Biodiversity of Rivers – Comenius Program 2013 – 2015 – Cyprus

Characterization of a river in Cyprus based on its nutrients and flow.

The following paper become from actions that have been in Saint Anthony's School for the purpose of the Comenius Program 'Biodiversity of Rivers'

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Introduction

The importance of rivers for humans is very high. Depending on the length, the level and the flow of a river can be used in many ways. For example, a river that has a calm flow and a high water level can be used as a waterway. In this way, people in the past carried goods and made the communication between regions which were in different parts of the river easier. If a river is raging, it can be used for the generation of electricity, as well as in hydroelectric power plants next to it. The waters of the rivers can be used for the irrigation of farmlands, as well as for water supply. The areas along the river are fertile and assist in the development of agriculture, because of the solid matter sediment of rivers.
In the context of our work we have looked at various factors which are an indication of the quality of water in a river. There is a reference to the rivers of Cyprus and then to detailed measurements that we have conducted in a river in Limassol.

The distribution of water on the planet

Almost ¾ of the Earth's surface is covered by water. Also, almost 97% is salt water which is located in oceans and rivers. The remaining approximately 2.5% of the water on the planet is fresh water, from which 68.6% is bound in the glaciers of the poles, 30,1% is in the form if underground water in underground tanks (aquifers) and only 1.3% is surface water in rivers and wetlands in the form of regional and atmospheric humidity (Papatheodoulou, 2013, Tutorial). The remaining 1% (surface water) shall be allocated primarily to snow and lakes and only 0.5% of the world's surface water flows in rivers (approximately 0,0001625% water world, **im. 1**.))

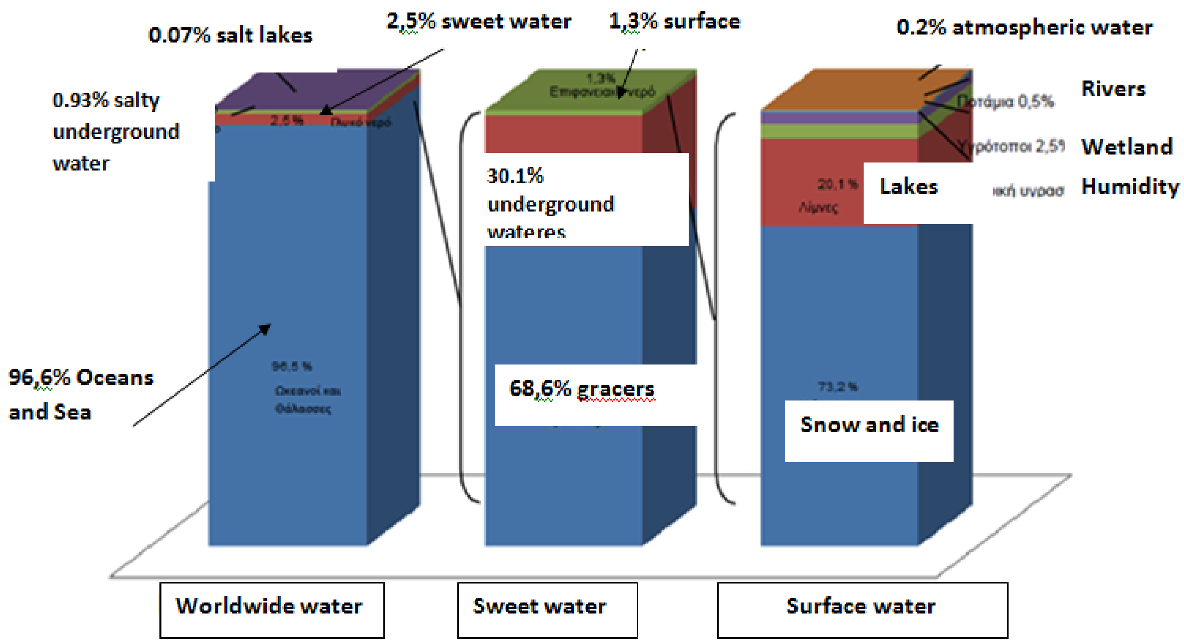

Image 1: The forms of the world (educational quide: ''Learning for Rivers in Rivers'', Papatheothoulou, 2013).

Introduction to the study of the river

Rivers are natural corridors of water springing from the mountains and ending at a sea or lake.

