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Investigation of the Phosphorus balance in the Vomb Lake

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LIST OF ABBREVIATIONS

DW : Dry Weight

mg/l : milligram per liter

ml : milliliter

P : phosphorus

µg/l : microgram per liter

pH : hydrogen potential

INTRODUCTION

Sweden is a country with a large proportion of lakes and ponds. The water production politic has been to use these formidable natural tanks of water for the production of drinking water.

In the south of Sweden, water production was entrusting to Sydsvatten. It produces enough water for more than 900 000 inhabitants which represent more than 70 million cubic meters per year. The firm takes this water from two lakes : Vombsjön and Bolmen. In this study we will be focused only on Vombsjön. The main feature of this lake is its huge recharge area which is mainly dominated by agricultural lands. It leads to an increase of phosphorus amounts in the rivers and then into the lake. However, the phosphorus does not only stay inert in water, it also forms complexes and fall into the sediments of the lake. These complexes constitute a big reserve of phosphorus in the sediments which can be available according to specific water conditions.

This excessive amount of phosphorus begins to be a problem when some algae come into the equation. In fact, due to an increase of phosphorus, a massive growth of primary producers start. Furthermore, the result of this high production of organisms is an increase of dead organisms that accumulate on the bottom sediment. Here, they get degraded consuming oxygen in the process leading to oxygen depletion in the bottom water. Last but not least, it also provokes a depletion of plants and animal population degrading water quality, and the algae blooms release a lot of toxins in the water. These toxins are harmful to humans and animals and it is a real problem for the drinking water production.

In this way, the aim of this report is to investigate the phosphorus balance of Vombsjön to be able to predict the amount of phosphorus stored in the lake, and so, to be able to plan actions to save and increase the water quality for the future. Indeed, the main goal is to secure the lake as a drinking-water reservoir. So our study is organized in three parts. First we used samplers to take water and sediment samples from the bottom of the lake to investigate the phosphorus level in the bottom sediments. The sediments samples will be analyzed by an external laboratory and will determine the percentage and the amount of the different phosphorus fractions in the sediments. Then the water column profile was analyzed thanks to a multi-parameter analyzing tool which measures pH, dissolved oxygen, redox potential, conductivity and temperature. These measurements allow us to find if there is a thermocline in the lake or not, and if there is optimal conditions for a phosphorus release. After that we will determine the total amount of phosphorus stored in the bottom sediments of the lake. To finish an estimation of the accumulation or the release of phosphorus per year by the lake will be done thanks to the study of the inflows and outflow's parameters.

 LITERATURE REVIEW

I. General presentation of Sydvatten

1. Sydvatten

The company supplies drinking water to municipalities in the South-Southwest of Sweden (Skåne region). It was founded in 1966 and today it produces water for more than 900 000 inhabitants. Every year, Sydvatten produces more than 70 million cubic meters, corresponding approximately to 2 300 liters per second. The firm draws off water from two different lakes : Vombsjön and Bolmen. In this report we will be focused on Vombsjön.

2. Vombsjön

The area of the lake is approximately about 12,8 km² (figure 1) and its maximum depth is 15 meters. The average volume of water in Vombsjön is about 76 Mm³. The water comes from 4 brooks and leaves by 1 river, and the lake's recharge area is about 444 km². Last, the residence time of water in the lake is about 7 to 8 months.

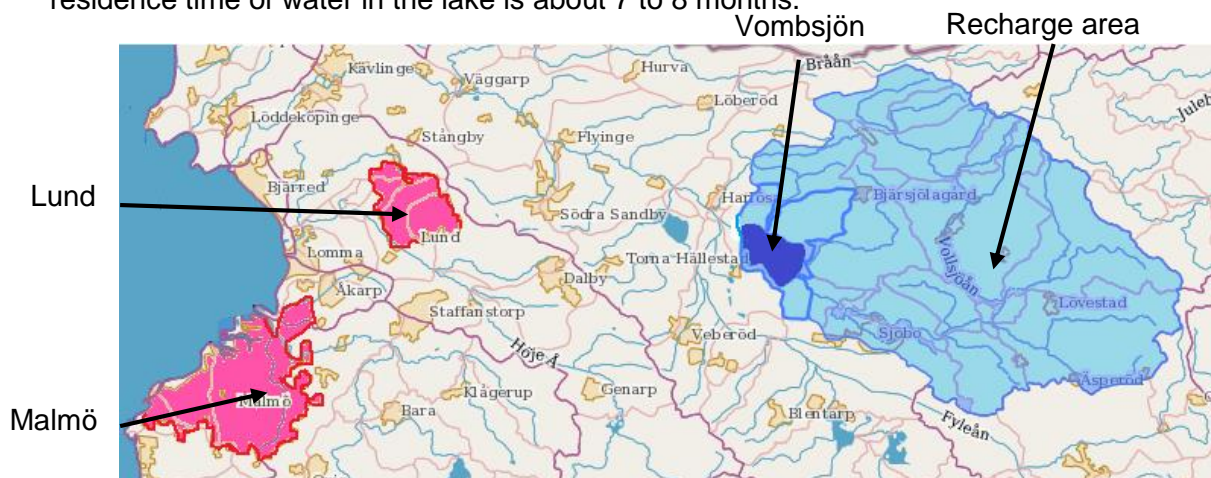


Figure 1 : Localisation of Vombsjön

3. The water production

The plant of Vombsjön (Vombverket) was built in 1940 and became operational in 1948. Today, the plant can produce 900 liters of drinking water per second. The following figure (figure 2) shows the different steps of the drinking water production process. To have more explanations concerning the steps of the water production, check Sydvatten internet website concerning "the water production".

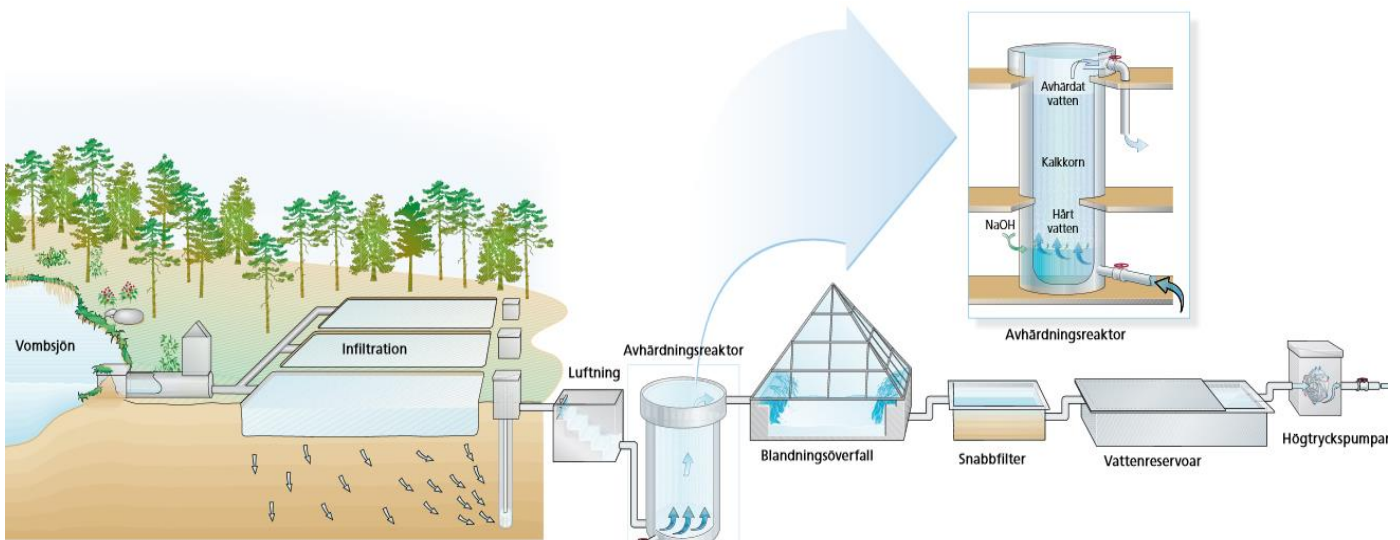


Figure 2 : Steps of the water production

II. Causes and results of the Eutrophication

More and more ponds and lakes are confronted to the phenomenon of Eutrophication. In the long term it leads to the death of the lake, that's why the lake's eutrophication is treated more and more seriously.

1. What is the Eutrophication ?

Due to an increase of phosphorus, a massive growth of primary producers starts. It leads to a reduction of the water transparency. One more this high production of organisms results in an increase of dead organisms which are accumulated as sediments in the bottom of the lake. Bacteria who mineralize this organic material consume a lot of oxygen and change the conditions of the natural environment. These modifications lead to the death of many different species of animals and plants.

The principal actors of eutrophication are the cyanobacteria. Cyanobacteria are in the same time bacteria and algae : they have no nucleus and intracellular organites (like bacteria) and they have chlorophyll A and many pigments in order to have photosynthesis activity (like algae). When there is a big explosion of the number of cells by milliliter we call this phenomenon "a bloom". In this case, the lake's water looks like a strange green stinking blend (figure 3).



Figure 3 : Bloom of Cyanobacteria in Vomb Lake

2. What are the causes ?

The appearance of a bloom requires, at first, the presence of a pre-existent population and a hyperfertilization of the environment : large amount of phosphorus. Then, a mixture of the water column (like fresh nights, stronger winds, precipitations, or storms) starts the algal growth. It is the establishment of a prolonged period of stability (heat wave, high sunlight, raise temperatures at night) which finally allows the formation of a bloom.

3. The consequences

At first, a proliferation of cyanobacteria increases the dimming of the light in the water column. This dimming of the light does not generally affect cyanobacteria thanks to their low need in energy and their specialized photosynthetic pigments. Then an increase of the solar radiations absorption, caused by the accumulation of cyanobacteria, leads to an increase of the water temperature during the day. This increase of temperature is beneficial for the cyanobacteria which have an optimum of growth in higher temperatures than other photosynthetic algae.

Furthermore, after their death, algae fall to the bottom and are mineralized by bacteria. More the bloom itself induces more algal blooms since more nutrients are released into the water due to the degradation of organic matter at the bottom. The consequence is an increase of the demand in O_2 by the phenomena of breath and mineralization. Furthermore, cyanobacteria present at the water surface play the role of a light barrier. The consumption of O_2 becomes superior to the production of O_2 . Also, oxygenated water at the surface might not reach the bottom water due to the division of the water column by temperature : the thermocline (cf: part concerning the thermocline). At medium-term it leads to the anoxia of the environment which leads to the liberation of phosphorus from the sediments. So the lake receives an additional contribution of dissolved phosphorus from sediments which only feeds the phenomenon of eutrophication.

The blooms can also cause an increase of the pH (high photosynthetic activity), the conditions give a net advantage to the cyanobacteria compared to the other-microscopic algae, due to a reduction of the availability in CO_2 . However cyanobacteria know how to bypass it (they can use the bicarbonate form). A algal bloom can also pull an increase of the nutrients released by the sediments and a decrease of the dissolved oxygen concentration in the water.

As noted above, the Eutrophication changes the water parameters a lot. It often leads to the death of native species of plants and animals in the lake. So one of the first results of the eutrophication is the exhaustion of the local biodiversity. Furthermore it is often said that eutrophication provokes literally "the death" of the lake. Indeed there will be also a silting of the stretch of water due to the accumulation of organic matter not degraded at the bottom.

Last but not least, the algae which growth in the lake will produce a lot of toxins. They are often dangerous for the health of animals like fish and even for humans. Moreover these toxins are very difficult to remove during the water treatment at the water treatment plants. Furthermore filters of the plant can be clogged faster due to the high amount of cells in the water.

III. The parameters influencing the phosphorus release

We know that the Eutrophication is the result of a blend of several physical and chemical parameters. But one of the more important parameter is the amount of phosphorus. Indeed, phosphorus is a limiting factor for the growth of algae and primary producers in fresh water systems. So in this part we are going to talk about phosphorus and the links between chemical and physical parameters and the release of phosphorus by the sediments.

1. General presentation

Contrary to the nitrogen and to the carbon, the phosphorus is little plentiful in the natural aquatic circles. At first, it is non-existent in the gas state. Then, the geology of grounds contains only approximately 0,1 % of phosphorus. Finally, it is strongly adsorbed by the major constituents of grounds (iron, aluminium, calcium, etc.). All these phenomena tend to make it too little bio-available.

However, the intensification of the anthropological activities generated an increase of the phosphorus amount in the aquatic ecosystems, which leads to an increase of the eutrophication.

2. Phosphorus' cycle

These excessive contributions of phosphorus lead to a hyperfertilization of the environment, which increases the primary production. Indeed, an algal bloom happens. After their death, the algae's bodies sink and are mineralized by bacteria at the bottom. In medium-term it leads to the anoxia of the environment and to the release of phosphorus by the sediments. Indeed, the dissolved phosphorus makes complexes with the oxidized iron and is stored in sediments. But in absence of O₂, this iron is reduced and, on one hand, cannot make any complexes with the present phosphorus, but on the other hand releases the one which was initially stored. The lake receives an additional contribution in dissolved phosphorus which only feeds the phenomenon of eutrophication (figure 4).

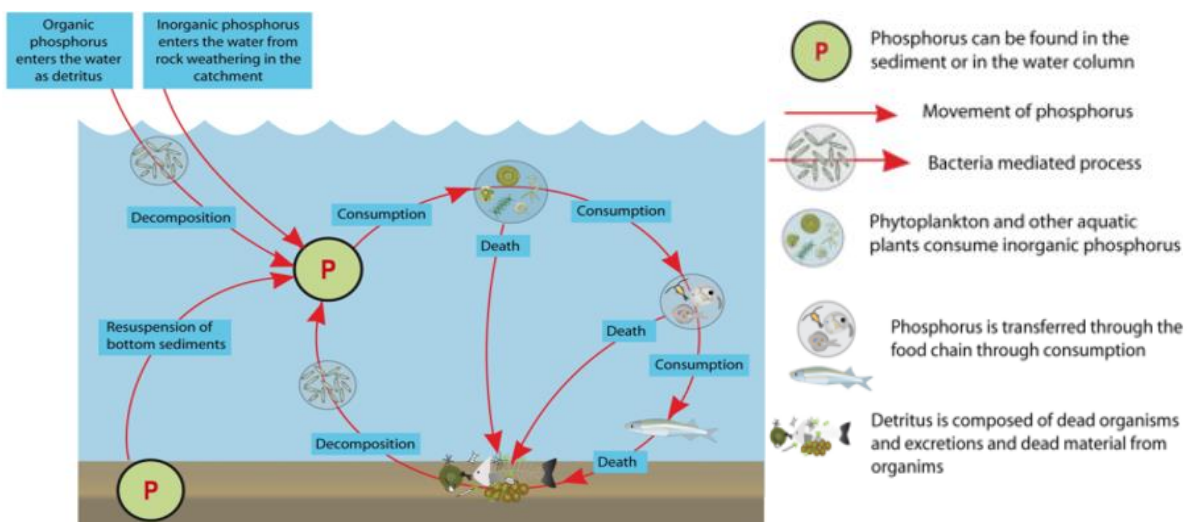


Figure 4 : Phosphorus cycle

3. Phosphorus fractions

Determination of phosphorus fractions in the sediment is very important for the ability for us to foresee possible release of phosphorus from sediments to water. Indeed, sediments act as a sink where phosphorus can be stored, and also as a source of phosphorus for the overlying water. However, the amount of phosphorus released from sediments to overlying water depends more on its content of available fractions than on its total P content in sediments.

In this study we will be focused on 6 phosphorus fractions. We are going to start by the easiest available fractions (Fe-P, Labile-P and Org-P) and then the less available phosphorus fraction will be presented (Al-P, Ca-P and Res-P).

a) Fe-bound : Fe-P

Also called BD-P, this fraction represents the amount of phosphorus which is fixed to iron. The Fe-bound represents one of the biggest reserve of available phosphorus in sediments. This fraction is characterized by seasonal fluctuations and plays an important role in the exchanges of phosphorus from sediments to water. This retention is partially controlled by the redox potential. The phosphorus seems to be essentially adsorbed in aerobic conditions and for high values of redox. However in summer, the increase of the temperature leads to the degradation of the organic matter by bacteria which engenders a reduction of the dissolved oxygen content and so of the redox potential. Consequently, there is a reduction of the Fe-P complex and so a release of phosphorus.

