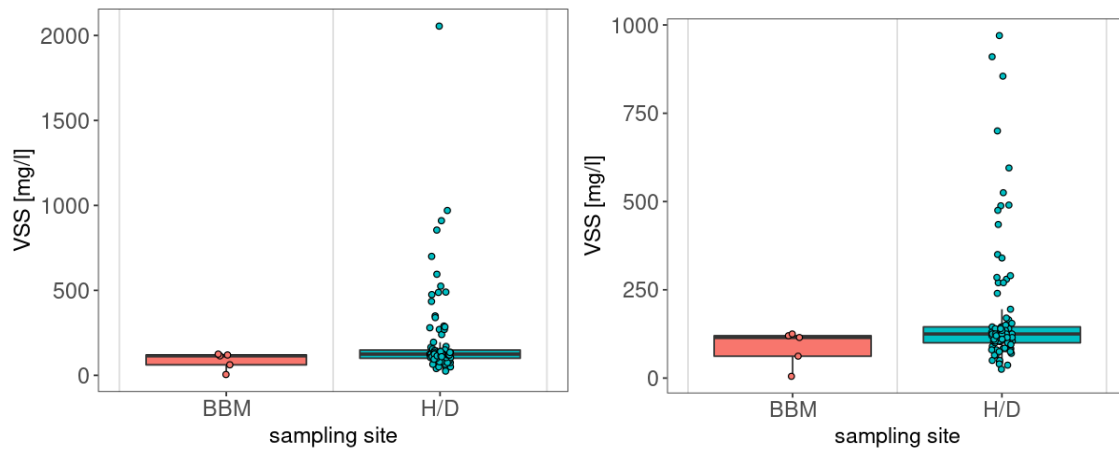
sampling date	VSS [mg/L]				
	mean	median	std	min	max
<b>2021-08-31</b>	484.333	488.0	8.145	475.0	490.0
<b>2021-09-01</b>	163.125	125.0	115.972	45.0	350.0
<b>2021-09-29</b>	70.833	81.7	22.832	36.7	83.3
<b>2021-10-08</b>	78.889	83.3	26.943	50.0	103.3
<b>2021-10-15</b>	133.750	127.5	23.464	90.0	170.0
<b>2021-10-20</b>	108.000	125.0	32.901	70.0	140.0
<b>2021-10-22</b>	111.538	120.0	25.115	65.0	145.0
<b>2021-10-25</b>	141.111	105.0	91.339	25.0	290.0
<b>2021-11-04</b>	120.000	120.0	15.000	105.0	135.0
<b>2021-11-06</b>	117.778	120.0	10.035	95.0	125.0
<b>2021-11-09</b>	125.833	125.0	10.206	115.0	140.0
<b>2021-11-26</b>	744.000	647.5	536.438	110.0	2055.0



**A-Fig. 73.** VSS [mg/L] values in subsequent sampling bottles at BBM quay.

**A-Tab. 30.** VSS [mg/L] statistical characteristics of the episodes at BBM quay.

sampling date	VSS [mg/L]				
	mean	median	std	min	max
2021-11-06	120.0	120.0	5.000	115	125
2021-12-02	33.5	33.5	40.305	5	62



**A-Fig. 74.** Comparison of the VSS [mg/L] measurements at BBM and H/D quays.

In A-Fig. 74, the left plot includes an extreme outlier registered at H/D quay. The plot on the right has this outlier removed for the purpose of better visualization. A-Fig. 4.76 shows that statistically VSS concentrations at BBM and H/D quays are similar (in terms of median values), however the VSS distribution at H/D has a long right tail. This means that it is likely to observe much higher values than those close to median.

## **Project WISA**

WISA (Water Innovation System Amplifier) is a 3-year project that will contribute to a cleaner Baltic Sea by developing and testing new green technologies to reduce pollution by stormwater from ports and other large hard surfaces.

---

The Baltic Sea is one of the world's most polluted seas. More than 45 million tonnes of fertilizer pass through the ports of the Baltic Sea annually, and the handling contributes to the release of fertilizers and nutrients into the stormwater. This leads to eutrophication with extensive algal blooms and dead seabed.

---

*The contents of this written output is the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union, the Managing Authority or the Joint Secretariat of the Interreg South Baltic Programme 2014–2020.*



European  
Regional  
Development  
Fund