How is a river created? The sources start as small streams which join the bigger streams that we have from the rain and the melting of ice. All these streams join together(contribution river) and create the main flow of the river. The main flow is the most significant part of the river where it can mix with its tributaries. The part where two rivers join is called contribution. The main flow is usually found in a plain. The

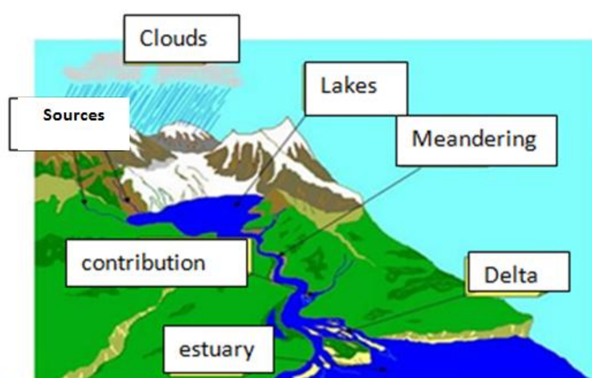

Image 2: The main characteristics of the river

continuous sharp turns of the river are called meandering. The estuary is the section of the river that flows into the sea. At that point it is divided into smaller parts forming many times a Delta **(im. 2).**

Dams are also very important, particularly in Cyprus. Dams are constructed as a measure for saving water and for the collection of river water, so that it will not end up in the sea and remain unused. In Cyprus until today we have 108 dams with a total capacity of 331,933,000 m^3, which makes Cyprus a pioneer in Europe. The water that is saved is used for water supply and irrigation. The dams are very important for Cyprus since the water is a natural resource of the island of which there is a shortage. **(im. 3)**.

Image 3: *The Kouris dam is the largest dam in Cyprus. Three rivers end up in this dam: the river Kouris, the river Limnatis and the river Krios. It's placed in the district of Limassol.*

Image 4: *Overflow of Kouris dam.*

On the other hand, rivers and dams in addition to being a source of life, can cause many problems when they flood. More specifically, the overflow of rivers that is due to bad weather the poor construction of dams or even the poor construction of flood projects, has disastrous consequences, on the fields and residential areas which are located near the rivers **(im. 4)**.

Visit to the River Krios

On 12.9.13 we visited Krios river, which is one of the 3 rivers that flow into the Kouris dam. From the dam, the water goes almost throughout Cyprus and is used for collecting and storing water from the southeast side of Troodos. The sample was taken near the village Lofou, below the flow meter of the department of water Development. The flow meter is a construction which makes continual measurements of water flow. There we were divided in to three groups. Each group was responsible for taking different measurements. In the first group, member where assigned to take measurements of the water flow and the opacity. The second group, which was our group, had to take measurements of the nutrients of the water from the river. Finally, the third group, with the use of special equipment (the pH-meter and the oxygen-meter), had to take measurements of pH (acidity-pH) and the concentration of oxygen dissolved in water.

Below are described some characteristics of measurements the made on the day of the sampling, and the method used for this. Before we continue with the process of measurement, we will mention some important features of these measurements and why we need to take these measurements in rivers. The measurements and the methodology of each group are shown below.

Measurement of flow (speed) of water

The flow is a key determinant of the ecological characteristics of rivers. The speed varies according to the angle of the ground and the shape of the river bed, and decreases due to friction. As the water flows, the speed is not the same at all points of a cross-section of the river. (This is confirmed by the measurements that we have made in the continuation of our reference). The water flow (speed) is measured by the flow meter **(im. 5).**

Image 5: Flow meter.

To measure the flow of water in various parts of the river, the flow meter was used for the speed of the water and tape measure for the calculation of the width of the watercourse and the distance from the bank of the river. The depth gauge and/ruler was used to measure the depth of the water, as shown in image **6.** In particular, starting from the bank of the river the speed of water was measured every half meter so that we had the water flow at in each point of the river so as to be able to calculate the supply of water. Also, at the same time the flow rate of the river was measured and the depth of the river at this point in orders to estimate the cross-sectional area of the water.

Image 6: Measurements of water flow at various points of the river.

The measurements are shown in the table:

Table 1: *Measurements of the speed of the water and the depth of the river at various distances from the one side of river to the other.*

Distance from Bank (m)	Depth (cm)	Water Speed (m/s)
0.5	0.16	0.7
1	0.15	1.5
1.5	0.15	0.9
2	0.12	0.4
2.5	0.10	0.1
3	0.13	0.2
3.5	0.11	0.1
4	0.10	0.2

On the basis of Table 1 we can see that on one side of the river the water speed was bigger than that on the other side of the river. Also, on that bank the river was a little deeper.