Last, it is important to know that the Fe-bound is the fraction which is most influenced by the oxygen content in the water.

b) Labile P

Also called NH_4Cl , this fraction equals to the loosely sorbed P in the sediments and this fraction may include dissolved P in water. This phosphorus fraction is the easiest available for algae and primary producers because it is the first one which is released.

c) Org-bound

This fraction represents the organic fraction and is also called NaOH-nrP. This fraction is often the main P fraction in the sediments. It decreases in summer due to an extensive bacterial activity at the surface of the sediments. The behaviour of this fraction presents many similarities with the iron-bound. This similarity can be explained by the creation of complexes between the organic matter, the iron and the phosphorus. Indeed, as it is previously said in the part concerning the iron, P can also form some complexes with humic-fluvic substances and give phytates and phosphanates. Phytates constitute an important part of the organic phosphorus in sediments. Moreover phytates can be mineralized into orthophosphate under

anoxic conditions and low redox potential. So the presence of a thermocline plays an important role for this fraction (cf : part concerning the thermocline). Furthermore it seems that this fraction has a very good mobility. Indeed in aerobic conditions this fraction is degraded and the organic bound P becomes Fe-P and Labile-P.

d) Al-bound : Al-P

Also called NaOH-P, this fraction represents the amount of phosphorus which is fixed to aluminium. Phosphorus makes some complexes with the aluminium ions in the water. However this fraction is not the most represented. Moreover it is not a very "labile" fraction, on the contrary, it is regarded as a permanent fraction. So it cannot be the origin of an important release of phosphorus from the sediments to the overlaying water.

e) Ca-bound : Ca-P

Also called HCl-P, this fraction matches to the amount of phosphorus which is fixed to the calcium. It represents an important way of storage of phosphorus in sediments. This fraction was considered for a long time as a relatively stable fraction of P in the sediments, but it can lead to a release of phosphorus further to a pH decrease. During spring and summer, the strong photosynthetic activity increases the values of the pH in the water column which promotes the calcite and phosphorus precipitation. But in autumn, the decrease of the pH releases the phosphorus from the sediments. The high HCl-P content is attributed to the calcareous terrain of the recharge area and to the lakes characterized by hard waters, as the lake of Vombsjön.

However the mobility of this fraction remains weak compared with the iron-bound and it is regarded as a permanent fraction.

f) Res-P

This fraction equals to the residual phosphorus. Indeed we can say that : $\text{Res-P} = (\text{total P}) - (\text{all P-fractions})$. Furthermore this fraction is the less available. Generally this fraction is mainly constituted by organic matter hardly bounded to the P and which cannot be transformed or degraded anymore.

g) Other information concerning the phosphorus fractions

Even if the literature say that most of the fractions can lead to a phosphorus release according to specific environmental conditions, we are going to fix, for this report, that it is the Fe-bound, the labile-bound and the Org-bound which are the most available phosphorus fractions. Indeed they are the easiest dissolvable fractions. Then it is also admitted that these "available-fractions" usually decrease with the depth contrary to the others fractions which increase. It is due to the phosphorus released from the "available-fractions" which promotes an additional amount of P in the water and which can be catch and fixed by the other fractions.

These fractions (Ca-P, Al-P and Rest-P) will keep the P in the sediments, that is why, according to the depth, the percentage of “available fractions” decreases while the others fractions increase.

4. Thermocline

In anoxic conditions, phosphorus becomes more soluble (dissolvable) and is released from the bottom sediments into the water column mainly by the iron-bound. During the summer, a stratification might appear in the water of the lake and is driven by density differences within the water body. Indeed, temperature has a significant effect on water density : warmer water is less dense and therefore will float on the top of cold water. So we call “thermocline” the horizontal plane corresponding to the zone where water temperature decreases quickly. If there is a thermocline, the lake will be split in different layers : the epilimnion which is the upper layer, warmer and well mixed ; and the hypolimnion which is the colder, heavier and relatively undisturbed layer.

As we saw, during the summer and a bloom, the bacterial activity consumes all the oxygen at the bottom of the lake. However, if a thermocline is set, there will be no exchange between the different layers of the lake. Indeed, the hypolimnion will stay without dissolved oxygen as long as the thermocline is present. Moreover these conditions allow a massive release of phosphorus from the sediments due to the prolonged period of anoxia, as we can see on the following figure : (figure5).

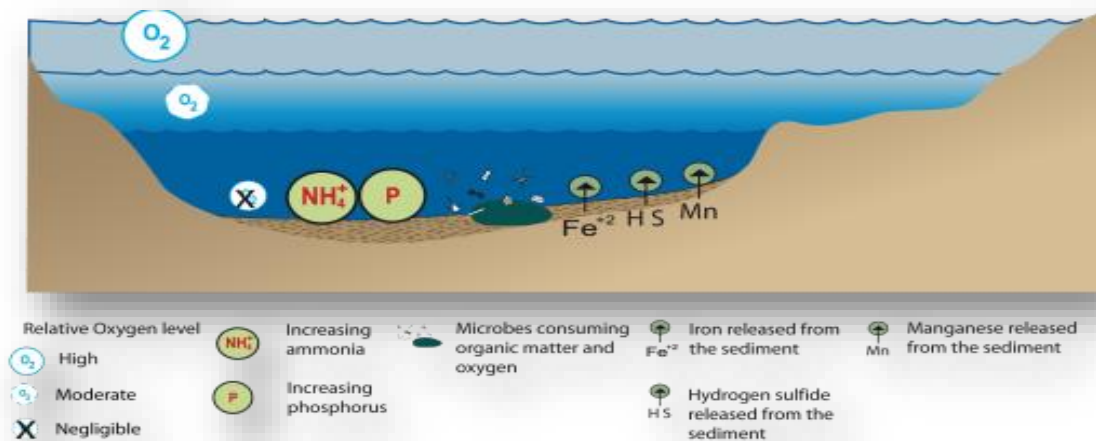


Figure 5 : Effects of the thermocline

MATERIAL AND METHODS

First the location of the different sampling sites was established. To do that, the lake's geography has to be known. So we used a map representing the bottom of the lake and a depth scale. Then we studied the depth, the inflows and the outflow to determine where the most representative samples can be taken. 6 sites were selected. Thanks to the website : www.eniro.se we were able to know the GPS coordinates of each one. Last we just had to enter these coordinates in our GPS to be able to find the place of each samples when we went out on the lake. The following figure (figure 6) represents the map of the lake with the 6 different locations and the GPS coordinates :

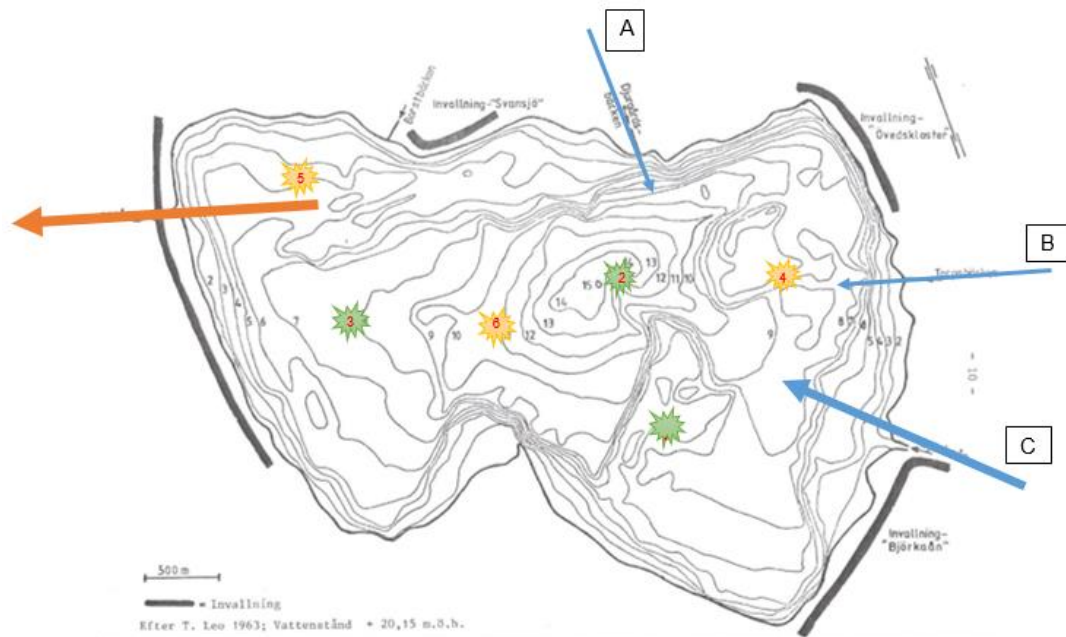


Figure 6 : Map of the lake

1 : 55°40.486 N 13°35.556 E	(7m)		water and sediment sample + profile
2 : 55°41.154 N 13°24.446 E	(14m)		water and sediment sample + profile
3 : 55°41.131 N 13°36.672 E	(6m)		water and sediment sample + profile
4 : 55°41.340 N 13°34.128 E	(7m)		water column profile
5 : 55°41.853 N 13°34.114 E	(4m)		water column profile
6 : 55°41.047 N 13°34.736 E	(10m)		water column profile

Main inflows

Outflow

I. Samples

In this part, the material that we used to take the water and sediment samples will be described.

1. Sediment sampler

To do the measures of the phosphorus which is stored in the sediments, we need to take samples of the bottom of the lake. To do that we used a sampler which is able to fall through the water and by its weight penetrate into the sediments to take a reel representative sediment core. So we used a homemade fabrication sampler (appendix 1).

The main difficulty with this sampler was to split the sample in 4 parts (sections) : 0-5 cm, 5-10 cm, 10-20 cm and 20-30 cm down from the surface. Indeed, we have to analyse separately each section of the sample to determine the amount of each phosphorus fraction in the sediments according to the depth of the sediment.

2. Water sampler

In order to determine the phosphorus released in the overlying water, we used a specific sampler (Ruttnerhämtare) which allows us to take a single sample of the deep water. So this time we used a generic sampler which can be bought in a specialized store (appendix 1).

Thanks to a weight that we let slide down the sampler's rope, we can close the sampler at the desired depth. The main difficulty was to take the water near to the bottom and not the sediments. Indeed, if there is some sediment particles in the sampler bottle, the analyses could be false.

3. Water column profile.

In order to better understand the conditions of phosphorus release and to anticipate them, an analyse campaign was done. Indeed we went to the lake as often as we could to measure some physicals and chemicals parameters in the water column.

To highlight any modifications according to the depth we did our measures each meters. 5 parameters were analysed : temperature, conductivity, redox potential, dissolved oxygen and pH. To do that we used a multi-parameter analyzing tool which allowed us to do all of these analyses in the same time (appendix 1).

Furthermore, this device can be connected to a computer to see all of the results on the computer screen and to save them on the PC software. So it is a very functional equipment which needs reduced maintenance requirements.

II. Phosphorus analyses.

1. Water analyses

Concerning the water analyses, we were able to do them in the lab of the plant. We used the Test kit LCK 349. Phosphate ions react with molybdate and antimony ions in an acidic solution to form an antimonylphosphomolybdate complex, which is reduced by ascorbic acid to phosphomolybdenum blue. With hydrolysis, Total phosphorus is measured and without it, only orthophosphates are measured. The range is: 0,05-1,50 mg/L PO₄ P. If the results stay under the range, we take a sample of 3 ml instead of the regular 1.5 ml. The entire protocol can be found in appendix 2.

However we will not study these data in this report. Indeed we did these analyses in the same time that we went on the lake, but the finality of these data is to be taken into account in a next study by Sydsvatten. But these measures allow us to become familiar with the use of a test kit (appendix 1).

2. Sediments analyses

To estimate the potential release of phosphorus we have to know the proportion of each phosphorus fractions which can be stored in the sediments. Indeed, several kinds of phosphorus forms can be present depending on the particles available in the bottom of the lake and the surrounding water conditions. In fact, each kind of complex is called "fraction". Unfortunately our lab is not enough equipped to do these analyses, so we sent the samples to another lab in the North of Stockholm (Erkenlaboratoriet). Then the results came back to us by email as an excel file.

3. Determination of the amount of phosphorus stored in the lake each year : the phosphorus balance

To carry out this study we need a lot of data concerning the inflows and the outflow of the lake, the average amount of phosphorus in the lake and in the rivers... To get this information we used a Swedish website which takes in inventory several physical and chemical parameters of lakes, ponds and rivers in all of Sweden : <http://vattenwebb.smhi.se/>. We take the flow data for each inflows and the outflow of Vombsjön from this website.

Moreover, concerning the phosphorus content in the water we used studies : kävlingeån – Recipientkontroll made by ALcontrol laboratory to find the concentration on total phosphorus in the water. However we don't have the data concerning all of the inflows. One of the three biggest inflows is missing. So to estimate the amount of phosphorus which enter the lake from this river we will proceed methodically, see below.

First the percentage of agricultural land for each inflow's recharge area was checked. We found that each one is about 70-73 %. Then, as only two of the three inflows have approximately the same flows, we estimated a factor between these two flows. To make it easier we are going to call "A" the inflow without phosphorus data and "B" the second one with all the data ("C" will concern the last inflow, the biggest one, but we also have all the data for this one). We can find the position of each inflow on figure 6. After that, we only need to calculate the total amount of phosphorus from "B" to find an estimation of the amount of phosphorus which comes from A. Indeed if we have the amount from B we only have to multiply this amount by the flow's factor to get the amount of phosphorus coming from A.

RESULTS AND DISCUSSION

One of the most important factors affecting the P concentration of lake ecosystems is the P release from the sediments into the overlying water. In this part we are going to see the distribution of phosphorus fractions in the sediments, the evolution of the main physical parameters of the water column, and finally, the total amount of phosphorus in the lake and the amount stored each year in the sediments.

I. Distribution of phosphorus fractions in the sediments

Determination of the phosphorus fractions in the sediments is very important for the release of phosphorus from sediment to water. To know the phosphorus composition of the sediments we sent some sediment samples to a laboratory. The amount of different P fractions is shown in [appendix 3](#).

1. Sample 1

The P-fractions for the first site of sediment sampling is represented in the following figure (figure 7) :

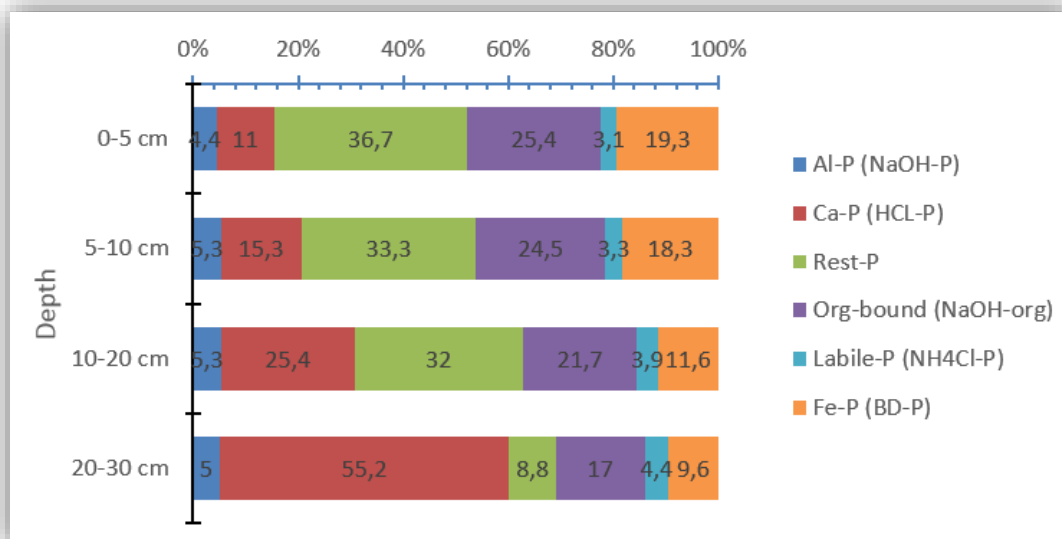


Figure 7 : Distribution of phosphorus fractions contents in sediments : sample 1

We can see that the repartition in the 2 firsts depths are approximately the same. It is the residual phosphorus which is the most represented (>30%). Then we find the organic fraction ($\approx 25\%$) and the iron-bound. But for the 2 lasts depths things changed. Indeed Ca-P

fraction increases (10-15% to 55%) while the residual phosphorus percentage decreases (8.8%).

