

## WASTEWATER TREATMENT AND ITS INFLUENCE ON SURFACE WATER IN UPPER PARTS OF JIZERA MOUNTAINS

Kateřina ZÁKOUTSKÁ<sup>1\*</sup>, František TOMAN<sup>1</sup>, Petra OPPELTOVÁ<sup>1</sup>, Jakub ELBL<sup>2</sup>

<sup>1</sup>Mendel University in Brno, Faculty of Agronomy, Department of Applied and Landscape Ecology, Czech Republic

<sup>2</sup>Department of Agrochemistry, Soil Science, Microbiology and Plant Nutrition, Czech Republic

\*(Corresponding author: zakoutska.katerina@gmail.com)

### Abstract

Jizera Mountains in the north part of Bohemia (Czech Republic) are increasingly the destination for visitors and tourists, who find here fun, movement and relaxation not only in summer but also in winter. Most of the visitors find some accommodation just in the center of Jizera Mountains. Therefore most of historical buildings in this area are rebuilt on recreational facilities. These objects are usually quite far from bigger village or towns, so they are not connected onto the public sewerage and they deal with their wastewater treatment individually.

This thesis is focused on two locations: Smřdava Cottage and settlement Jizerka, which are both in the heart of the mountains and deal with wastewater treatment in a similar way, but each with different results. The influences of surface water by this are monitored above and below the place, where the treated waste water is let out. This influence is monitored with measurement of physicochemical indexes of water quality both in terrain with the portable meter and in laboratory with spectrophotometry method. Readings are compared with legislation in force in Czech Republic. This project has started in March this year, so the results are not completed yet. But it is already possible to state that in settlement Jizerka the wastewater treatment is more effective and influence water quality less than in cottage Smřdava.

**Key words:** wastewater treatment, surface water, recreation facilities, water quality

### Introduction

Water is matter necessary for live on our planet and very important economic material. That's why it is important to deal with its quality in streams and reservoirs and to realize that everything passes thru the pipeline could end in a stream.

The Czech Republic is a state lays on a interface of three drainage, therefore we can say, that our country is like a "roof of the Europe". Quality of outflowing water depends particularly on natural conditions, but the main influence comes from anthropogenic activities.



**Fig. 1: Area of interest in the Czech Republic**

At the beginning of 90's of 20<sup>th</sup> century the water pollution, mainly surface water, was perceived as one of the main issues of Czech environment. Majority of significant flows belonged into the class of strongly or very strongly polluted flows. Even serious contaminations of ground water appeared. Cessation or restriction of some of big industrial productions resulted in decrease of pollution discharged from point sources. While in the first half of 90th the volume of discharged pollution decreased mainly due to a decrease of the production, from the mid-90<sup>th</sup> an effect of large-scale construction and modernization of waste water treatment plant (WTP) technology began to show, which has continued until nowadays. [5]

Notwithstanding the pollution of streams decrease, an importance of pollution by substances, which are difficult to remove, increase. Load phosphates and inorganic nitrogen, which comes from agriculture and household (mainly from washing powders), is very serious. Some of point sources without the third level of waste water treatment contribute to this too.

Not only big city agglomerations or industry areas on lower parts of the rivers pollute the streams, it starts already on upper parts. The Sm dáva cottage could be a simple of this issue. This place is situated in the central part of Jizera Mountains. This chalet is very attractive for tourists; it is secluded without connection to public sewer. It has its own treatment plant, but it not effective enough to manage higher flow during the tourism season. The river Sm dá is a recipient of the purified water, the water quality is getting worse by this.

The second locality, which was chosen for this study, is an opposite of this situation. It is Jizerka settlement, also in the central part of Jizera Mountains without connection to public sewer, but wastewater disposal is designed so that the water quality in the river Jizerka is not influenced.

### Materials and Methods

Jizera Mountains are on the north of Czech basin by the borders with Poland (see Fig. 1). It is a typical Hercynian Central Mountains, which flush with the edge of forest but with well developed montane communities and with great large-scale peats on top platforms. Industrial air pollutants mainly in 80<sup>th</sup> of previous century have caused catastrophic breakdown of both spruce monocultures and natural spruce forests on a giant area. On the other hand extensive beech forests retained on north slopes. [3]

At the turn of 1967 and 1968 protected landscape area (PLA) was declared with the area 368 km<sup>2</sup> mainly for protecting extensive forests (73 % of PLA; 269 km<sup>2</sup>). [9]

Altitude is between 700 and 1000 m asl. This country is nearly unsettled, nevertheless very important terms of tourism. Annual precipitation reaching even 1300 – 1800 mm is one of the highest in the Czech. The average annual temperature in 789 m asl is + 4,4°C. Surface water is acid, low mineralized with higher content of aluminum. This area is situated on the watershed of the rivers Elbe and Oder. This territory consists of Krkonoše-Jizera Massif. The main rock is granite (simple Liberec granite).