Calculation of the flow of the River

We use the term **flow** of the river to refer to the volume of water that passes through a given cross-section of the river bed per time unit (e.g. water volume per second). By multiplying the cross-sectional area of the river at a point with the average speed of the water at this point, we calculate the volume of water passing through from the surface intersection of the river at the unit of time. The unit of measurement is the m3/s. The flow of water does not remain constant throughout the year.

For the conversion of the speed of water (m/s) flow in m^3/s used the relation:

Q= ΣAiVi

Where:

Q= flow (m^3/s)

A= cross-sectional area river

V= water speed (m/s)

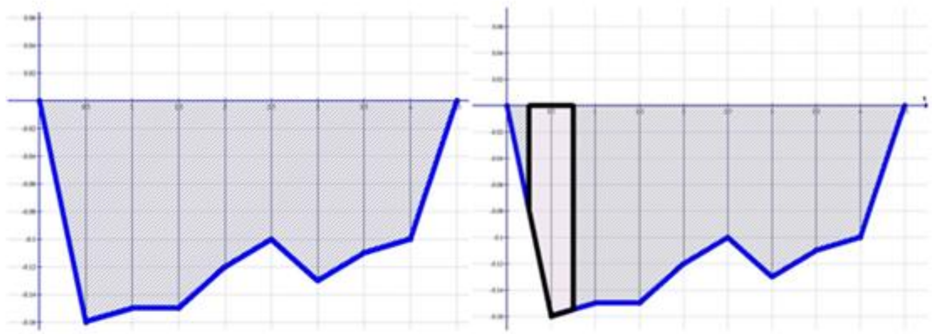

Image 7: Calculation of the sectional area of the river. The area of each separate incision needed was calculated by the program graph32 in which we represented the riverbed as you can see in the picture.

Measurements of the flow rate were determined in accordance t with **Table 2,** calculating this each variable of water flow.

Table 2: *Calculation of the water on the river Krios (Monday 9 December 2013 at 10.00 a.m.)*

Average distance (m)	Sectional Area of the river	Water Speed (m/s)	Flow ($m^{3/}s$)
0.25-0.75	0.069375	0.7	0.0485625
0.75-1.25	0.075625	1.5	0.1134375
1.25-1.75	0.073125	0.9	0.0658125
1.75-2.25	0.060625	0.4	0.02425
2.25-2.75	0.053125	0.1	0.0053125
2.75-3.25	0.061875	0.2	0.012375
3.25-3.75	0.055625	0.1	0.0055625
3.75-4.25	0.044375	0.2	0.008875
4.25-4.50	0.006250	0.7	0.004375
		Total Flow (m^3/s)	0.2885625

The individual measurement of flow cannot lead us to a final conclusion on the amounts of water that are transported to the Kouris dam, because at the same time many parameters have to be taken into account such as rainfall. Near the point at which the measurements were made there is the flow-meter station of the Water Department of Development. The calculation of flow in rivers is a very important parameter because it is an indication of the volume of water supply to dams and hence the quantity available for the citizens. Also the calculation of the flow at various points along a river can give us an indication of the use of water upstream. For example, if reduction of flow from one point to another along a river is observed than a hypothesis can be formulated for the extraction of water directly from the river, having previously ruled out natural water loss. Taking into account the limited rainfall the previous two months prior to sampling, we believe that the flow of water is reduced. For a more complete picture and the drawing of conclusions we should have had rainfall and flow data from previous years for comparison purposes.

Measuring the turbidity of water

Image 8: Here Mrs. Athena explains the difference between water that is cloudy and water that is clear.

On the day of the sampling, we also took measurements of the turbidity of the water, i.e. how cloudy the water is. The calculation of the turbidity of the water is important because the rays of the sun, if the water is cloudy, can't get to the plants below the water and so there is no photosynthesis. Also, within the river we have animals that breathe with gills, and if it has sediment, then this may get stuck on their gills and they could die.

Image 9: Turbidimeter

Turbidity can be measured with Ntu (nephelometric turbidity unit). For the measurement, after taking the sample of water from the river, this water is shaken so that any solids inthe sample can be mixed evenly. The measurement of turbidity can be done with the turbidimeter **(im. 9)**
For the measurement of turbidity we followed the procedure below:

Image 10: Here the 10ml water is transferred in the bottle, after the team took a sample of water from the river. The bottle then goes into the turbid meter for measurements.