Moreover we know that the Ca-P should increase according to the depth. Indeed, the P fixed to the “labile-bounds” like Fe-P, Org-P and Labile-P is easier released than the P fixed to the others fractions. So phosphorus which is released can be caught and fixed by the others fractions “less mobilisable”. So with time, Fe-P, Labile-P and Org-P must decrease while the other fractions increase and are stored deeper down into the sediments. In this case we can see that Fe-P and Org-P decreases according to the depth. It is normal because the Org-bound is usually transformed in Labile-P and Fe-P in the shallower part of the sediments (with the presence of oxygen). But as we know, the deeper into the bottom the older the sediment are. That is why we find a smaller percentage of Fe-P and Org-P in the deeper sediments : the Org-P has had time to be transformed in Fe-P. Then Fe-P might have been reduced due to anoxic conditions.

To verify this hypothesis we draw the graphs which can be found in appendix 4. We can see on these graphs that the site 2 and the site 3 have the same characteristics : Fe-P and Org-P decrease with the depth but Labile-P stay the same or increases (this phenomenon is not explicable in this case, maybe it is due to local conditions or maybe there was an event in the lake long time ago). However, if we have a look on the first graph we can see that all of the three fractions decrease with sediment-depth according to what it was said previously. Hence, the labile fractions should be the main fraction close to the surface of the sediment, while the more permanently fractions should be deeper down into the sediment.

2. Sample 2 and 3

For these samples, the results show the same repartition between each fraction (figure 8).

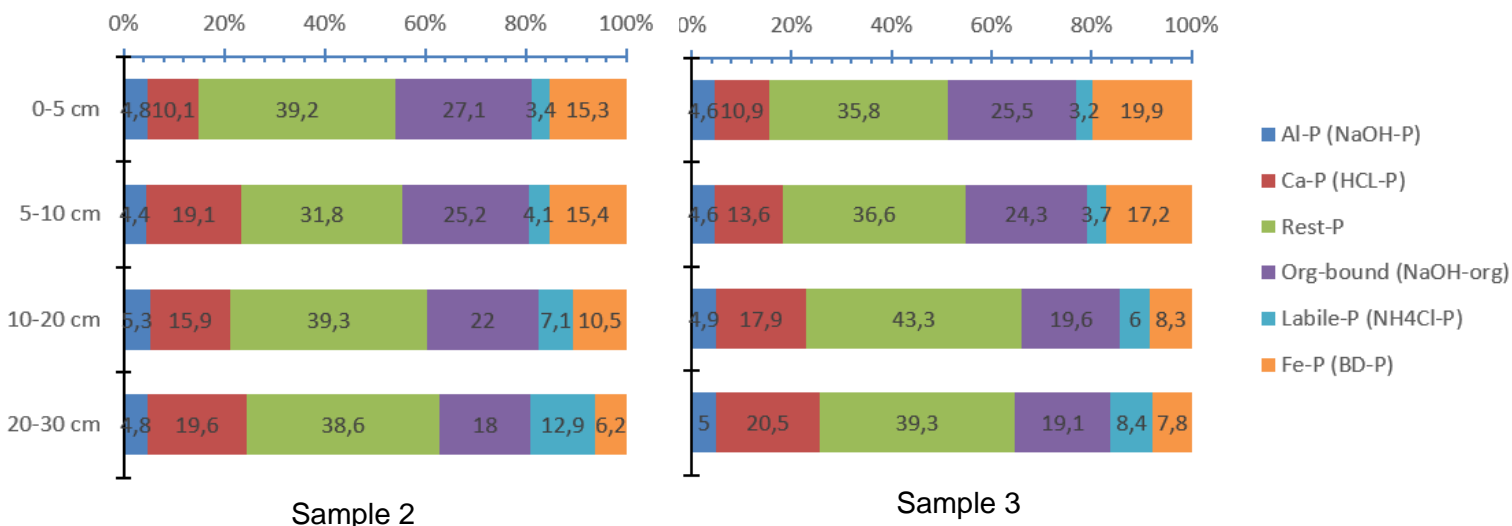


Figure 8 : Distribution of phosphorus fractions in sediments : sample 2 and 3

But the results are not so different compare to the first sample. So we can consider an average percentage for each fraction, according to the depths. We get : Al-P ≈ 5 % ; Labile-P ≈ 3-12 % ; Fe-P ≈ 7-20 % ; Ca-P ≈ 10-20 % ; Org-bound ≈ 20-30 % and Rest-P ≈ 40 %.

We can also note that the org-bound and the Fe-bound decrease one more time with the depth.

3. Optimal releasing conditions according to the phosphorus fractions distribution

We established that the most represented fractions are Rest-P, Org-bound, Ca-P and Fe-P. However the “available fractions” are the Fe-P, Labile-P and the Org-bound.

- ✓ Org bound : According to the bibliography, this form is the most represented in the sediments. In oxygen condition this form can be transformed into Fe-bound or in Labile-bound. Indeed this fraction is not directly available for primary producers.
- ✓ Labile-P : This is the easiest available source of phosphorus for algae and primary producers because this fraction is always the first to be released. One more this stock can change, depending on the oxygen conditions. Indeed with oxygen, Org-P is transformed into Labile-P and Fe-P. So this fraction seems to be the smaller one, but it is almost always available according to the oxygen's conditions in the bottom of the lake.
- ✓ Fe-P : The Fe-bound is the most available phosphorus fraction. Indeed, despite its low proportion compared to Ca or org-bound, this fraction is the one which allows the most important release of phosphorus from sediments to water in oxygen depleted conditions. This release is caused by the decrease of the redox potential. As it is noticed in the literature review, a low redox potential leads to a reduction of the Fe-P complex and so to a phosphorus release.

To sum up, the mains conditions for a phosphorus release seem to be the temperature and a decrease of the dissolved oxygen content in the bottom of the lake. Indeed if there is a decrease of dissolved oxygen, there is anoxic condition which leads mainly to a release of phosphorus from Fe-P. Furthermore if there is a thermocline in the lake, it will be no exchange between the different water layers of the lake, and the bottom will continue to be in anoxic conditions since no oxygen is supplied from the surface water. One more a lack of dissolved oxygen leads to a decrease of the redox potential (important for the org-bound and Al+Fe-P).

4. Other parameters concerning the sediments

In addition to the phosphorus fraction analyses, we got other data about the sediments. They are in the appendix 5. It concerns the amount of total phosphorus (TP) in the sediments. We can see that the concentration of TP ($\mu\text{g} / \text{g DW}$) decreases quickly with sediment depth. Indeed, concerning the sample 1 we start with 1600 $\mu\text{g TP/g}$ for 0-5 cm depth to finish with 600 $\mu\text{g TP/g}$ for 20-30 cm depth. We can see the same phenomenon with sample 2-3 (respectively 1700 and 1600 $\mu\text{g TP/g}$ for 0-5 cm depth ; 940 and 980 $\mu\text{g TP/g}$ for 20-30 cm depth).

Then we can also see that the water content decreases with the depth. For the samples 2 and 3 10 % of water content is lost, and more than 20 % concerning sample 1. It can be easily explained by the fact that : deeper down into the sediment less water is able to go through the sediments because of the soil compaction. One more these results may be interesting for the phosphorus release. Indeed, if there is less water in the sediments, the physical-chemicals conditions are more stable and it will be more difficult for the phosphorus to be released (less oxygen in the deeper sediments).

II. Evolution of the different water column's parameters

As we saw previously, the main parameter which leads to a phosphorus release by the sediments is the dissolved oxygen content. If a thermocline is present in the lake, the potential of phosphorus release increases because the thermocline prevents oxygen from surface water to enter the bottom water.

So the results achieved through the use of the multi-parameter analysing tool were analyzed. All the data (pH, conductivity, redox potential, temperature, dissolved oxygen content) can be found in [appendix 6](#).

1. Presence of a thermocline

A thermocline is defined by the presence of different water layers in a lake. The main characteristic of this phenomenon is a pronounced decrease of the water temperature at a certain depth. However we usually find a thermocline in lakes during the summer, when the atmosphere temperature are the warmest. Indeed, the sun and the air warm the shallower layers of the lake but not the deeper water. The followings graphs will show this phenomenon for Vomb lake for two different dates. These dates were chosen because they are the most representative of the physical phenomenon : no exchange between the different layers so a decrease of the dissolved oxygen content.

Oxygen and temperature's progression according to the depth :
site 2 - june 30

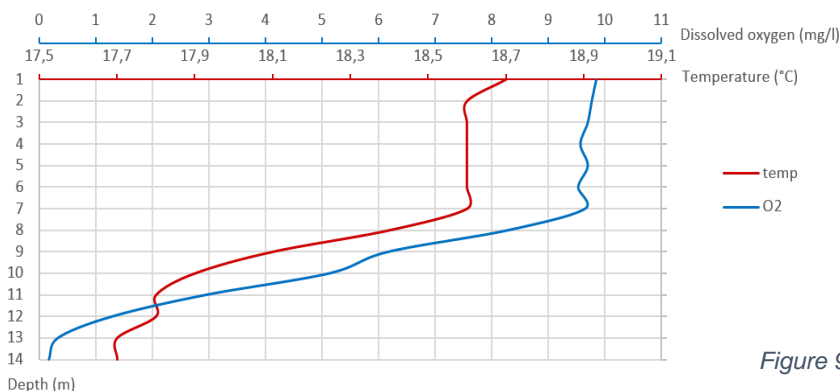


Figure 9 : The thermocline – site 2 June 30

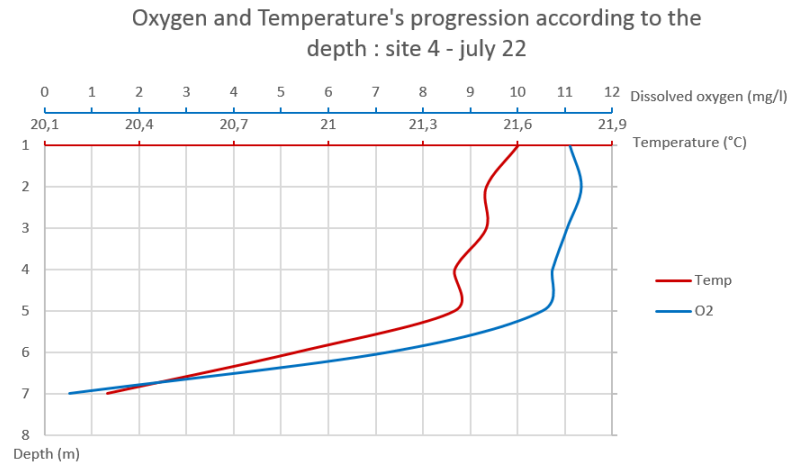


Figure 10 : The thermocline - site 4 July 22

On these graphs we see that when the temperature falls, the dissolved oxygen decreases too. This is the result of the segregation between the layers. Indeed, the decrease of the temperature is the proof of the presence of different layers.

For these examples, even if it is not the same dates, the weather conditions were the same : warm, without a lot of wind and no cloud. So we can deduce that these environmental conditions lead to a thermocline. So there is a depletion of oxygen in the bottom of the lake leading to a phosphorus release. But in the same time, these physical conditions are the best for the cyanobacteria growth. Furthermore, with the additional amount of phosphorus released in the water, we could think that we will assist to a bloom. However the thermocline prevents mixing of the 2 water layers : nothing go up and nothing go down. So there is no oxygen down and no P reach the surface where the cyanobacteria are. The P that is released from the sediments is trapped in the bottom water until autumn when the thermocline disappears due to storms and decrease in air temperature. The P that is released during summer actually feed next year bloom !

Last, we can see on these graphs that there is a switch between the layers at different depth according to the sampling site and the total depth of the site. When the bottom of the lake is at 14m we can see that the thermocline is about 7m, but when the bottom is at 7m the thermocline is found at 5m. So this shows that the horizontal plan which represents the thermocline is not flat. It depends on the geography of the bottom of the lake, and probably on the water currents and the moves of the water bodies.

2. Thermocline : an ever changing phenomenon

As we said in the last part, the thermocline changes depending on many parameters as the depth, and the movements of the water body and needs specific weather conditions. Usually, in big lakes, a thermocline is a constant phenomenon. Indeed, the water body has such an inertia that the water temperature changes extremely slowly. So even if the weather conditions are not conducive, there will be no change in the deeper layers of the lake. We are going to stay in the same anoxic conditions.

But in our case, the depth of the lake is not big/deep enough to guarantee same temperature during a storm or a raining day. Indeed, as we can see on the following graph (figure 11), the thermocline can disappear during a few days ! Another example is available in [appendix 7](#).

Oxygen and temperature's progression according to the depth:
site 2 - July 17

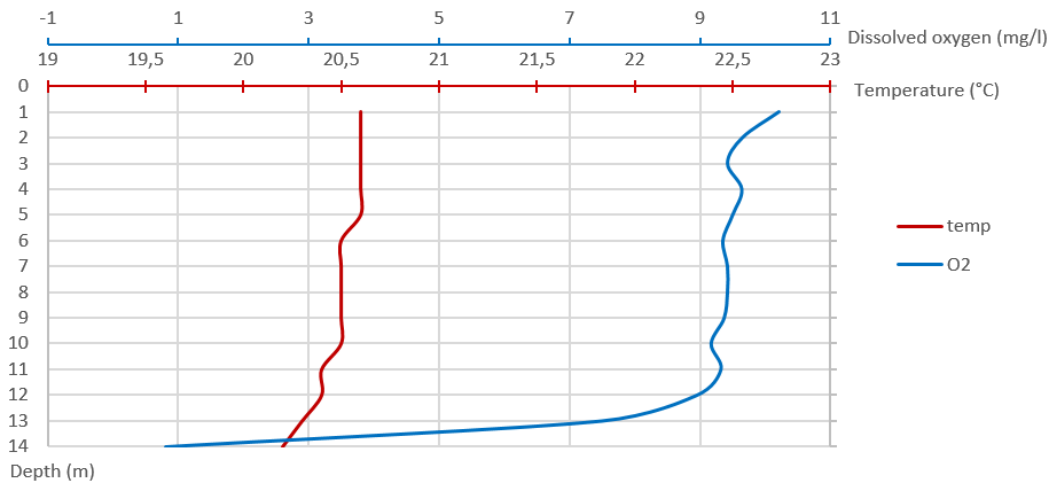


Figure 11 : Example of a no thermocline

Indeed, we can see on the figure 11 that the temperature decreases of only 0.4 °C and the dissolved oxygen content only begins to fall near of the bottom (12m). So in this case we can say that there is no thermocline in the lake.

This phenomenon can be easily explained. We said that the thermocline is very sensitive to the weather. But just before we have done the measures for the July 17th, the weather was extremely bad : a lot of rain, wind and so a lot of big waves on the lake. As the lake is not very deep, the water body must have been mixed so all the water layers must have been homogenized.

Moreover, there is always a bacterial activity which leads to an oxygen consumption at the bottom of the lake. So the decrease of the oxygen content seems to be logical. Indeed it is normal for an eutrophicated lake as Vombsjön where (due to a high primary production in the surface water) there is a lot of dead organic material accumulating at the bottom that is using up all the oxygen during its degradation. However if there is a thermocline in the lake (there will not be a re-oxygenation of the bottom water) because there will be no dissolved oxygen exchange between the different layers of the lake, so there will be no dissolved oxygen coming from the surface. The result will be that the depth limit where the dissolved oxygen decreases will become shallower and shallower.

To sum up this part, it is important to know that a thermocline can be present in the Vombsjön Lake, but, it can disappear when weather conditions change. Then it will take several days of sun and quiet water to re-form the thermocline.

III. Determination of the amount of phosphorus stored in the lake's sediments

In this part we are going to study the amount of total phosphorus stored in the bottom sediments of the lake, and the amount of “available phosphorus” in the sediments.

