WSE-HWR Module 5 – Water Quality

Laboratory report

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1 Introduction

1.1 Water sample

The water samples collected by group 3 on 14th February 2020 and were taken to the IHE laboratory for analysis. The following parameters were checked:

Field projection:

- pH
- Transparency
- Turbidity
- Electrical Conductivity (EC)
- Water temperature
- Dissolved Oxygen (DO)

Laboratory projection:

- Ammonium (NH_4^+-N)
- Nitrate (NO_3^--N)
- Phosphate(PO_4^{3-})
- Sulphate (SO_4^{2-})
- Total Organic Carbon (TOC)
- Total Nitrogen (TN)
- Chloride (Cl^-)

1.2 Aim of the field trip

The field trip aims to gain practical experience in the collection, analysis, and interpretation of water quality samples from different land-use in the vicinity of Delft. Emphasis is placed on potential contamination by nutrients and organic matter, which are the most common water quality issues worldwide.

1.3 Water sample locations

The water sampling locations are indicated on Plates 1 to 3 and shown in figure 1 below.

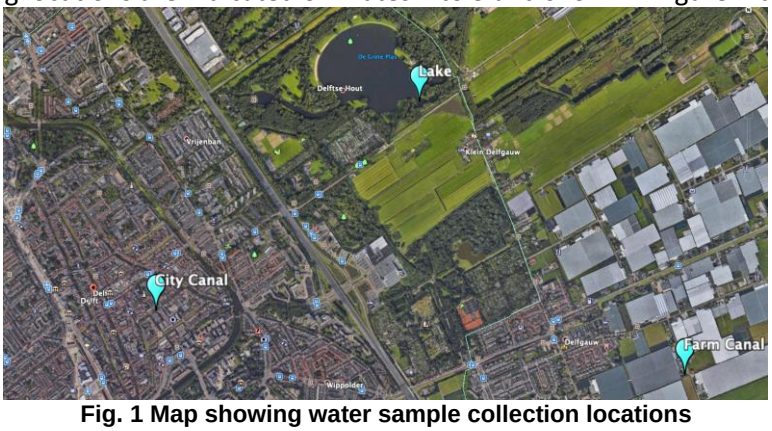


Fig. 1 Map showing water sample collection locations

Plate 1: City canal

Plate 2: Lake

Plate 3: Farm canal

2 Methodology

2.1 water sample collection

First, the bottles are washed using water from those sites to reduce the influence of chemicals attached to the bottle wall. Then, the bottle is to be full filled the water without any gas. Finally, the labels, noted the date, time, location, group, and sample number, are attached to the container.

2.2 Field projection

(1) Water temperature, Electrical Conductivity, pH and Dissolved Oxygen are analyzed using field meters. The probe of all field meters put into the water stable, then make the field meter work until the parameter stable. Specifically, the probe needs to stir the water until the parameter stable when measured the dissolved oxygen. And the pH meter needs to set the temperature of the water before measurement.

(2) Turbidity is analyzed using a turbidity tube and the minimum value of the tube is 5 TU. The water from the canal gives it to the tube until the yellow label on the tube bottom cannot see. If the label is still visible when the water overflows, the data can record as less than 5 TU.

(3) Transparency is analyzed using a Secchic disc. The Secchic disc put into the water until we cannot see disc, then reading the value. If the disc will reach the bottom, the result needs to mention that values are more than measured values and the disc reached to the bottom.

2.3 laboratory projection

(1) Total Organic Carbon (TOC) and Total Nitrogen (TN) are analyzed using Shimadzu TOC/TN analyzer.

(2) Ammonium (NH_4^+-N), nitrate (NO_3^--N), and phosphate (PO_4^{3-}) are analyzed using spectrophotometric. The range and types of ammonium (NH_4^+-N), nitrate (NO_3^--N), and phosphate (PO_4^{3-}) are LCK 304(0.015-2 mg N/L), LCK 339(0.23-13.50 mg N/L) and LCK 349 (0.05-1.50 mg P/L) respectively. The measurement follows the

(3) Sulphate (SO_4^{2-}) concentration is analyzed by ion chromatography (IC).

(4) Titration precipitation to determine chloride concentration

The principle of the process is that soluble $AgNO_3$ titrant is added lead to white AgCl precipitate formed, written as

$$Cl^- + Ag^+ \text{ —> } AgCl$$

. After a yellow K_2CrO_4 put into the sample until all Cl^- consumed, the solution gets red Ag_2CrO_4. The indicator is potassium chromate (K_2CrO_4).