- Sample water 10 ml was transferred to bottle where the measurement would be conducted. **(im. 10)**
- The bottle was closed and wiped well.
- The bottle was placed in the turbid meter and the order was given for the measurement.
- After several seconds, the display of the turbidity of the water was 19.27 Ntu.

The single value of the measurement cannot lead us to terminal conclusions regarding water quality in the river Krios. Generally, it may have changes throughout the year, especially seasonal ones. After heavy rains we expect high opacity value, because of the sediments washed into the river. It should also be taken into consideration that if there was another group within the river upstream at the point of the sampling, that would increase the opacity with the scraping of the sediment of the bottom.

pH measurements, water temperature (θoC) and quantity of the Dissolved Oxygen (DO) in the water.

Image 11: Oxygen meter.

The oxygen meter (im. 11), takes the measurement of dissolved oxygen and the temperature of the water. The dissolved oxygen in the water, has a direct relationship with the temperature. As the temperature increases, the dissolved oxygen in water decreases. In the summer we expect to have lower oxygen concentrations in water because of the high temperature.

The dissolved oxygen (DO- dissolved oxygen) in rivers is required by all the aerobic organisms and that's why it is vital. This oxygen comes from 3 major processes:

- From the airing of water during the flow
- From the photosynthesis from the plants of the river and
- From the diffusion of oxygen into the atmosphere.

The concentration of oxygen depends on many factors according to the above processes. Small values of dissolved oxygen show waters strongly laden with organic substances. Unit of measurement of dissolved oxygen is the mg/l (i.e. the mass of oxygen in mg (10-3 g) in each liter of water). *The measurement showed that the quantity of dissolved oxygen in the water of the river Krios was **11.3 mg/l.***

The temperature of the water of the river is a parameter which has great importance in aquatic environments, as it establishes the presence or not, of some specific groups of micro-organisms. The temperature has a significant influence on the density of the water, the solubility of the ingredients in water, the pH, conductivity, and the rate of chemical reactions and biological activity developed in water. The temperature certainly depends on where we are, which period of time it is and at what altitude we are. Unit of measurement for the temperature is the Celsius degree.

The measurement of the temperature in the river Krios on 19 December 2013 at 10:00am was **5.2** degrees Celsius.

The pH meter **(im. 12)** calculates the acidity of the water, the pH of the water. To take measurement, the meter was immersed in water and the machine was instructed to provide the measurement. The pH has no unit of measurement. The values it takes are between 0 and 14, with 7 being neutral and the values above 7 basic and below 7 acid as we approach the two ends of the scale of measurement. The pH is affected by temperature, rocks (the salts present on the rocks), photosynthesis, free CO2, organic acids and the salts of strong acids. The pH has a particular importance as the living organisms (organisms in rivers) have their own range of values and show little tolerance to changes. In our case the **pH was 9.38**.

Image 12: pH meter.

Nutrients of the river water.

Nutritive salts are inorganic materials necessary for life, since their basic components are used or as building materials, either for energy production through oxidation. The main characteristic of nutrientive salts in waters is that they are seasonal and have regional variation. The biological productivity in water also depends on the nutritive salts dissolved in this.

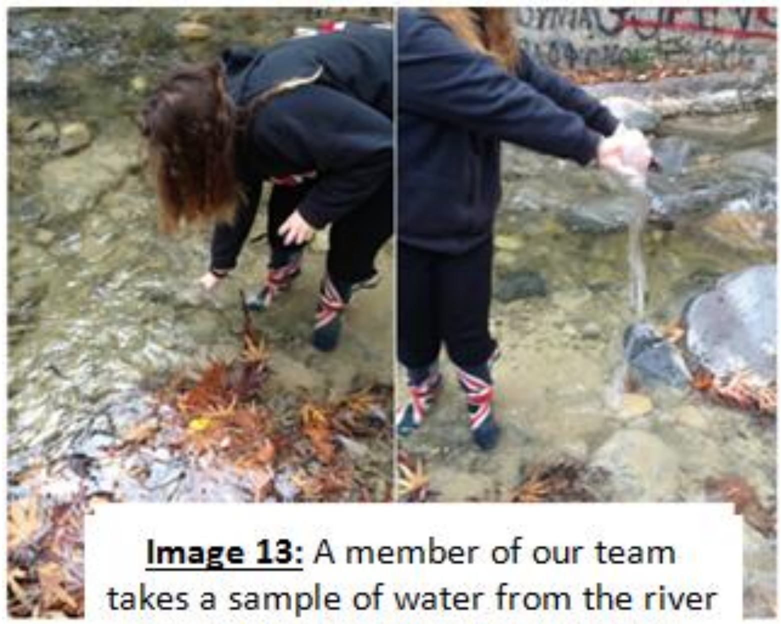

Image 13: A member of our team takes a sample of water from the river for the measurement of nutrients.