1. Total amount of phosphorus in the “wet sediments”

To estimate this amount we used the results given by the laboratory. The way that we used them to obtain the final amount of phosphorus is explained in the [appendix 8](#). We can see that we decided to split them into two different parts. Indeed we decided to do an average of the values concerning site 1 and 3 because they both represent the same depth : 7 m. Then we used separately the results of site 2. In fact we took site 2 to estimate the amount of phosphorus in the deeper part of the lake : 10 -14 m of depth, because the morphology of the bottom of the lake is not the same for the deeper area : there are some “cliffs” surrounding this area. So we think that the sediments might fall from the shallower parts to the deeper parts and accumulate here due to the slope so we have decided to take the results of the site 2 to make the phosphorus estimations in this specific part of the lake (deeper part). Moreover, we took “site 1 and 3” average to estimate the amount of phosphorus in shallower parts : 4 - 10 m. We begin the study at 4m because there is no accumulation of sediments shallower than this depth.

Finally, according to the results, we can see that **more than 590 tons of phosphorus is stored in the lake at present**. It can seem to be a lot but the lake is mostly dominated by a recharge area which have more than 70 % of agricultural lands. So the inflows of phosphorus must be very high, and as we saw previously, the sediments are able to store the phosphorus.

Table 1 : Amount of phosphorus in the sediments according to the depth

	Site 1				Site 2				Site 3			
	0-5 cm	5-10 cm	10-20 cm	20-30 cm	0-5 cm	5-10 cm	10-20 cm	20-30 cm	0-5 cm	5-10 cm	10-20 cm	20-30 cm
Amount of total P (mg P /m²)	9176	11361	22922	23224	7878	8598	21142	20174	8112	10033	19954	20537

Indeed, as we can see in this table, the amount of phosphorus (in the wet sediments) increases with the depth until a certain maximal limit ($\approx 20\ 000$ mg P/m²). So as the life continues to grow and to die in the lake for many centuries, the sediments continue to be produced by accumulation of organic material. So the sediment layer increases each year and the phosphorus that is not released into the water is stored leading to this big amount of phosphorus in the sediments. Indeed the deeper sediments are more compact than the shallower sediments and have lower water content.

2. The amount of bio-available phosphorus stored in the sediments

In the last part we estimated that **more than 590 tons of phosphorus is stored in the lake**. But as we saw previously, not all this P is bio-available for the algae. Indeed, we find that only three fractions of P are easily and mainly released from sediments to overlaying water. These three fractions are : Fe-bound, Org-Bound and labile-bound and are called in this report “available fraction”.

So to estimate the amount of phosphorus which can be released by the sediments we used one more time the results gotten from the laboratory. The details of the calculation are in the appendix 9. We split the result into two different areas like it was done with the total amount of phosphorus.

There is more than 226 tons of the “available fraction” of phosphorus in the first 30 cm sediments. So it means that 38.4 % (590 / 226) of the total amount of phosphorus in the lake is able to be available for the algae’s growth if the physical-chemical conditions are optimal. Indeed, as we saw previously, there is always a lack of oxygen in the bottom of the lake. **So the sediments stay in anoxic conditions which means a possibility of a P release by the iron-bound.** Moreover this big amount is not good news because even if there is no more additional phosphorus which come into the lake, the present stock is so big that the eutrophication of the lake can continue during several years to come.

IV. Determination of the phosphorus balance in the lake

This part concerns the estimation of the amount of phosphorus which comes from the inflows, and the estimation of the amount of P which is released by the sediment and leaves the lake by the outflow.

1. Estimation of the amount of phosphorus which comes from the tributary of the lake

As it is showed in the figure 6 (map), there are 3 rivers representing the inflows. As it is explained in the last part of the “material and methods”, we need to determine a factor between the flow of “A” and the flow of “B” (cf figure 6) to determine the amount of phosphorus coming from the river A. To do that the flows of 2012 and 2013 have been used.

When the flow factor is determined, we estimate the total amount of phosphorus which comes from the river B (in kg/year). Then, as the agricultural percentages are the same between the recharge areas of these two rivers, we just have to multiply the flow factor with the total amount of phosphorus coming from B.

To finish, we added the result obtained for each river to get the total amount of phosphorus which comes in the lake every years. All the calculations can be found in the appendix 10. Finally the estimation shows that **there is more than 6380 kg of P which come every year from the rivers A, B and C.**

2. Determination of the amount of phosphorus which leaves the lake and the phosphorus balance

In the same way that it has been done in the last paragraph, we did an estimation of the amount of P leaving the lake. All the values can be found in the appendix 11. This time we find that **7710 kg of P leave the lake every year**.

Concerning the phosphorus balance, we just have to do the difference between the inflows and the outflows. So it appears that **more than 1330 kg of P is leaving the lake every years**.

3. Discussion of the P balance results

In the last parts, **the study shows that there is more than 1,3 ton of P which leaves the lake each year**. Since there is oxygen depletion in the bottom water, P can be released from the bottom sediment and, if not used by primary producers, will leave the lake through the outlet. Another explanation is that the P which enters through the inlets never get stored, instead, if not used for primary production, goes directly out through the outlet. Last, it happens that lakes release P and lose a part of the stored P. It is particularly true when some arrangements are made to decrease the amount of P which comes from the recharge area. So a new policy in the use of fertilizer by farmers, in the consumption pattern of households (phosphate free household and cleaning products) or a better sewer system, can decrease the content of P stored in the lake. So thanks to these results it seems, on one hand, that the Vomb lake is on the way to get better regarding its trophic condition because it loses P each year, but on the other hand, there is a big storage of P in the bottom sediment that can be released if there is oxygen depletion. So this P in the sediments is and will be released for many years to come increasing the already ongoing eutrophication in the lake. To sum this up, even if the results of the study are encouraging, the P loss represents only a drop in the bucket compare to the amount of P which is stored and can be released by the sediments

However it is important to know that the results calculated in the appendix 10 & 11 are based on "one day" phosphorus values. Indeed it means that the P concentrations are measured during one day per month or every second month. So, the phosphorus concentrations and the P-balance calculations must be interpret with care. It might not represent all the events which can happen in the recharge area during these periods. Indeed it is possible that during one day the P amount which comes from the rivers is very low compared to the values of another day in the same month. Unfortunately there is no comprehensive study made on the inflows and the outflow of Vombsjön to be used. So we have got this conclusion: a release of P from the lake ; but it should be verified with another study concerning the lake.

CONCLUSION

Vombsjön is a lake in the South of Sweden which is used for the drinking water production. However an eutrophication phenomenon is set in the lake for many years. This phenomenon leads to the development of algal blooms in the lake which produce and release toxins into the water. Therefore, besides being a problem for the fauna, the flora and the ecosystem of this natural site, these toxins are a real issue for the drinking water production. Moreover, the algae can grow and form some blooms if there is too much nutrients in the lake and especially if there is too much bio-available phosphorus.

So this study is actually done in order to have an estimation of the total amount of phosphorus stored in the sediments. Indeed, there is a bigger stock of phosphorus in the sediments (in 6 different forms which are called fractions) than in the water. Some sediment samples have been taken from the bottom of the lake in order to know the amount and the percentage of each phosphorus fraction according to the depth of the sediments. The results show that there is **more than 590 tons of phosphorus stored in the sediments. One more, 38 % (226 tons) of this amount concern only three P-fractions, which are really labile,** and so which can release P in the overlaying water.

Then a measurement campaign has been done concerning six different sites on the lake. The aim of these analyses was to measure 5 parameters (conductivity, dissolved oxygen content, pH, redox potential and temperature) at every meter of depth in the water column for each site. With these data, we were able to know if the physical-chemical parameters form optimal conditions for a P release by the three labile fractions. Indeed, if there is a thermocline in the lake, the chances for anoxic condition in the bottom of the lake significantly increase (the O₂ content is the main condition for a P release). It has been well established that **a thermocline can be present during few day or during more than a week in the lake,** but it stays as ever-changing phenomenon lead by the weather (waves, wind, storm).

Last a study was done concerning the phosphorus balance in the lake. To do that the amount of P going into the lake was estimated for each inflows, as well as the amount of phosphorus leaving the lake by the outflow. At the end of this study, the results show that there is a loss of phosphorus from the lake. Indeed we estimate that **more than 1.3 ton of P leaves the lake every year.** Unfortunately, even if it is good news for the future of the lake as a drinking water tank, this estimation must be interpret with care. Moreover all the P leaving the lake will go to another place in Sweden (river or lake) or into the sea. So this loss of P by the Vomb lake might feed the eutrophication of another site. Last, even if the lake seems to lose P, the amount which is already stored in the sediment and which can be released from the labile fractions is so huge that it will lead to the eutrophication of the lake for a long time to come.

In order to continue this project, it will be very interesting to resume the water profile analyses. Indeed, we know that the thermocline is set in the lake during more or less short periods during the summer, but we do not know what will happens during the months of September and October (the temperature are still enough warm but it could be more storms). Moreover it is necessary to check the results of the phosphorus balance as soon as a new study concerning the P in Vomb lake will be done.

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APPENDIX

Appendix 1 : equipment/material used

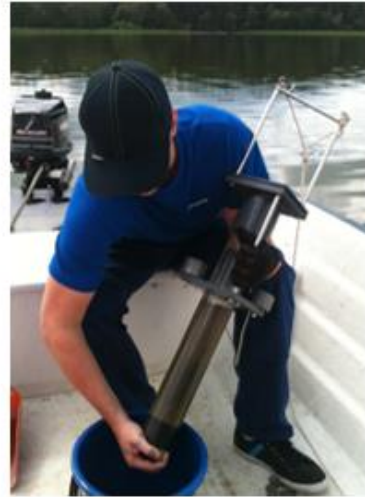
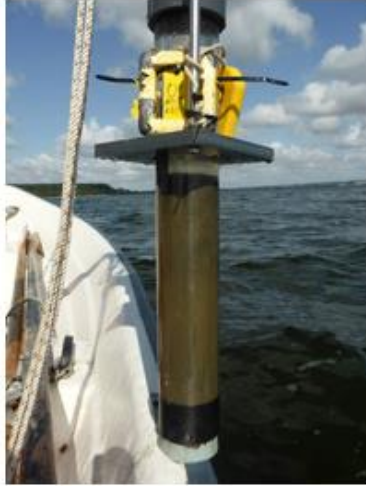


Figure 12 : Sediment sampler



Figure 13 : Water sampler



Figure 14 : Multiparameter



Figure 15 : Kit LCK 349 + spectrophotometer

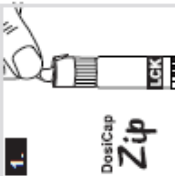
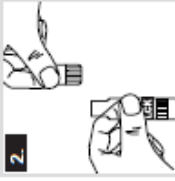

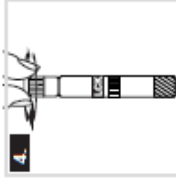

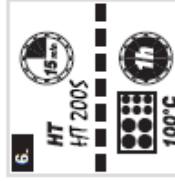


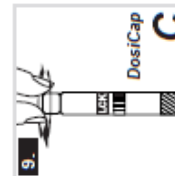

Appendix 2 : Phosphorus analyse

LCK 349 – PO₄-P / PO₄-P_o

06/2013

1.-10.
Gesamt-Phosphor
Phosphore total
Fosforo totali
Total Phosphorus

3., 8. – 10.
Ortho-Phosphat
Orthophosphate
Ortofosfati
Orthofosphate

DE

1. Siegelolie von dem aufgeschraubten DosiCap Zip vorsichtig abziehen.
2. DosiCap Zip abschrauben.
3. 2,0 mL Probe pipettieren.
4. DosiCap Zip fest aufschrauben; Riffelung oben.
5. Kräftig schütteln.
6. Im Thermostaten erhitzen.
7. Thermostat: 60 min bei 100°C
8. In erhaltete Küvette pipettieren; 0,2 mL Reagenz B (LCK 349 B).
9. Reagenz B nach Gebrauch sofort verschließen.
10. Graues DosiCap C (LCK 349 C) auf die Küvette schrauben.

FR

1. Enlevez délicatement la feuille de protection du DosiCap Zip détachable.
2. Dévissez le DosiCap Zip.
3. Pipetter 2,0 mL d'échantillon.
4. Vissez le DosiCap Zip fermement; dirigez le cannelage vers le haut.
5. Secouer énergiquement.
6. Chauffer dans le thermostat.
7. Thermostat: 60 min à 100°C
8. Laisser refroidir à température ambiante. Secouer énergiquement.
9. Pipetter dans la cuve une fois refroidie: 0,2 mL de réactif B (LCK 349 B).
10. Fermer immédiatement le réactif B après emploi.

EN

1. Carefully remove the foil from the screwed-on DosiCap Zip.
2. Unscrew the DosiCap Zip.
3. Pipette 2.0 mL sample.
4. Screw the DosiCap Zip back tightly; fluting at the top.
5. Shake firmly.
6. Heat in the thermostat.
7. Thermostat: 60 min at 100°C
8. Allow to cool to room temperature. Shake firmly.
9. Pipette into the cooled cuvette: 0.2 mL Reagent B (LCK 349 B).
10. Close Reagent B immediately after use. Screw a grey DosiCap C (LCK 349 C) onto the cuvette.

IT

1. Rimuovere con attenzione il foglio di alluminio.
2. Svitare il DosiCap Zip.
3. Pipettare 2,0 mL di campione.
4. Avvitare saldamente il DosiCap Zip; scanalatura esterna verso l'alto.
5. Agitare energicamente.
6. Riscaldare nel termostato.
7. Fare raffreddare a temperatura ambiente.
8. Pipettare nella cuvetta raffreddata: 0,2 mL di reattivo B (LCK 349 B).
9. Dopo aver prelevato il reattivo B, richiudere immediatamente.
10. Avvitare un DosiCap C (capsula grigia) (LCK 349 C).

NL

1. Afdekfolie voorzichtig verwijderen.
2. DosiCap Zip afschroeven.
3. 2,0 mL monster pipetteren.
4. DosiCap Zip stevig vast opschroeven; geribbelde zijde naar boven.
5. Krachtig schudden.
6. In het thermostaat verhitten.
7. Thermostaat: 60 min bij 100°C
8. Laten afkoelen tot kamertemperatuur. Krachtig schudden.
9. In afgekoelde kuwet pipetteren: 0,2 mL reagens B (LCK 349 B). De reagens B-fles na gebruik onmiddellijk dicht draaien.
10. Een grijze DosiCap C (LCK 349 C) op het kuwet schroeven.