Specific steps：

Chloride determination (Do the duplicate experiment)

1) Transfer 50mL sample to an Erlenmeyer flask
2) Add 1 ml 5% K_2CrO_4 indicator solution (around 20 drops)
3) Titrate with 0.015M $AgNO_3$ until a reddish-brown colour persists
4) Carry out a blank by taking 50.00mL distilled water instead of the sample

The concentration is obtained by equation, given as

$$Cl^- = (V - V_b) * M * 35.45 * (1000/S) \text{ mg/L}$$

, where V is the volume of $AgNO_3$ used for the sample; V_b is the volume of AgNO3 used for the blank; M is the molarity of the $AgNO_3$ solution; S is sample volume.

3 Results

The results are appended in the following table and the samples are analysed only one time without duplication experiment.

Number	sample 1	sample 2	sample 3
Location	Near HEMA, molslaan 33 and downstream of a bridge	Near a lake and the upstream of a white bridge	Greenhouse, Hagen(facing)
Date	14/02/2020	14/02/2020	14/02/2020
Turbidity (TU)	less than 5	less than 5	15
Transparency (cm)	110	larger than 55 (reached the bottom)	larger than 12.5 (reached the bottom)
pH	8.2	8.2	7.6
DO(%)	75	94	83
DO (mg/L)	9.5	11.9	9.8
EC (µS/cm)	969	688	686
temp (C)	5.9	6	7.5
Cl (mg/L)	79	60	25
TOC (mg/L)	15.0	12.9	9.67
TN (mg/L)	1.71	1.14	2.97
NH4-N (mg/)	0.03	0.05	0.34
NO3-N (mg/L)	1.86	0.68	2.55
PO4-P (mg/)	0.07	<0,05	0.71
SO4 (mg/L)	128	131	57.8

The results are shown in a table that pH, dissolved oxygen, and temperature are reached at a similar level, while other parameters fluctuate a lot.

The city canal with high water level compares with others because of the transparency with low results of other locations

Sample 2 in the lake has the highest dissolved oxygen with 94% and 11.9 mg/L, while the lowest is in sample 1 from the city canal, which accounts for 75%.

The EC values, chloride concentration and TOC concentration of sample1, with 969 µS/cm, 79 mg/L and 15.0 mg /L respectively, are more than other samples. Meanwhile, the values of sample 3 are the smallest and the EC values between samples 2 and 3 are similar.

On the contrary, the TN, nitrate, phosphate concentration and turbidity in sample 3 from the farm canal, with 2.97 mg/L, 0.34 mg/L, 3.69 mg/L, 0.71 mg/L and 15 UT, exceed other samples, which values are similarly, excepted the nitrate concentration with 1.86 mg/L in sample 1 and 0.68 mg/L in sample 2.

Finally, the sulphate concentration of sample 1 and sample 2 are similar, while the value is much small in sample 3 with 57.8 mg/L.

3.1 Compare the values with the values of other groups

Group	Sample name	pH	DO(%)	DO (mg/L)	EC (µS/cm)	temp (C)
G1	S1	8.2	74	9.5	987	6
G2	S1	7.8	75	11.5	983	6
G3	S1	8.2	75	9.5	969	5.9
G1	S2	8.6	97	12.3	688	6
G2	S2	8.6	97	12.3	688	6
G3	S2	8.2	94	11.9	688	6
G1	S3	7.9	94	11.5	596	7
G2	S3	8.1	105	13.6	706	6.7
G3	S3	7.6	83	9.8	686	7.5

The table presents that the pH, dissolved oxygen, electrical conductivity and temperature were measured by three different groups in the city canal (S1), lake (S2) and farm canal (S3). The dissolved oxygen of group 2 in sample 1 exceeds other groups with 11.5 mg/L, while the EC value of group 3 is smaller with 969 (µS/cm). In the lake, the results vary is in the confidence range, particularly obtained the same results of groups 2 and 3. However, the percentage of dissolved oxygen of group 2 in sample 3 from the farm canal is more than 100%, which is unrealistic and might be caused by the wrong operation. Meanwhile, The DO values of group 3 is relatively smaller than other groups with 9.8 mg/L and 83%.

