Water and wastewater treatment – Homework 6

1. Water resources quality

The Tables below show the water composition of two raw waters used for drinking water production. Assess the water quality in terms of the Swiss drinking water regulations. Also try to identify the possible water resource of these waters.

Water type 1

Parameter	Measured value
Temperature	7-12°C
pH	6.4-7.1
DOC	1-5 mg/L
UV (254 nm)	1.3-19.5 m^{-1}
Calcium	122 mg/L
Magnesium	3.5 mg/L
Nitrate as NO_3^-	25 mg/L
Atrazine	150 ng/L
Tetrachlorethylene	20 µg/L
Trichlorethylene	15 µg/L
Bromide	20 µg/L
Turbidity FTU	0.2 - 150

Discussion of water quality for water type 1:

T:

pH:

DOC:

UV:

Calcium and Magnesium:

Nitrate:

Atrazine:

Tetrachloroethylene, trichloroethylene:

Bromide:

Turbidity:

Water type 2

Parameter	Measured value
Temperature	11.4^{o}C
pH	7.1
DOC	4 mg/L
Total Hardness ^{o}F	39
Calcium Hardness ^{o}F	35
Magnesium Hardness ^{o}F	3.9
Oxygen	0 mg/L
Nitrate as N	< 0.01 mg/L
Nitrite as N	0.02 mg/L
Ammonium as N	1.2 mg/L
Iron	6.6 mg/L
Manganese	0.22 mg/L

Discussion of water quality for water type 2:

T:

pH:

DOC:

Hardness:

Oxygen:

Nitrogen species:

Iron, manganese:

2. Riverbank filtration

Mixing and Transformation processes

A river water (20ºC) infiltrates according to the scheme below. Thereby, as a function of the infiltration distance, the mixing ratio with groundwater increases. The two waters differ in their chloride concentration: river water 0.1 mM, groundwater 0.3 mM.

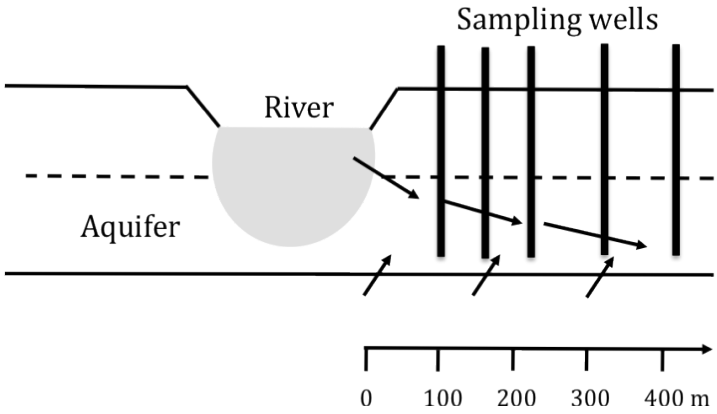


Table 1 shows the measured chloride concentrations in sampling wells as a function of the infiltration distance.

Table 1. Water quality parameters as a function of the infiltration distance

Infiltration distance m	Chloride concentration mM	O_2 mM	NO_3^- mM	SO_4^{2-} mM	HCO_3^- mM	Ca^{2+} mM	pH
0	0.1	0.25	0.4	0.5	2	0.9	7.7
20	0.104	0.05	0.25	0.49	2.4	1.15	7.4
80	0.11	0.02	0.054	0.485	2.6	1.3	7.5
90	0.12		0.04	0.46			
140	0.14			0.44			
250	0.3	0.15	0.2	0.2	2.6	1.3	7.5

a) Based on the chloride concentrations, sketch the relative contribution of river water in the groundwater.

b) The information from the chloride profile can now be used to estimate whether a concentration-distance profile for a given redox-sensitive species (O_2, NO_3^-, SO_4^{2-}) is

caused by chemical/microbiological processes or by dilution. Sketch the concentrations of the redox-sensitive parameters as a function of the river water content. What can be deduced from such graphs?

c) Is the $CaCO_3$ equilibrium fulfilled at each sampling well or do we expect a precipitation of $CaCO_3$ upon contact with the atmosphere (what is pCO_2 compared to the atmosphere)? $pK_{so} = 8.39$, pK_1 (H_2CO_3*) = 6.4, pK_2 (HCO_3^-) = 10.2, $K_H = 3.39 \times 10^{-2}$ M atm^{-1}.