Figure 16 : Phosphorus analyse

Appendix 3 : amount of different P fractions

Table 2 : Amount of the phosphorus fractions

	Labile-P (NH ₄ Cl-P) µg/g DW	Al-P (NaOH-P) µg/g DW	Ca-P (HCl-P) µg/g DW	Rest-P µg/g DW	Org-bound (NaOH-org) µg/g DW	Fe-P (BD-P) µg/g DW
Sample 1	0-5 cm	49	69	170	580	300
	5-10 cm	48	77	220	480	270
	10-20 cm	44	60	290	360	130
	20-30 cm	27	30	330	53	57
Sample 2	0-5 cm	57	81	170	660	260
	5-10 cm	59	62	270	450	220
	10-20 cm	80	62	190	460	120
	20-30 cm	120	45	180	360	58
Sample 3	0-5 cm	52	75	180	580	320
	5-10 cm	50	62	180	500	230
	10-20 cm	65	54	200	470	91
	20-30 cm	82	49	200	380	76

Appendix 4 : Progression of the amount of the "available fractions"

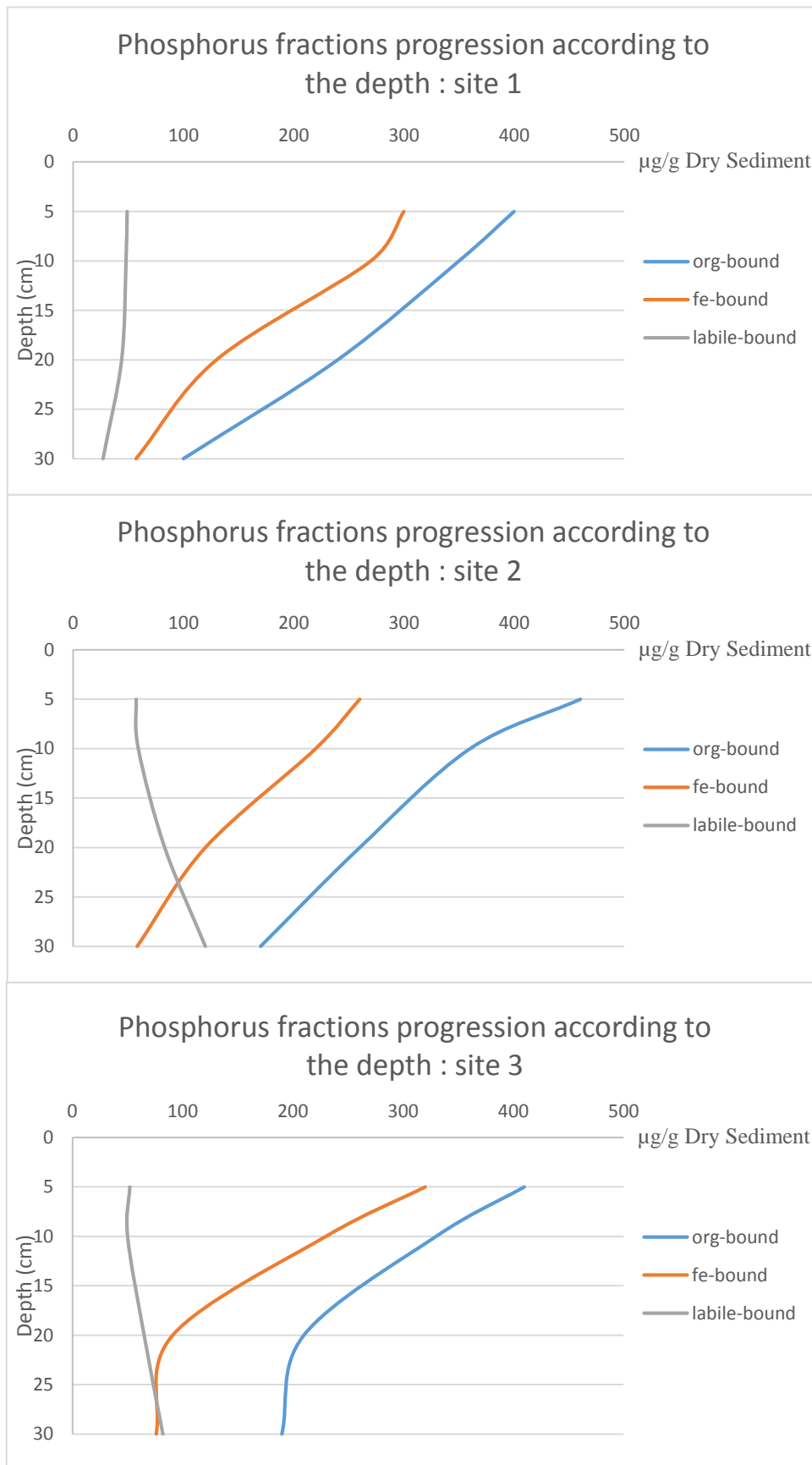


Figure 17 : Amount of the "labile fraction" according to the depth

Appendix 5 : Total amount of phosphorus and water content in the sediments

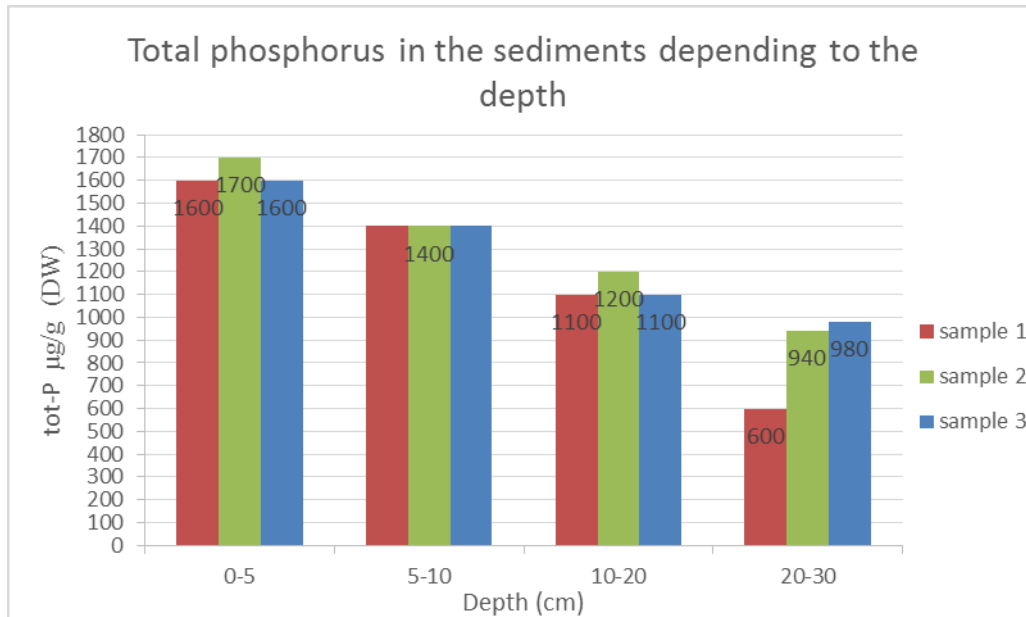


Figure 18 : Total P in the sediments

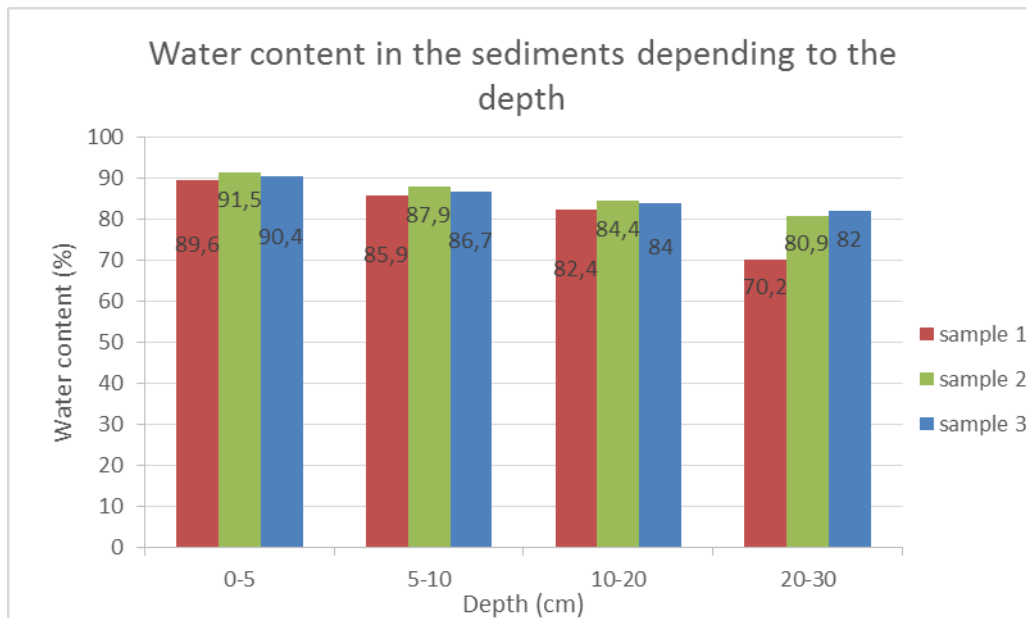


Figure 19 : Water content in the sediments

Appendix 6 : Water column profiles

Table 3 : Water column profile site 1 : 30/06 -10/07

Site 1	Depth							
	1 m	2 m	3 m	4 m	5 m	6 m	7 m	
30/06	Temperature (°C)	18.7	18.7	18.6	18.6	18.2	18.1	/
	pH	8.54	8.55	8.55	8.53	8.13	8.04	/
	Dissolved oxygen (mg/l)	9.8	9.9	9.67	9.74	6.26	5.86	/
	Redox potential (mV)	122.4	121.9	122.6	123.5	133.7	-23.6	/
	Conductivity (µS)	427.6	429.8	430	430.3	437.1	438.3	/
01/07	Temperature (°C)	18.8	18.8	18.7	18.7	18.6	18.4	18.3
	pH	8.58	8.59	8.59	8.59	8.55	8.3	7.79
	Dissolved oxygen (mg/l)	10.23	10.48	10.47	10.46	10.04	8.15	0.76
	Redox potential (mV)	136.1	133.3	133.3	134.1	134.5	-105.5	-177.7
	Conductivity (µS)	427.5	427.8	427.8	428.1	429.1	429	424.1
03/07	Temperature (°C)	18.9	18.9	18.8	18.8	18.8	18.7	18.7
	pH	8.64	8.63	8.63	8.62	8.6	8.55	8.32
	Dissolved oxygen (mg/l)	10.63	10.56	10.48	10.52	10.38	9.92	8.66
	Redox potential (mV)	180.8	177.5	176	175	174.3	174.1	-134.5
	Conductivity (µS)	423.5	425	425.1	425.4	426	427.2	426.1
07/07	Temperature (°C)	20.6	20.4	20.2	19.5	19.4	18.8	18.7
	pH	8.81	8.8	8.78	8.63	8.57	8.09	8.02
	Dissolved oxygen (mg/l)	12.74	12.8	12.51	10.52	9.7	5.11	4.59
	Redox potential (mV)	78.3	79.1	79.7	175	83.6	-123.8	-81.1
	Conductivity (µS)	422.1	421.7	421.1	425.4	429	436.9	437.7
08/07	Temperature (°C)	21.5	21.5	21.3	20.1	19.1	18.6	/
	pH	8.78	8.77	8.74	8.54	8.28	7.97	/
	Dissolved oxygen (mg/l)	12.34	12.4	12.26	9.74	6.95	4.1	/
	Redox potential (mV)	89.8	91.3	93.7	98.7	104.1	-145.2	/
	Conductivity (µS)	412.9	421.8	413.4	424.1	433.5	435.1	/
10/07	Temperature (°C)	21	21	21	20.9	20.9	20.7	20.7
	pH	8.47	8.48	8.48	8.47	8.47	7.65	7.63
	Dissolved oxygen (mg/l)	8.81	8.72	12.76	8.73	8.7	0.07	0.06
	Redox potential (mV)	128.5	127.7	8.74	127.5	-1.8	-60.2	-68.9
	Conductivity (µS)	424.7	424.6	424.7	424.8	424.8	408	409.2

Table 6 : Water column profile site 1 : 14/07 - 23/07

Site 1	Depth						
	1 m	2 m	3 m	4 m	5 m	6 m	7 m
14/07	Temperature (°C)	20.4	20.4	20.4	20.4	20.4	20.3
	pH	8.47	8.48	8.48	8.49	8.49	8.49
	Dissolved oxygen (mg/l)	8.72	8.5	8.54	8.69	8.33	8.29
17/07	Redox potential (mV)	122.7	125.5	128.5	129.6	131.5	134
	Conductivity (µS)	420.6	420.5	420.5	424.8	420.5	420.6
	Temperature (°C)	20.9	20.8	20.7	20.7	20.7	20.5
18/07	pH	8.88	8.75	8.73	8.7	8.71	8.41
	Dissolved oxygen (mg/l)	12.82	11.31	11.27	10.75	10.68	8
	Redox potential (mV)	104.6	108.6	111.8	114.3	116.3	121.2
21/07	Conductivity (µS)	410.4	413.9	414.4	415.1	415.7	421.3
	Temperature (°C)	21.1	20.9	20.8	20.7	20.6	20.3
	pH	8.95	8.84	8.69	8.61	8.62	8.26
22/07	Dissolved oxygen (mg/l)	15.72	13.46	10.87	9.53	10.15	6.64
	Redox potential (mV)	99.1	103.3	106.7	108.5	108.3	112.9
	Conductivity (µS)	399.1	406.5	413.3	416.6	415.9	423.2
23/07	Temperature (°C)	21.1	21.1	21.1	21.1	21.1	21.1
	pH	8.64	8.63	8.62	8.62	8.62	8.6
	Dissolved oxygen (mg/l)	10.96	10.79	10.63	10.65	10.61	10.5
22/07	Redox potential (mV)	96.6	98.8	102.8	104.7	106.9	109.4
	Conductivity (µS)	405	405.3	405.6	405.7	405.7	406
	Temperature (°C)	22.3	22.2	22.2	21.5	21.3	21.2
23/07	pH	8.85	8.83	8.82	8.71	8.68	8.59
	Dissolved oxygen (mg/l)	12.38	12.19	12.07	10.86	10.76	9.89
	Redox potential (mV)	119.4	122.1	127	131.4	133	134.9
23/07	Conductivity (µS)	387.7	387.4	387.2	396.5	399.2	402.8
	Temperature (°C)	22.5	22.2	22.1	22	21.9	21.5
	pH	8.81	8.78	8.78	8.77	8.74	8.49
23/07	Dissolved oxygen (mg/l)	11.73	11.56	11.53	11.48	11.13	8.55
	Redox potential (mV)	104.5	108.7	113.7	117.2	119	123.5
	Conductivity (µS)	388.1	391.1	390.7	393.7	395.7	405.7

Table 9 : Water column profile site 2 : 30/06 - 10/07

Date	Parameter	Depth														
		1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	11 m	12 m	13 m	14 m	
30/06	Temperature (°C)	18.7	18.6	18.6	18.6	18.6	18.6	18.6	18.4	18.1	17.9	17.8	17.8	17.8	17.7	17.7
	pH	8.55	8.55	8.55	8.54	8.54	8.54	8.53	8.39	8.09	7.96	7.78	7.67	7.62	7.61	7.61
	Dissolved oxygen (mg/l)	9.84	9.76	9.69	9.56	9.69	9.52	9.64	8.27	6.16	5.12	2.94	1.29	0.33	0.17	0.17
	Redox potential (mV)	112.6	112.9	113.4	114	114.7	115.3	115.9	119.4	124.8	128.6	40.1	-25.9	-63.6	-76.6	-76.6
01/07	Conductivity (µS)	429.3	430	430.1	430.5	430.7	430.8	430.9	434	437.2	439.6	441.7	435.2	431.6	431.2	431.2
	Temperature (°C)	18.8	18.7	18.7	18.7	18.6	18.6	18.6	18.6	18.5	18.5	18	18	18	18	18
	pH	8.52	8.52	8.52	8.51	8.48	8.44	8.44	8.46	8.46	8.43	7.87	7.7	7.65	7.62	7.62
	Dissolved oxygen (mg/l)	9.5	9.4	9.55	9.43	9.15	8.61	8.72	8.92	9.04	8.74	4.08	4.26	4.22	4.2	4.2
03/07	Redox potential (mV)	196.9	189.2	187.4	185.6	182.5	181.6	180	178.3	177	176.4	185.2	-20.5	-31.4	-28.7	-28.7
	Conductivity (µS)	429.5	429.8	429.8	429.9	430.4	431.5	431	430.8	430.6	431.1	441.7	440.3	440.1	439.9	439.9
	Temperature (°C)	18.7	18.7	18.7	18.7	18.7	18.7	18.6	18.5	18.5	18.5	18.4	18.4	18.5	18.5	18.5
	pH	8.49	8.48	8.48	8.46	8.45	8.45	8.44	8.43	8.4	8.39	8.38	7.95	7.78	7.71	7.71
07/07	Dissolved oxygen (mg/l)	9.84	9.78	9.74	9.64	9.58	9.42	9.36	9.33	9.06	8.88	8.95	6.04	2.84	2.11	2.11
	Redox potential (mV)	136.3	140.2	141.6	143.7	145.8	147.6	149.3	150.7	151.9	153.5	154.6	-127.6	-34.9	-16.4	-16.4
	Conductivity (µS)	427.4	428.3	428.7	428.7	428.9	429.1	429.2	429.4	429.8	429.9	430	425.3	415.8	415	415
	Temperature (°C)	21.3	20.8	20.1	19.5	19.4	19.3	18.7	18.7	18.6	18.5	18.5	18.4	18.3	18.3	18.3
08/07	pH	8.83	8.81	8.71	8.61	8.59	8.55	8.23	8.24	8.19	8.13	8.03	7.76	7.68	7.67	7.67
	Dissolved oxygen (mg/l)	14.3	13.88	12.01	10.22	10.04	9.52	6.81	6.9	6.43	6.12	5.21	2.48	0.05	0.03	0.03
	Redox potential (mV)	88.7	89.	92.8	95.4	96.2	96.8	102.5	103.3	103.9	104.9	107.9	-114.4	-67	-65.9	-65.9
	Conductivity (µS)	409.9	412.8	420.5	427.6	428.3	429.1	433.4	433.2	433.7	434.4	435.4	434.9	428.6	428	428
10/07	Temperature (°C)	21.3	21.2	20.9	19.7	19.5	19.4	19.3	19.2	18.9	18.7	18.6	18.4	18.4	18.4	18.4
	pH	8.74	8.73	8.65	8.53	8.51	8.5	8.47	8.35	8.17	8.01	7.95	7.69	7.68	7.68	7.68
	Dissolved oxygen (mg/l)	11.97	12.43	11.27	9.39	9.04	9.06	8.64	7.67	6.2	4.73	4.13	0.06	0.06	0.12	0.12
	Redox potential (mV)	89.2	92.3	95.8	99.3	101.8	102.7	103.9	106.5	110.6	114.6	115.9	-139.9	-142.8	-142.4	-142.4
08/07	Conductivity (µS)	409.4	409.8	415.3	428.2	429.1	429.8	430.7	432.2	434.8	436.7	437.6	425.2	424.1	423.9	423.9
	Temperature (°C)	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21	21	20.9	20.8	20.7	20.6	20.5	20.5
	pH	8.53	8.53	8.53	8.53	8.53	8.51	8.51	8.51	8.5	8.48	8.44	8.12	7.59	7.59	7.59
	Dissolved oxygen (mg/l)	9.33	9.26	9.17	9.12	9.22	9.07	9.08	9.06	9.04	8.92	8.7	6.06	0.64	0.29	0.29
10/07	Redox potential (mV)	102.9	103.3	104	104.9	105.7	107.1	108.3	109.5	110.6	110.4	111.5	-144.9	-51	-100.8	-100.8
	Conductivity (µS)	421.2	421.2	421.2	421.2	421.2	421.1	421.2	421.3	421.4	422.5	423.5	419.7	408.6	409.3	409.3