Group	Sample name	Cl (mg/L)	Cl on IC	TOC (mg/L	TN (mg/L)	NH4-N (mg/L)	NO3-N (mg/L)	NO3 -N IC	PO4-P (mg/L)	PO4 -P IC	SO4 (mg/L
G1	S1	121	82	14.1	1.66	0.21	3.34	1.61	0.52	< 0,3	129
G2	S1	114	84	12.5	1.50	<0.015	2.13	1.57	0.06	< 0,3	125
G3	S1	79.2	83	15.0	1.71	0.03	1.86	1.61	0.07	< 0,3	128
G1	S2	64.9	58	11.7	0.99	0.17	2.11	0.42	0.34	< 0,3	132
G2	S2	85.1	57	11.4	0.96	0.02	0.71	0.39	<0.05	< 0,3	132

G3	S2	59.6	57	12.9	1.14	0.05	0.68	0.38	<0,05	< 0,3	131
G1	S3	65.4	27	10.3	1.61	0.27	3.43	1.63	0.59	< 0,3	111
G2	S3	71.3	30	11.5	1.46	<0.015	1.78	1.33	0.44	< 0,3	129
G3	S3	25.0	29	9.67	2.97	0.34	2.55	3.69	0.71	0.9	57.8

The table clearly shows that Chloride (Cl^-), ammonium (NH_4^+-N), nitrate (NO_3^--N), phosphate (PO_4^{3-}), sulphate (SO_4^{2-}), total organic carbon, and total nitrogen concentration are in three types of samples located in the city canal, lake and farm canal, analyzed in the laboratory with different groups and Ion Chromatography (IC).

(1) Chloride (Cl^-):

The Cl^- concentration of samples from the same place measured by three groups are big differences. Meanwhile, the results of group 1 and 2 in all samples far more than those analyzed in IC. The experimental results are unreliable and samples need to be reanalyzed.

(2) Total Organic Carbon (TOC):

The variation of TOC concentration for all the samples assessed is within the limit.

(3) Total Nitrogen (TN), Ammonium (NH_4^+-N) and Nitrate (NO_3^--N):

The variation of TN concentration for all the samples assessed is within the limit, excepted sample 3 of group 3, which the concentration of total nitrogen, with 2.9 mg/L, overtakes other samples collected by group 1 and 2 with 1.61 mg/L and 1.46 mg/L respectively.

The differences in concentration of Ammonium (NH_4^+-N) and Nitrate (NO_3^--N) among three groups of each sample is huge. Therefore the results are unrealistic and need to be check again in the laboratory.

The Nitrate concentration of sample 3, which is obtained by group 3 and analysed by IC, with 3.69 mg/L, is more than other groups, with 1.63 mg/L and 1.33 mg/L respectively.

(4) Phosphate (PO_4^{3-}) and Sulphate (SO_4^{2-}):

The values of phosphate concentration measured by three groups are unrealistic because of the big difference among those samples, compared with the results from IC.

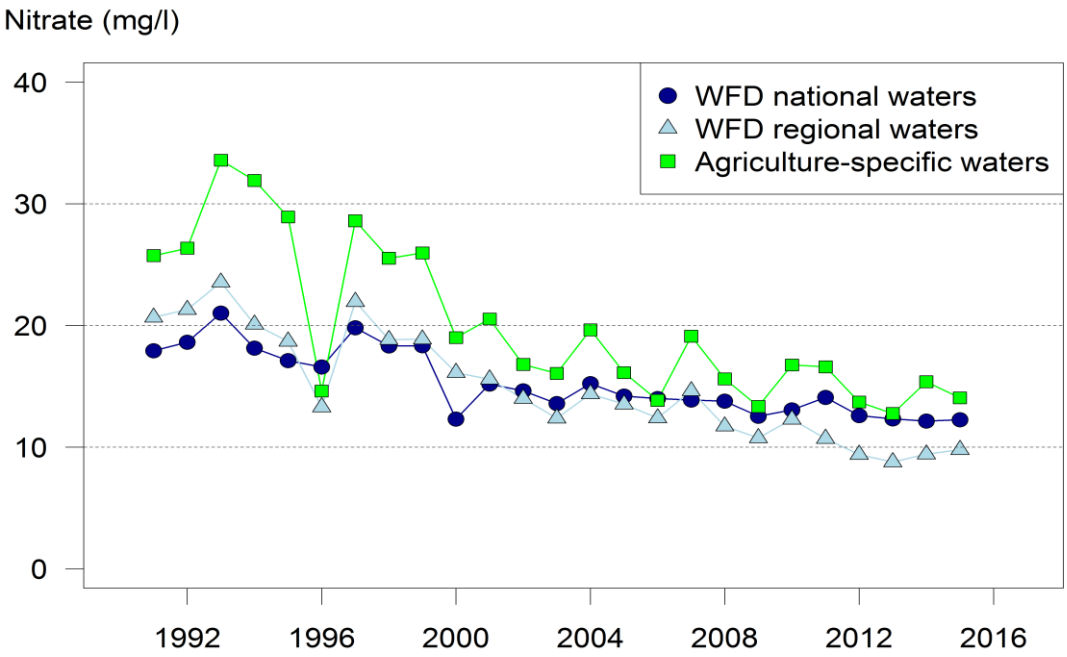
On the other hand, the phosphate concentration in sample 3 by group3, with 0.9 mg/L, exceeds other groups with lower than 0.3 mg/L, while the sulphate concentration, with 57.8 mg/L, is smaller.