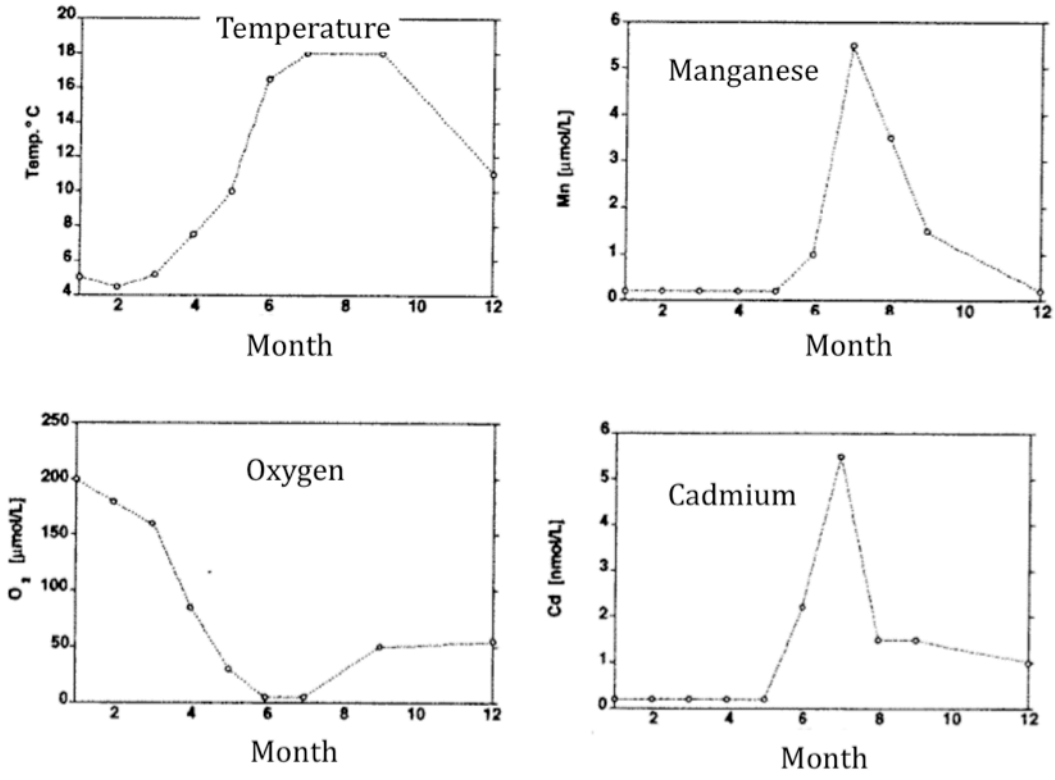
d) Riverbank filtration is an important source for drinking water in Switzerland (ca. 25%). If one considers an oxygen concentration of 8 mg/L (0.25 mM), what is the critical concentration of DOC to yield anaerobic conditions (assumption: DOC present as CH_2O and only source of carbon in the water)?

e) What happens if the DOC concentration is 5 mg C/L and nitrate is 5 mg/L (assumption: all DOC is biodegradable)?

Biogeochemical processes and geochemical consequences

During infiltration of the Glatt river (Glattfelden) samples were taken at one sampling well to obtain seasonal information (month) on temperature, oxygen, manganese and cadmium (Figure below).

f) How do you interpret these field observations?



3. Phosphate fertilization in a lake

A stagnant lake has a phosphate concentration of 50 µg P/L in the epilimnion. 90% of this phosphate is transformed into biomass, which sinks to the hypolimnion. The volume of the epilimnion is 2.5×10^6 m^3.

a) What is the minimum volume of the hypolimnion to avoid anoxic conditions. Assumption: the hypolimnion is a completely mixed reactor with an average oxygen concentration of 8 mg/L.

b) What happens if the volume is smaller and what are the consequences for water quality?

c) An industrial company would like to use lake water for cooling purposes. This is not authorized in Switzerland. Why?