Table 12 : Water column profile site 2 : 14/07 - 23/07

Site 2	Depth														
	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	11 m	12 m	13 m	14 m	
14/07	Temperature (°C)	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.5	20.5
	pH	8.4	8.41	8.4	8.39	8.38	8.38	8.37	8.36	8.35	8.33	8.31	8.24	7.88	7.88
	Dissolved oxygen (mg/l)	7.72	7.79	7.72	7.68	7.62	7.68	7.7	7.7	7.59	7.62	7.52	2.53	0.08	0.08
	Redox potential (mV)	220.1	219.6	219.2	219.4	219.5	218.8	218.8	218.4	218	219	218.4	72.9	-184.1	-211.8
17/07	Conductivity (µS)	422.1	422	422.2	422.4	422.4	422.4	422.4	422.5	422.8	423.1	414.2	413.8	412.8	412.8
	Temperature (°C)	20.6	20.6	20.6	20.6	20.6	20.5	20.5	20.5	20.5	20.4	20.4	20.3	20.1	20.1
	pH	8.69	8.63	8.62	8.62	8.6	8.58	8.58	8.57	8.57	8.56	8.57	8.52	8.37	7.74
	Dissolved oxygen (mg/l)	10.21	9.65	9.42	9.64	9.5	9.35	9.42	9.42	9.37	9.17	9.32	8.95	7.49	0.81
18/07	Redox potential (mV)	136.3	137.1	137.6	138.1	139.4	140.3	140.5	142	141.5	142.7	142.8	143.3	146.2	-127
	Conductivity (µS)	415.3	416.1	416.4	416.3	416.8	417.3	417.2	417	416.8	416.6	416.7	417.6	420.8	416.3
	Temperature (°C)	21.2	21.1	21.1	21	20.6	20.6	20.6	20.5	20.5	20.5	20.5	20.2	20	19.8
	pH	8.91	8.86	8.84	8.73	8.58	8.55	8.54	8.52	8.52	8.51	8.49	8.07	7.91	7.78
21/07	Dissolved oxygen (mg/l)	14.68	14.1	13.51	11.62	9.57	9.07	8	8.93	8.93	8.75	8.69	5.18	3.22	0.29
	Redox potential (mV)	91.8	94.9	98.5	101.5	104.1	104.9	105.5	107.2	107.4	107.8	108.3	113.7	117.9	-183.6
	Conductivity (µS)	401.1	403.1	405	410.9	417.3	418.1	418.2	418.6	418.6	418.8	419.3	425.9	430.3	423.7
	Temperature (°C)	21.5	21.5	21.5	21.5	21.4	21.4	21.3	21.3	20.9	20.8	20.4	20.4	20.1	20.1
22/07	pH	8.75	8.74	8.75	8.73	8.72	8.71	8.68	8.64	8.44	8.29	8.01	7.94	7.79	7.74
	Dissolved oxygen (mg/l)	12.35	12.3	12.2	12.2	12.13	12.02	11.78	11.63	9.51	8.35	6.09	5.81	2.9	0.52
	Redox potential (mV)	107.5	107.5	107.6	108.1	108.5	109.5	110.3	112.4	115.1	119	124.3	127.1	-90	-159.1
	Conductivity (µS)	393	393.2	393.3	394.2	394.7	394.7	396.7	397.8	407.9	412.8	421.2	422	430.6	434.2
23/07	Temperature (°C)	21.6	21.5	21.5	21.4	21.4	21.4	21.4	21.4	21.4	21.3	21.3	20.9	20.8	20.7
	pH	8.76	8.75	8.7	8.69	8.68	8.67	8.66	8.57	8.54	8.5	8.49	8.16	8.1	7.91
	Dissolved oxygen (mg/l)	11.7	11.52	11.09	11.1	11.02	10.97	10.79	9.89	9.79	9.54	9.35	6.25	6.23	4.79
	Redox potential (mV)	104.4	111	116.7	120.7	125.7	128.1	131.1	134.2	134.1	135.9	138.2	144.4	146.6	-110
23/07	Conductivity (µS)	398.7	398.5	398.8	399	399.6	399.5	400	404.9	406.2	407.9	408.1	415.6	416.4	416.5
	Temperature (°C)	22	22	21.9	21.9	21.8	21.8	21.6	21.4	21.3	21	20.9	20.9	20.6	20.6
	pH	8.73	8.73	8.72	8.68	8.62	8.6	8.55	8.45	8.36	8.11	8.06	8	7.79	7.78
	Dissolved oxygen (mg/l)	11.12	11.03	10.78	10.46	10.21	10.02	9.49	8.67	8.17	6.04	5.8	5.14	2	0.36
23/07	Redox potential (mV)	123.3	123.4	123.3	124	124.8	125	125.7	126.9	128.2	131.4	132.8	133.8	-122.9	-205.5
	Conductivity (µS)	397.3	397.5	397.8	399.2	401.5	401.7	404.4	407.4	409.5	414.6	414.6	416	426.7	424.5

Table 15 : Water column profile site 3 : 30/06 - 10/07

Site 3		Depth						
		1 m	2 m	3 m	4 m	5 m	6 m	7 m
30/06	Temperature (°C)	18.7	18.6	18.6	18.5	18.5	18	18
	pH	8.55	8.54	8.53	8.51	8.46	8	7.71
	Dissolved oxygen (mg/l)	9.72	9.79	9.6	9.45	9.09	5.31	0.04
	Redox potential (mV)	121.9	121.8	121.9	122.6	123.6	132.4	-107.2
01/07	Conductivity (µS)	429.3	428	429.9	430.5	431.3	438.5	424.5
	Temperature (°C)	18.8	18.8	18.8	18.6	18.5	18.4	18.4
	pH	8.57	8.57	8.56	8.52	8.45	8.42	8.31
	Dissolved oxygen (mg/l)	10.09	10.09	9.96	9.65	9.18	8.78	8.11
03/07	Redox potential (mV)	121.9	125.6	125.9	128.4	130.6	130.4	-143.3
	Conductivity (µS)	429.6	429.6	429.6	430.6	431.5	431.8	432.2
	Temperature (°C)	18.8	18.8	18.8	18.8	18.8	18.8	/
	pH	8.52	8.51	8.51	8.5	8.48	8.35	/
07/07	Dissolved oxygen (mg/l)	9.84	9.8	9.56	9.78	9.56	8.51	/
	Redox potential (mV)	118.8	119.5	120.4	122.6	123.9	-93.2	/
	Conductivity (µS)	428.4	428.6	428.8	428.8	429.3	429.4	/
	Temperature (°C)	20.8	20.8	20.8	20.6	20.2	19.3	18.7
08/07	pH	8.79	8.79	8.78	8.77	8.68	8.36	7.88
	Dissolved oxygen (mg/l)	13.63	13.62	13.6	13.22	11.78	7.8	3.41
	Redox potential (mV)	67.2	68.2	67.9	69.6	72.9	77.5	-144.4
	Conductivity (µS)	412.5	412	411.9	413.9	419.1	431.8	428.9
10/07	Temperature (°C)	21.5	21.4	21.2	20.1	19.6	18.8	18.7
	pH	8.75	8.72	8.69	8.52	8.36	8.06	7.82
	Dissolved oxygen (mg/l)	12.91	12.71	12.51	9.71	8.2	5.44	2.79
	Redox potential (mV)	86.3	88.4	92.8	97.2	101.2	-93.8	-127.2
10/07	Conductivity (µS)	405	406.1	407.5	421.1	427.3	434.3	430.2
	Temperature (°C)	21.9	21.9	21.8	21.8	21.8	21.8	21.3
	pH	8.65	8.65	8.64	8.63	8.64	8.62	7.84
	Dissolved oxygen (mg/l)	9.58	9.56	9.54	9.51	9.52	9.41	0.07
10/07	Redox potential (mV)	112.8	112.3	112.6	113	113.1	114	-182.8
	Conductivity (µS)	412.5	412.5	412.5	412.5	412.6	412.6	401.3

Table 18 : Water column profile site 3 : 14/07 - 23/07

Site 3		Depth						
		1 m	2 m	3 m	4 m	5 m	6 m	7 m
14/07	Temperature (°C)	20.6	20.6	20.6	20.6	20.6	20.6	20.6
	pH	8.43	8.43	8.43	8.42	8.42	8.41	8.4
	Dissolved oxygen (mg/l)	8.11	7.88	7.99	7.88	7.91	7.94	8.02
	Redox potential (mV)	133.5	134.5	135.8	138.2	139.2	140.9	145.8
17/07	Conductivity (µS)	420.3	420.3	420.2	420.3	420.3	420.3	420.3
	Temperature (°C)	20.7	20.6	20.5	20.4	20.3	20.3	20.3
	pH	8.73	8.66	8.57	8.58	8.56	8.56	8.53
	Dissolved oxygen (mg/l)	11.06	10.19	9.01	8.93	9.15	9.13	8.9
18/07	Redox potential (mV)	132	131.1	136	135.1	138.3	138.1	137.9
	Conductivity (µS)	414.4	416.1	417.8	417.7	418	417.9	418.4
	Temperature (°C)	21	20.8	20.7	20.6	20.6	20.5	20
	pH	8.94	8.87	8.84	8.8	8.78	8.66	8.3
21/07	Dissolved oxygen (mg/l)	14.39	13.15	12.47	12.37	11.85	10.46	6.67
	Redox potential (mV)	126.7	127.7	128.5	129.2	129.9	131.9	137.1
	Conductivity (µS)	406.3	408.9	410.4	410.2	410.3	415.1	422.8
	Temperature (°C)	22.5	22.5	22.5	22.4	22.3	22	21.2
22/07	pH	8.83	8.83	8.83	8.81	8.8	8.75	8.12
	Dissolved oxygen (mg/l)	13.19	13.17	13.25	13.25	13.23	12.79	1.12
	Redox potential (mV)	106.2	108.5	110.2	112.2	114.5	117.4	-195.1
	Conductivity (µS)	378.4	378.4	378.7	379.2	380.5	385.7	401.3
23/07	Temperature (°C)	22.9	22.8	22.3	21.8	21.4	21.2	21.1
	pH	8.86	8.84	8.71	8.66	8.46	8.37	8.22
	Dissolved oxygen (mg/l)	12.18	12.12	11.46	10.71	8.9	8	6.77
	Redox potential (mV)	130.7	132.6	136.9	139.9	143	145.2	-126.3
23/07	Conductivity (µS)	376.7	376.3	386.9	396.6	409.8	412.6	415.8
	Temperature (°C)	22.8	22.7	22.4	22.3	22.3	22.3	21.1
	pH	8.82	8.82	8.77	8.76	8.78	8.79	8.08
	Dissolved oxygen (mg/l)	11.84	11.96	11.53	11.5	11.52	11.53	5.6
23/07	Redox potential (mV)	128.3	129.1	130.2	131.6	131.8	132	144.1
	Conductivity (µS)	379	379.6	386.6	389.1	389.1	389	416.5

Table 21 : Water column profile site 4 : 30/06 - 10/07

	Depth						
	1 m	2 m	3 m	4 m	5 m	6 m	7 m
30/06	Temperature (°C)	18.7	18.7	18.7	18.6	18.6	/
	pH	8.53	8.53	8.52	8.5	8.5	/
	Dissolved oxygen (mg/l)	10.03	9.82	10	9.83	9.81	/
	Redox potential (mV)	77.6	77.7	78.9	79.6	44.4	/
	Conductivity (µS)	429.3	429.6	429.7	430.1	426.8	/
	Temperature (°C)	18.8	18.8	18.8	18.7	18.7	18.6
	pH	8.43	8.46	8.48	8.46	8.45	8.42
01/07	Dissolved oxygen (mg/l)	9.51	9.51	9.31	9.11	9.16	8.84
	Redox potential (mV)	90.4	91.3	94.8	97.2	102.1	109.2
	Conductivity (µS)	430	430.4	430.4	430.9	431.1	431.9
	Temperature (°C)	18.9	18.9	18.9	18.9	18.8	18.8
03/07	pH	8.58	8.58	8.57	8.56	8.55	8.51
	Dissolved oxygen (mg/l)	10.11	10.37	10.29	10.29	10.26	9.78
	Redox potential (mV)	234.8	227.6	224.3	222.3	219.8	29.7
	Conductivity (µS)	426.1	426.9	426.8	426.9	427	427.1
07/07	Temperature (°C)	20.2	20	19.9	19.4	18.9	18.6
	pH	8.68	8.65	8.58	8.53	8.34	8.07
	Dissolved oxygen (mg/l)	11.73	11.71	11.28	10.15	8.32	6.24
	Redox potential (mV)	110.8	111.5	113.7	113	115.7	120.3
08/07	Conductivity (µS)	422.7	422.9	423.6	428	431.4	435.8
	Temperature (°C)	21.4	21.4	20.6	20.3	19.8	18.5
	pH	8.77	8.75	8.64	8.62	8.53	7.9
	Dissolved oxygen (mg/l)	12.04	12.29	10.46	10.33	9.26	2.65
10/07	Redox potential (mV)	93.7	98.8	102.5	104.1	106.5	-105
	Conductivity (µS)	412.1	412.1	421	425.1	429	442.2
	Temperature (°C)	21.1	21	21	21	20.9	19.2
10/07	pH	8.5	8.48	8.48	8.47	8.46	7.91
	Dissolved oxygen (mg/l)	9.02	8.76	8.7	8.5	8.4	3.15
	Redox potential (mV)	174.3	170.8	168.2	166	163.8	-97.5
	Conductivity (µS)	423.6	423.7	423.8	424.1	424.2	441