3.2 Compare your average results with historical data from the three sites provided by Delfland Water Authority.

Name	Type	Temperature °C	DO mg/l	Ammonium mg N/l	Nitrate mg N/l	Total Nitrogen mg N/l	Phosphate mg P/l	Sulphate mg/l
historical data of city canal in winter(Dec.-Feb.)	maximum	9.5	10.9	0.9	2.2	4.8	0.62	135
	minimum	0.6	6.4	0.1	1.4	2.4	0.11	95
	average	4.3	8.3	0.4	1.8	3.5	0.24	119
sample 1	2/14/2020	5.9	9.5	0.03	1.6	1.7	< 0,3	128
historical data of lake in winter(Dec.-Feb.)	maximum	8.7	17.1	0.54	0.59	2.5	0.2	142
	minimum	0.0	7.5	0.03	0.35	1.0	0.0	127
	average	5.0	11.6	0.20	0.49	1.6	0.1	136
sample 2	2/14/2020	6	11.9	0.05	0.38	1.1	< 0,3	131
historical data of farm canal in winter(Dec.-Feb.)	maximum	9.4	20.0	3.5	5.4	40.0	6.8	151
	minimum	1.8	3.7	0.2	3.0	4.0	0.4	32
	average	5.6	10.2	0.9	3.9	10.9	1.7	87
sample 3	2/14/2020	7.5	9.8	0.3	3.7	3.0	0.9	58

The table presents that the results of three sample which measured by group 3 are within the range of historical data in winter from December to February. However, the temperature is a little warmer and the dissolved oxygen of sample 1 and 2 are higher than the average. Interestingly, the phosphate concentration in sample 1 and 2 are smaller than 0.3 mg/L, which is the minimum value obtained by IC. In my opinion, the results fluctuate within a reasonable range and are consistent with historical data.

3.3 Compare your results with the wider status and trends of water quality in The Netherlands.



The figure presents the wider status and trends of Nitrate concentration (winter average of NO_3 in mg/l) in fresh surface waters in the period 1990-2015. And the various types of waters which can be identified are agriculture-specific waters and regional and national waters which have been designated as a WFD (European Water Framework Directive) body of water (Water quality in the Netherlands).

The Nitrate concentrations of samples from the city canal, the lake and the farm canal, with 8.3 mg/L, 3.8 mg/L and 11.3 mg/L(Agriculture-specific), are lower than the winter average values in Netherland and the EU standard of 50 mg/l, which is used in this report as the benchmark figure for nitrate. That means the water quality in those areas is better than more than half areas in Netherland.

4 Interpretation

Sample 2 in the lake has the highest dissolved oxygen with 94% and 11.9 mg/L which might be that the biomass of oxygenic photosynthetic organisms is higher in the lake. The EC values, chloride concentration and TOC concentration of sample1 are more than other samples due to the easily biodegradable organic wastes, such as kitchen wastes, discharged from the sewage to the city canal. On the contrary, the TN, nitrate, and phosphate concentration in sample 3 from the farm canal exceed other samples due to the fertilizer used by farmers lead to non-point source pollution. Conversely the sulphate concentration of sample 1 and sample 2 are similar, while the value is much small in sample 3 with 57.8 mg/L. It means the source of sulphate is not the fertilizer contaminant.

Compared with chloride concentration of each site measured by three groups, the variations of concentration between IC and the groups are high. Because the reddish-brown colour persists, produced by titrating with 0.015M $AgNO_3$, are inferred subjectively by the researcher and it has a big laboratory error.

The results of samples in each site by three groups might be similar if the laboratory errors are small, except in sample 3 of group 3 with a higher concentration of nitrate and phosphate and a high value of turbidity. Because the sample of group 3 was collected in the drainage canal of the greenhouse influenced by fertilizing, as shown in the following picture. However, the phosphate concentration returns to normal, with less than 0.3mg/L, when discharge to the downstream of the farm canal due to dilution of freshwater, according to the samples collected by other groups.

Consequently, the distributions of chemical components from different types of land-use are different and are consistent with historical data. Meanwhile, the water quality of those sites is good compared with the average water quality in Netherland.

5 Recommendations

The phosphate and nitrate concentration of the water located on the drainage canal of the greenhouse in the farm area of Delft should be monitored in the winter, although it returns to normal on the downstream due to dilution of freshwater.