Image 14: Chrome meter - the measuring instrument that we used for the measurement of nutrients.

Our group was responsible for the measurement of nutrients in the water from the river. We had to measure for the nitrates , phosphates and ammonia contained in the water of the river.

For correct measurement the bottle had been rinsed at least three times.

In general, since nitrates and ammonia are nitrogenous compounds, we do not expect large quantities in clean rivers that are not affected by the presence of people. Increased concentrations indicate contamination/pollution in the water. Ammonia comes primarily from fertilizers and from the decomposition of organic substances, such as waste or household waste. The above also apply to phosphates. To measure the quantity of nutrients in mg/l we used the chromo meter **(im. 14).**

The methodology followed for the measurements of nutrients was as follows:

- We put some water from the river in a bottle.
- For each analysis we transferred 10ml of water in bottles.
- We calibrated the measuring instrument with deionized water.

Image 15: The bottles for the measurement of nutrients.

Measurement of Ammonia

As explained above, if we find high ammonia concentration, *then we see a recent index of water contamination.*

Also, we put special ammonia pills in the water to release the ammonia. We could not touch the pills with our hands.

- Firstly we took the first bottle with 10 ml and put the pill 1. Immediately we dissolved it well in the water.
- Then into the same bottle we put another pill (pill 2) and dissolved it. (Here we saw the reaction, the liquid turned yellow.)
- We shook well and wiped the bottle without touching the glass, so we wouldn't leave any fingerprints on the glass.
- We then put the bottle in the machine pressed the test button and waited for 10 minutes.

*The measurement that we got for the ammonia was **0.38 mg/L.***

Image 16: *Special pills of ammonia and their dissolution in water.*

Measurement of Phosphates

As we have said above we do not expect large phosphate concentrations. In the water we've put specific phosphate pills.

- We calibrate the machines.
- We then take the second bottle with 10 ml and put pill 1 and then dissolve the pill.
- Then we put in the same bottle pill 2 and dissolve it as well.
- We shake the bottle and then wipe without touching the glass.
- Then we put the bottle in the machine and wait for 10 minutes.

*The measurement that we got for the phosphate was **0.08 mg/L.***

Image 17: *Phosphorus pills.*

Measurement of Nitrates

As mentioned before, we don't expect large quantities because nitrates are nitrogenous unions. Below we used special pills for nitrates.

- We took the third bottle with 10 ml and put pill 1 in the water and dissolved it.
- Then immediately we put pill 2 and dissolved it also.
- We closed the bottle and shook it well. In addition, we wiped without touching the glass.
- Then we calibrated the machine and put the bottle in for 5 minutes.

*The measurement that we got for the nitrates was **0.1 mg/L**.*

Image 18: Nitrate pills

Conclusions from the measurements of nutrients

The measurements of nutrients are a good indicator of the quality of the water from the river at the moment of sampling. For conclusive conclusions about the pressures of the river, such measurements must be taken repeatedly over time, and at many points in the course of the river, in order to cover all the seasons of the year and possible activities (e.g. fertilization of adjacent fields, water extraction, waste disposal etc).

General conclusions

Rivers are very important and at the same time very sensitive systems for Cyprus with its limited water resources. Any burden charge placed on their situation has a direct impact on us. It is very important to learn to appreciate and to protect these sensitive systems which offer us, in addition to the natural processes of transportation, filtration and conservation of species of flora and fauna, areas for relaxation, walking, and inspiration.

BIBLIOGRAPHY:

Texts:
(A) Tutorial riversQ Learning rivers in Rivers, Athina Papatheodoulou, 2012, Cyprus
(B) Our own notes from the 12.9.13 with the help of Mrs Athina Papatheodoulou.
(C) Wikipedia. ***http://bit.ly/1er1PA1***

Photos:
(A) Tutorial rivers.
(B) Photos that we took.
(C) Photos by Mrs Athina Papatheodoulou.