Table 24 : Water column profile site 4 : 14/07 - 23/07

	Depth						
	1 m	2 m	3 m	4 m	5 m	6 m	7 m
Site 4							
14/07	Temperature (°C)	20.5	20.5	20.5	20.5	20.5	20.4
	pH	8.48	8.47	8.48	8.47	8.47	8.44
	Dissolved oxygen (mg/l)	8.02	8	8	7.83	7.91	7.8
	Redox potential (mV)	302	295.5	298.1	284.6	276.5	268
17/07	Conductivity (µS)	419.9	419.8	419.9	419.8	419.6	420.7
	Temperature (°C)	20.8	20.7	20.7	20.7	20.6	20.6
	pH	8.87	8.78	8.74	8.73	8.73	8.72
	Dissolved oxygen (mg/l)	11.84	10.99	10.54	10.33	10.55	10.57
18/07	Redox potential (mV)	136.6	136.6	137.3	137.4	133.9	136.6
	Conductivity (µS)	411.3	413.5	414.3	414.6	414.7	414.8
	Temperature (°C)	21.3	21.3	20.9	20.8	20.7	20.6
	pH	8.89	8.83	8.66	8.6	8.56	8.53
21/07	Dissolved oxygen (mg/l)	14.97	14.35	10.71	9.88	9.29	9.67
	Redox potential (mV)	76.5	81	87.7	91.7	94.7	90.9
	Conductivity (µS)	398.8	400.7	413.8	415.8	417	418.2
	Temperature (°C)	21.3	21.3	21.3	21.2	21.2	21
22/07	pH	8.65	8.65	8.66	8.64	8.6	8.49
	Dissolved oxygen (mg/l)	11.19	11.28	11.21	10.94	10.57	9.5
	Redox potential (mV)	101.6	101.2	100.3	100.8	101.2	102.9
	Conductivity (µS)	400.2	400.4	400.7	401.5	403.4	408.6
23/07	Temperature (°C)	21.6	21.5	21.5	21.4	21.4	20.9
	pH	8.76	8.74	8.72	8.68	8.66	8.29
	Dissolved oxygen (mg/l)	11.1	11.34	11.04	10.73	10.52	7.27
	Redox potential (mV)	162	160.9	159.1	158.5	158	162.5
23/07	Conductivity (µS)	398.4	398.8	399.2	400.9	402	414.7
	Temperature (°C)	21.5	21.5	21.5	21.5	21.4	21.2
	pH	8.68	8.68	8.67	8.65	8.51	8.34
	Dissolved oxygen (mg/l)	10.7	10.47	10.49	10.45	8.89	7.87
23/07	Redox potential (mV)	105	105.5	106.5	107.7	110	112.8
	Conductivity (µS)	402.6	402.5	402.6	403	406.5	409.9

Table 27 : Water column profile site 5 : 30/06 - 10/07

Site 5		Depth			
		1 m	2 m	3 m	4 m
30/06	Temperature (°C)	/	/	/	/
	pH	/	/	/	/
	Dissolved oxygen (mg/l)	/	/	/	/
	Redox potential (mV)	/	/	/	/
01/07	Conductivity (µS)	/	/	/	/
	Temperature (°C)	18.7	18.7	18.4	18.3
	pH	8.55	8.55	8.41	8.36
	Dissolved oxygen (mg/l)	9.65	9.96	8.82	8.32
03/07	Redox potential (mV)	206.6	200.8	198.3	-40.3
	Conductivity (µS)	429.1	429.4	430.9	431.2
	Temperature (°C)	18.7	18.7	18.7	18.7
	pH	8.53	8.53	8.52	8.52
07/07	Dissolved oxygen (mg/l)	9.93	9.87	9.92	9.83
	Redox potential (mV)	109.4	111.2	113.7	94.2
	Conductivity (µS)	427.7	427.9	427.8	428
	Temperature (°C)	22	21.9	21.7	21.2
08/07	pH	8.78	8.77	8.76	8.66
	Dissolved oxygen (mg/l)	13.61	14.11	14.1	12.93
	Redox potential (mV)	58.7	60.3	66.7	66.1
	Conductivity (µS)	405.2	404.9	404.4	407.4
10/07	Temperature (°C)	20.9	20.9	20.8	19.5
	pH	8.66	8.66	8.65	8.23
	Dissolved oxygen (mg/l)	11.45	11.37	11.24	6.71
	Redox potential (mV)	90.6	91.6	93	100.2
10/07	Conductivity (µS)	416.6	416.6	417	430.7
	Temperature (°C)	21.9	21.9	21.8	21.8
	pH	8.64	8.65	8.63	8.62
	Dissolved oxygen (mg/l)	9.7	9.74	9.62	9.62
10/07	Redox potential (mV)	111	110.3	110.9	51.7
	Conductivity (µS)	413.6	413.5	413.7	413.8

Table 30 : Water column profile site 5 : 14/07 - 23/07

Site 5		Depth			
		1 m	2 m	3 m	4 m
14/07	Temperature (°C)	20.5	20.5	20.5	20.5
	pH	8.48	8.48	8.47	8.45
	Dissolved oxygen (mg/l)	8.25	8.35	8.31	8.21
	Redox potential (mV)	120.9	123.1	125.4	90.9
17/07	Conductivity (µS)	417.9	417.9	417.9	418
	Temperature (°C)	20.5	20.5	20.4	20.2
	pH	8.73	8.67	8.55	8.5
	Dissolved oxygen (mg/l)	10.8	10.22	8.65	7.85
18/07	Redox potential (mV)	117.4	121.9	125.3	127
	Conductivity (µS)	414.7	415.8	418.2	418.9
	Temperature (°C)	21.2	21	20.9	20.8
	pH	8.93	8.86	8.84	8.79
21/07	Dissolved oxygen (mg/l)	14.9	13.16	13.08	12.29
	Redox potential (mV)	114.9	118	119.2	120.6
	Conductivity (µS)	400.9	405.8	406.7	408.7
	Temperature (°C)	22.3	22.3	22.3	22.2
22/07	pH	8.79	8.8	8.79	8.79
	Dissolved oxygen (mg/l)	12.89	13.01	12.92	12.84
	Redox potential (mV)	86.5	88.8	91.9	93.7
	Conductivity (µS)	381	381.4	381.7	382.4
23/07	Temperature (°C)	22.6	22.6	22.4	21.7
	pH	8.85	8.85	8.83	8.58
	Dissolved oxygen (mg/l)	12.47	12.56	12.35	10.2
	Redox potential (mV)	108.8	112.6	116.4	122.7
23/07	Conductivity (µS)	378.4	378.7	380.6	401.2
	Temperature (°C)	22.6	22.6	22.6	22.1
	pH	8.8	8.79	8.79	8.53
	Dissolved oxygen (mg/l)	11.68	11.66	11.67	9.3
23/07	Redox potential (mV)	111.1	115.6	118.7	124.2
	Conductivity (µS)	382.4	382.5	382.8	396.4

Table 33 : Water column profile site 6 : 30/06 - 10/07

Date	Parameter	Depth												
		1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m			
30/06	Temperature (°C)	/	/	/	/	/	/	/	/	/	/	/	/	/
	pH	/	/	/	/	/	/	/	/	/	/	/	/	/
	Dissolved oxygen (mg/l)	/	/	/	/	/	/	/	/	/	/	/	/	/
	Redox potential (mV)	/	/	/	/	/	/	/	/	/	/	/	/	/
01/07	Conductivity (µS)	/	/	/	/	/	/	/	/	/	/	/	/	/
	Temperature (°C)	19	18.9	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
	pH	8.64	8.62	8.53	8.5	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45
	Dissolved oxygen (mg/l)	10.6	10.64	9.63	9.41	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07	9.07
03/07	Redox potential (mV)	202.5	192.7	190.5	187.3	-76.5	430.1	430.1	430.1	430.1	430.1	430.1	430.1	430.1
	Conductivity (µS)	426.8	427.4	429.7	430.1	430.1	430.1	430.1	430.1	430.1	430.1	430.1	430.1	430.1
	Temperature (°C)	18.8	18.8	18.8	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.6	18.5	18.5
	pH	8.6	8.57	8.57	8.54	8.52	8.53	8.45	8.44	8.23	8.23	8.45	8.44	8.23
07/07	Dissolved oxygen (mg/l)	10.55	10.24	10.22	10.04	9.82	9.73	9.09	9.06	8	8	9.09	9.06	8
	Redox potential (mV)	100	102.9	106.3	108.1	113.9	116	118.9	120.6	-105	-105	118.9	120.6	-105
	Conductivity (µS)	425.9	426.8	427	427.9	428.4	428.3	429.9	430	428.9	430	429.9	430	428.9
	Temperature (°C)	20.5	20.3	20.2	19.8	19.5	19.3	18.8	18.6	18.6	18.6	18.8	18.6	18.6
08/07	pH	8.79	8.78	8.77	8.7	8.53	8.39	8.19	8.13	7.8	7.8	8.19	8.13	7.8
	Dissolved oxygen (mg/l)	12.6	12.55	12.34	11.41	9.23	8.06	6.36	5.73	1.08	1.08	6.36	5.73	1.08
	Redox potential (mV)	74.1	75.8	77	79.2	82.2	83.8	86.9	88.7	-39.4	-39.4	86.9	88.7	-39.4
	Conductivity (µS)	420	420.2	420.3	422.6	428.5	430.9	434.3	434.9	432.5	432.5	434.3	434.9	432.5
10/07	Temperature (°C)	21.4	21.4	21.3	19.6	19.2	19.1	18.8	18.7	18.7	18.7	18.8	18.7	18.7
	pH	8.75	8.74	8.72	8.46	8.33	8.28	8.15	8.03	7.8	7.8	8.15	8.03	7.8
	Dissolved oxygen (mg/l)	12.69	12.73	12.41	9	7.73	7.27	6.09	4.98	1.08	1.08	6.09	4.98	1.08
	Redox potential (mV)	82.4	85.5	87.5	95.1	99.5	101.3	103.9	-72.7	1.08	1.08	103.9	-72.7	1.08
10/07	Conductivity (µS)	408.2	408.4	409.2	426.6	430.7	431.9	434.4	435.5	435.5	435.5	434.4	435.5	435.5
	Temperature (°C)	21.5	21.5	21.5	21.4	21.3	21.2	21.1	21	20.6	20.6	21.1	21	20.6
	pH	8.59	8.6	8.59	8.59	8.56	8.55	8.52	8.49	7.67	7.67	8.52	8.49	7.67
	Dissolved oxygen (mg/l)	9.57	9.54	9.46	9.37	9.25	9.17	9.02	8.68	0.08	0.08	9.02	8.68	0.08
10/07	Redox potential (mV)	123.3	122.5	122.5	121.6	122.8	123.1	123.9	71.8	-169.7	-169.7	123.9	71.8	-169.7
	Conductivity (µS)	417.1	417.2	417.3	417.6	420.1	421.3	423	423.5	410.8	410.8	423	423.5	410.8

Table 36 : Water column profile site 6 : 14/07 - 23/07

Date	Site 6	Depth														
		1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m					
14/07	Temperature (°C)	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.4	20.4	
	pH	8.42	8.42	8.42	8.42	8.41	8.4	8.4	8.39	8.4	8.4	8.39	8.4	7.82	7.82	
	Dissolved oxygen (mg/l)	7.85	7.79	7.7	7.75	7.79	7.74	7.56	7.71	7.72	7.72	7.56	7.71	7.72	4.72	4.72
	Redox potential (mV)	146.6	147	147.7	149.1	152.2	152.8	153.1	153.4	154.1	154.1	153.1	153.4	154.1	-136	-136
17/07	Conductivity (µS)	420.9	421	421	421	420.9	420.9	420.9	420.7	419.7	419.7	420.7	419.7	412.6	412.6	
	Temperature (°C)	20.7	20.6	20.6	20.6	20.5	20.4	20.2	20.1	20.1	20.1	20.2	20.1	20.1	20	
	pH	8.73	8.68	8.66	8.63	8.56	8.58	8.54	8.5	8.48	8.48	8.54	8.5	8.48	7.88	
	Dissolved oxygen (mg/l)	10.91	10.02	10.06	9.76	8.92	9.11	8.37	8.37	8.41	8.41	8.37	8.37	8.41	3.98	
18/07	Redox potential (mV)	136.8	139.1	138.8	140.5	142.2	141.6	143.4	143.6	144.1	144.1	143.6	143.6	144.1	-142.7	
	Conductivity (µS)	414.3	415.5	416	416.4	417.9	417.3	417.9	418.5	419	419	418.5	418.5	419	425.5	
	Temperature (°C)	21	20.9	20.8	20.8	20.6	20.5	20.4	20.4	20.3	20.3	20.4	20.4	20.3	20.2	
	pH	8.9	8.82	8.76	8.74	8.54	8.54	8.53	8.5	8.43	8.43	8.53	8.5	8.43	7.82	
21/07	Dissolved oxygen (mg/l)	14.15	12.56	11.94	11.5	8.97	9.1	9.06	8.64	8.22	8.22	9.06	8.64	8.22	3.19	
	Redox potential (mV)	136.7	136.5	136.4	136.6	138.8	138.2	137.5	137.1	137.5	137.5	137.5	137.1	137.5	-46.7	
	Conductivity (µS)	405.3	408.9	411	412.7	418.5	418.5	418.2	419	420.3	420.3	418.2	419	420.3	422.3	
	Temperature (°C)	22.3	22.3	22.1	21.8	21.6	21.5	21.5	21.3	21.2	21.2	21.5	21.3	21.2	20.2	
22/07	pH	8.77	8.77	8.79	8.68	8.62	8.65	8.66	8.6	8.49	8.49	8.66	8.6	8.49	7.84	
	Dissolved oxygen (mg/l)	12.67	12.7	12.91	11.9	11.33	11.62	11.6	10.95	9.94	9.94	11.6	10.95	9.94	0.33	
	Redox potential (mV)	83	88.2	94.4	101.6	104.1	106.6	108.1	111.8	114.4	114.4	108.1	111.8	114.4	-226.9	
	Conductivity (µS)	382.2	382.5	384	391.6	396.1	395	394.9	399.5	403.9	403.9	394.9	399.5	403.9	425.2	
23/07	Temperature (°C)	22.6	22.5	22.5	22.4	21.8	21.6	21.5	21.2	20.8	20.8	21.5	21.2	20.8	20.6	
	pH	8.88	8.87	8.83	8.77	8.74	8.7	8.65	8.39	8.08	8.08	8.65	8.39	8.08	7.82	
	Dissolved oxygen (mg/l)	12.81	12.7	12.14	11.63	11.44	11.02	10.42	8.11	5.57	5.57	10.42	8.11	5.57	0.33	
	Redox potential (mV)	99.9	106.4	113.9	117.4	121.4	127.9	133	137.6	141.6	141.6	133	137.6	141.6	-201.9	
23/07	Conductivity (µS)	377.8	378.5	379.3	380.7	395.1	398.5	403	411.9	418.6	418.6	403	411.9	418.6	419.9	
	Temperature (°C)	22.7	22.7	22.3	22.2	22.2	22	21.3	21	20.7	20.7	21.3	21	20.7	20.6	
	pH	8.83	8.84	8.61	8.73	8.72	8.73	8.19	8	7.83	7.83	8.19	8	7.83	7.83	
	Dissolved oxygen (mg/l)	12.15	11.95	9.95	11.06	10.77	11.09	6.74	4.97	3.3	3.3	11.09	6.74	4.97	0.37	
23/07	Redox potential (mV)	139.6	139.9	143.3	141.8	141.6	141.4	149.5	152.5	155.6	155.6	141.4	149.5	152.5	-190.9	
	Conductivity (µS)	381.6	382.4	383.7	393	394.8	392.7	412	416.2	421.2	421.2	412	416.2	421.2	419.9	

Appendix 7 : Example of a no-thermocline situations

Oxygen and temperature's progression according to the depth:
site 1 - July 21

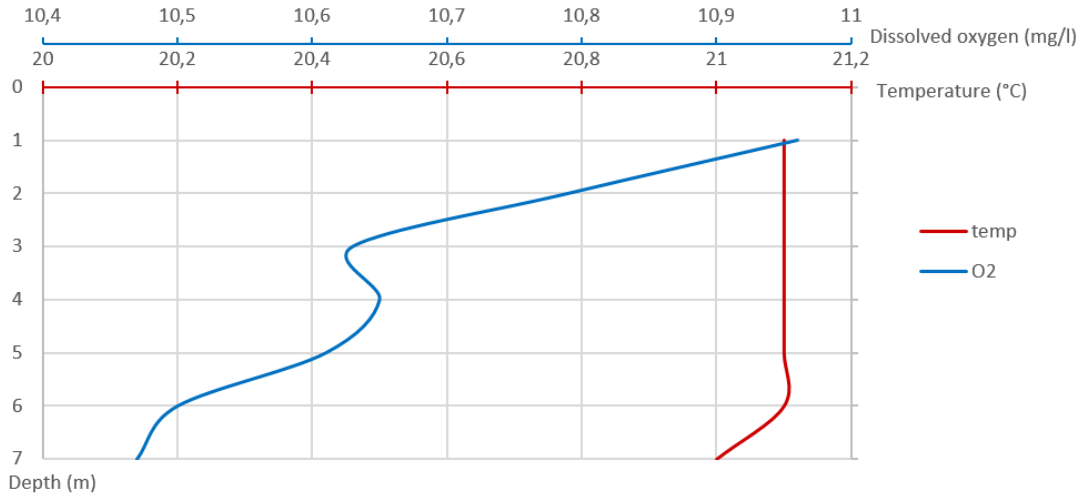


Figure 21 : Oxygen and temperature progression : site 1 21/07 (high oxygen condition)

Oxygen and temperature's progression according to the depth:
site 2 - July 17

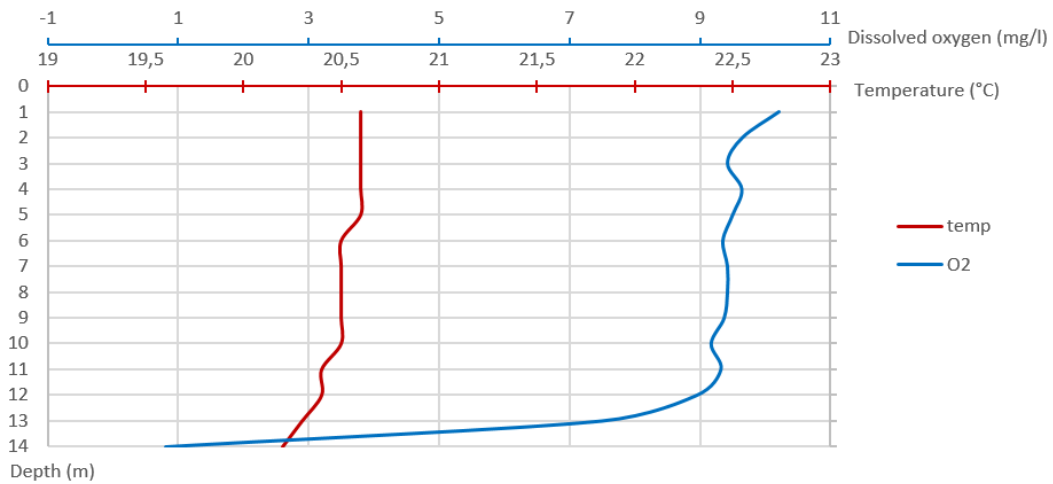


Figure 22 : Oxygen and temperature progression : site 2 17/07 (low oxygen condition)

Appendix 8 : Estimation of the total amount of phosphorus stored in the sediments

Table 38 : Calculation of the total amount of phosphorus stored in the sediments of each site : mg P / m²

		Dry weight (g)	Total phosphorus (µg / g DW)	mg P / 20 ml (sample) (*)	mg P / m ³	mg P / m ²	mg P / m ²	
Site 1	0-5 cm	2.294	1600	3.6704	183520	9176	66682.7	Depth : 7m
	5-10 cm	3.246	1400	4.5444	227220	11361		
	10-20 cm	4.1676	1100	4.58436	229218	22921.8		
	20-30 cm	7.7413	600	4.64478	232239	23223.9		
Site 2	0-5 cm	1.8536	1700	3.15112	157556	7877.8	57791.43	Depth : 14 m
	5-10 cm	2.4565	1400	3.4391	171955	8597.75		
	10-20 cm	3.5236	1200	4.22832	211416	21141.6		
	20-30 cm	4.2924	940	4.034856	201742.8	20174.28		
Site 3	0-5 cm	2.0279	1600	3.24464	162232	8111.6	58636.07	Depth : 7 m
	5-10 cm	2.8666	1400	4.01324	200662	10033.1		
	10-20 cm	3.628	1100	3.9908	199540	19954		
	20-30 cm	4.1913	980	4.107474	205373.7	20537.37		
Step :		1			2	3	4	

(*) the lab used a sediment volume of 20 ml to do the analyses

Step 1 : Here we want to determine the amount of phosphorus in each sample. We do : Concentration of P in the DW (mg / g DW) x DW (g). The result is in mg P / 20 ml

Step 2 : Now we translate the result in mg P / m³. We do [P] (mg P / 20 ml) / 20 x 10⁶

Step 3 : To have the results expressed by square meter we must multiply the previous results by the height of each sample. I do [P] (mg / m³) x 0.05 (m) or x 0.1 (m) according to each depth. We get the result in mg P / m²

Step 4 : Now We add each results to have the amount of P for all the height of the sample (0-30 cm depth)

Then we do an average with site 1 and 3 which have the same depth and we translate in g P /m²

	Site 1-3	Site 2
g P /m ²	62.65939	57.79143

Now we have to determine the area of each part of the lake : 4-10 m and 10 -14m depth. To do that we used a free software : Imagej. This software allows us to estimate the area on a picture thanks to a scale previously done on the same picture. So we used the map of the lake that we can find on the figure 6.

Total area : 4-14 m (m ²)	10 -14 m area (m ²)	4 – 10 m area (m ²) (*)
9546530	1629432	7917098

(*)4 – 10 m area (m²) = Total area : 4-14 m (m²) - 10 -14 m area (m²)

Then we multiply the total area with the global amount of P (g/m²) :

	P total (g)	P total (tons)
Site 1-3	496080491.7	496.1
Site 2	94167205.37	94.1

496.1 + 94.1 = 590.2 There more than **590.2 tons** in the first 30 cm of sediments in the lake

Appendix 9 : Estimation of the amount of “ available fraction” of phosphorus in the lake

Table 39 : Calculation of the amount of phosphorus fractions stored in the sediments for each site : $\mu\text{g P/g DW}$

		Dry weight (g)	Org-P ($\mu\text{g P / g DW}$)	Fe-P ($\mu\text{g P / g DW}$)	Labile - P ($\mu\text{g P / g DW}$)	
Site 1	0-5 cm	2.294	400	300	49	Depth : 7m
	5-10 cm	3.246	350	270	48	
	10-20 cm	4.1676	240	130	44	
	20-30 cm	7.7413	100	57	27	
Site 2	0-5 cm	1.8536	460	260	57	Depth : 14 m
	5-10 cm	2.4565	360	220	59	
	10-20 cm	3.5236	260	120	83	
	20-30 cm	4.2924	170	58	120	
Site 3	0-5 cm	2.0279	410	320	52	Depth : 7 m
	5-10 cm	2.8666	330	230	50	
	10-20 cm	3.628	210	91	65	
	20-30 cm	4.1913	190	76	82	

(*) the lab used a sediment volume of 20 ml to do the analyses

Step 1 -2 : Here we want to determine the amount of phosphorus in each sample. We do : Concentration of P in the DW (mg / g DW) x DW (g). The result is in mg P / 20 ml . Then we translate the result in mg P / m^3 . I do $[\text{P}] (\text{mg P / 20 ml}) / 20 \times 10^6$

Table 40 : Estimation of the amount of phosphorus fractions stored in the sediments in mg P / m^3

		Org-P (mg P / m^3)	Fe-P (mg P / m^3)	Labile -P (mg P / m^3)	
Site 1	0-5 cm	45880	34410	5620.3	Depth : 7m
	5-10 cm	56805	43821	7790.4	
	10-20 cm	50011.2	27089.4	9168.72	
	20-30 cm	38706.5	22062.7	10450.75	
Site 2	0-5 cm	42632.8	24096.8	5282.76	Depth : 14 m
	5-10 cm	44217	27021.5	7246.7	
	10-20 cm	45806.8	21141.6	14622.9	
	20-30 cm	36485.4	12447.96	25754.4	
Site 3	0-5 cm	41571.95	32446.4	5272.54	Depth : 7 m
	5-10 cm	47298.9	32965.9	7166.5	
	10-20 cm	38094	16507.4	11791	
	20-30 cm	39817.35	15926.94	17184.3	

Step 3-4 : To have the results expressed by square meter, we must multiply the previous results by the height of each sample. We do $[\text{P}] (\text{mg / m}^3) \times 0.05 (\text{m})$ or $\times 0.1 (\text{m})$ according to each depth.

We get the result in mg P / m^2 . Then we add each results to have the amount of P for all the height of the sample (0-30 cm depth)

Table 41 : Estimation of the amount of each phosphorus fraction in mg P /m²

		Org-P (mg P / m ²)	Addition (mg P / m ²)	Fe-P (mg P / m ²)	Addition (mg P / m ²)	Labile -P (mg P / m ²)	Addition (mg P / m ²)
Site 1	0-5 cm	2294	14006.02	1720.5	8826.76	281.015	2632.48
	5-10 cm	2840.25		2191.05		389.52	
	10-20 cm	5001.12		2708.94		916.872	
	20-30 cm	3870.65		2206.2705		1045.07	
Site 2	0-5 cm	2131.64	12571.71	1204.84	5914.87	264.138	4664.2
	5-10 cm	2210.85		1351.075		362.33	
	10-20 cm	4580.68		2114.16		1462.3	
	20-30 cm	3648.54		1244.796		2575.4	
Site 3	0-5 cm	2078.6	12234.67	1622.32	6514	263.63	3519.485
	5-10 cm	2364.94		1648.295		358.325	
	10-20 cm	3809.4		1650.74		1179.1	
	20-30 cm	3981.735		1592.694		1718.4	

Then we do an average with site 1 and 3 which have the same depth :

	Org - P (mg /m ²)	Fe - P (mg/m ²)	Labile - P (mg/m ²)
Site 1-3	13120.349	7670.405	3075.984
Site 2	12571.71	5914.871	4664.2

Now we have to determine the area of each part of the lake : 4-10 m and 10 -14m depth. To do that we used a free software : Imagej. This software allows us to estimate the area on a picture thanks to a scale previously done on the same picture. So we used the map of the lake that we can find on the figure 6.

Total area : 4-14 m (m ²)	10 -14 m area (m ²)	4 – 10 m area (m ²) (*)
9546530	1629432	7917098

(*)4 – 10 m area (m²) = Total area : 4-14 m (m²) - 10 -14 m area (m²)

Then we multiply the total area with the global amount of P (mg/m²) and we translate it in tons:

	Org - P (tons)	Fe - P (tons)	Labile - P (tons)	Total (tons)
Site 1-3	103.875	60.727	24.353	226.678
Site 2	20.485	9.638	7.600	

There more than **226.7 tons** of available P in the first 30 cm of sediments in the lake.

Appendix 10 : Estimation of the P inflows from the rivers

Table 42 : Estimation of the P inflows

River	A		B			C		
	Flow (m ³ /s)	factor	Flow (m ³ /s)	Phosphorus µg/l	Amount of P (kg)	Flow (m ³ /s)	Phosphorus µg/l	Amount of P (kg)
01/12	0.881	0.587	1.37	1.0	393.8	10.5	46	1293.7
02/12	0.391		0.629			5.64	40	565.3
03/12	0.165		0.262	0.180	28.5	2.59	39	270.5
04/12	0.0497		0.0988			1.32	33	112.9
05/12	0.0379		0.0757	0.067	42.37	0.990	30	79.5
06/12	0.0320		0.0583			0.666	57	98.4
07/12	0.0394		0.0713	0.059	50.3	0.841	71	159.3
08/12	0.0287		0.0460			0.495	37	49.1
09/12	0.0259		0.0436	0.065	55	0.429	210	233.56
10/12	0.0543		0.0867			1.59	51	217.2
11/12	0.227		0.350	0.582	242.1	4.44	66	759.6
12/12	0.491		0.813			6.75	85	1536.7
01/13	0.645		1.01	0.905	184.4	8.92	43	1027.3
02/13	0.481		0.799			6.79	42	689.9
03/13	0.133		0.250	0.272	31.5	2.55	28	191.2
04/13	0.156		0.293			2.91	14	105.6
05/13	0.0324		0.0717	0.073	108.4	0.884	31	73.4
06/13	0.0376		0.0752			0.784	61	123.0
07/13	0.0409		0.0780	0.064	92.2	0.759	62	126
08/13	0.0314		0.0505			0.449	60	72.2
09/13	0.0295		0.0467	0.083	43.23	0.379	37	36.3
10/13	0.0706		0.119			1.30	72	250.7
11/13	0.381		0.560	0.691	243.83	5.90	72	1101.1
12/13	0.552		0.821			6.89	64	1181.1
Total amount of P kg/year	445.03		758.14			5177.6		
Total amount of P kg/year	6380.8							

- 1) Estimation of the flow factor. To do this the flow of the river A has been divided by the flow of the river B for each month. Then an average was done with all the results to get a flow factor around 0.587.
- 2) Calculation of the total amount of phosphorus coming from the river B. First we can see that there is not all the data concerning the phosphorus concentration. We only have 1 value every 2 months. So to do the estimation of the amount of P we did an average of the flow every two months and then we multiply it by the P concentration. We get an amount of P for every two months. Then to have the total amount of P (kg/year) we add all the results and then we divide it by two to get an average for one year.
- 3) Determination of the amount of phosphorus coming from the river A. For this step we only have to multiply the total amount of P coming from B by the flow factor : $758.14 \times 0.587 = 445.03$

Appendix 11 : Determination of the P outflow

Table 43 : Estimation of the release of P from the lake

Outflow			
	Phosphorus $\mu\text{g/l}$	Flow (m^3/s)	Amount of P (kg)
01/12	51	13.5	1844
02/12	49	6.52	800.5
03/12	40	5.06	542.1
04/12	9	1.24	30.2
05/12	28	1.19	89.24
06/12	23	0.753	44.9
07/12	26	0.993	69.2
08/12	140	0.624	234
09/12	200	2.74	1420.4
10/12	160	2.45	1050
11/12	110	2.77	790
12/12	91	5.91	1440.5
01/13	61	12.7	2075
02/13	59	9.20	1313.1
03/13	42	4.09	460.1
04/13	38	3.15	310.3
05/13	18	1.06	51.1
06/13	30	0.946	73.6
07/13	44	0.800	94.3
08/13	160	0.500	214.3
09/13	130	2.75	926.64
10/13	30	2.37	190.4
11/13	61	2.84	449
12/13	45	7.56	911.2
Total amount kg/year		7711.87	

ABSTRACT

The Vomb lake (Vombsjön) is a tank of water which is used by Sydvatten for drinking water production. Unfortunately, the lake is confronted by the phenomenon of Eutrophication. It leads to an algae development which can produce and release toxins in water. The main origin of the algae growth is the presence of a too big amount/concentration of phosphorus. So the order of this study is : to determine the amount of phosphorus stored in the sediments and also the proportion of each P-fractions, to do the profile of the water column at 6 different sites and to estimate the phosphorus balance of the lake.

It will be highlighted in this report that there is more than 590 tons of phosphorus stored in the sediments. Moreover, 38% (226 tons) of this amount concern three P-fractions which are the most labile and so which can lead to a phosphorus release from the sediments. This report also shows that a thermocline can be present in the lake for short periods (depending on the weather), and leads to anoxic conditions at the bottom of the lake. These conditions are required for a phosphorus release by the labile-fraction. To finish, concerning the phosphorus balance, it seems that the lake is losing 1.3 ton of P every years. However it is necessary to re-evaluate this result if a new study is done concerning the P in Vombsjön's inflows and outflow.

RESUME

Le lac Vombsjön (à côté de la commune de Vomb) est sujet au phénomène d'eutrophisation. Celui-ci entraîne le plus souvent le développement d'algues qui peuvent produire et relâcher des toxines dans l'eau. Dans le cas du lac de Vomb ce problème est d'autant plus important que le lac est utilisé par Sydvatten afin de produire de l'eau potable. La principale cause du développement massif d'algues (aussi appelés « blooms ») est un excès en phosphore dans le lac. Le but de cette étude va donc être : de déterminer la quantité de phosphore stockée dans les sédiments et la proportion de chaque fraction de phosphore, faire le profil de colonne d'eau à 6 endroits différents, et d'estimer le bilan du phosphore dans le lac.

Il sera mis en évidence dans ce rapport qu'il y a plus de 590 tonnes de phosphore stockées dans les sédiments, et que 38 % de ce stock (226 tonnes) concernent les fractions qui sont les plus aptes à relarguer du phosphore (fractions labiles). Il sera aussi montré qu'une thermocline se forme dans les eaux du lac pendant plusieurs jours à plus d'une semaine (en fonction des conditions climatiques) et provoque des conditions anoxiques au niveau des sédiments. Celles-ci vont alors entraîner un relargage du phosphore contenu dans les fractions labiles. Pour finir, ce rapport montre qu'il y a plus de 1.3 tonnes de P qui quittent chaque année le lac. Cependant ces résultats sont à prendre avec précautions et devront être réévalués dès qu'une nouvelle étude concernant le P dans les affluents et effluents du lac de Vomb sera réalisée.