Terrain is ragged, mostly with large gradients of slopes. Forrest soils are partly waterlogged and peaty. In Jizera Mountains there is water naturally acid and mineralized. But increased deposition during 80<sup>th</sup> negatively influenced water quality. [1]

**Sm dava** is a name of area around the same name chalet in Jizera Mountains in 847 m asl (see Fig. 2, 3). It is a place of confluence of rivers Bílá, ěrná and Hn dá Sm dá (White, Black and Brown Sm dá) and therefore of emergence of the river Sm dá. The chalet Sm dava with a bigger part of parking places around belongs to the municipality Bílý Potok (White Stream). North of the chalet there is a group of houses, which belongs to the Hejnice town.

The river Sm dá stems in the east part of Jizera Mountains; near the village Ves it crosses the state border with Poland in 209 m asl. Catchment area is 273,8 km<sup>2</sup>; length of the river is 45,9 km, average flow on the borders is 3,61 m<sup>3</sup>.s<sup>-1</sup>. [6] Water quality in this river is influenced by the lack of solutions of wastewater disposal in chalet Sm dava. Nowadays a new project of construction of treatment plant is now approved. This project should be realized till the end of 2013, it will cost roughly 1,5 mil. CZK

The first mention of settlement **Jizerka** is from 1539, when it was the seat of fowlers. Later lumberjacks and collectors of precious stones came. In the mid-19<sup>th</sup> century two glassworks were established, one of them is still working. The same name stream flows through the settlement as well as stream Saphir, where were deposits of precious stones (sapphire, ruby, chalcedony, topaz). [4] About 10 residents live there permanently.

Jizerka is exceptional by its altitude, which is 850 – 900 m asl. The combination of the altitude, relief of the valley and the river Jizerka supports the extreme weather in winter time. [4] The maximum snow depth 29. 4. 1944 was 315 cm. Instantaneous measured value -36°C appeared several time. Temperature under the freezing-point occurs even in the summer. [1]

Geografická mapa Libereckého kraje  
Geographical map of the Liberecký Region



Fig. 2: Area of Liberec Region with marked area of interest (yellow stars)



Fig.3: Location of sampling water (stars) ([www.mapy.cz](http://www.mapy.cz))

Due to convenient location the settlement is an often destination of variety recreation activities. Accommodation holiday homes gradually adapted to this fact. Thanks to the distance from other municipalities this settlement is not connected to the public sewerage system. Wastewater of

permanent settlers is accumulated into the endorheic sink with subsequent removal to the treatment plant in Tanvald (15 km far). Other wastewater flows after individual pretreatment in septic right to the river and very often to the soaking. Mountain Ranch Jizerka in the middle of the settlement has its own domestic WTP with 13 biodisks for 130 population equivalent (PE). [7]

On these localities sampling is realized monthly. Water samples are taken above and below expected sources of pollution (see the Fig.: 3). The most important chemical parameters of water quality are a scope of the analysis (COD, total nitrogen, total phosphorus, nitrous nitrogen, ammonia nitrogen, chlorides, sulphates, iron, manganese). These are determined by spectrophotometry methods. Other indicators are set in the field using portable multimeter HQ30d by Hach-Lange (temperature of water, dissolved oxygen, conductivity and pH).

### Results and discussion

How Sm dava so Jizerka are situated on the upper parts of rivers in the top part of Jizera Mountains. That's why the surface water has very high quality, this is seen in results from places above recreational facilities, where values measured are under the limits set by the law (see Fig.: 5; 6)

PH-value, which is nearly in all of cases on both localities under the limit given by law, is a result of presence of large peats, which are typical for this area (National Nature Reserve Jizerka peat). As Kulasová sais (2006), water in Jizera Mountains are naturally acid and low mineralized. Significant acidity of Jizera Mountains' environment was caused in 80<sup>th</sup> thanks to acidic atmospheric deposition.

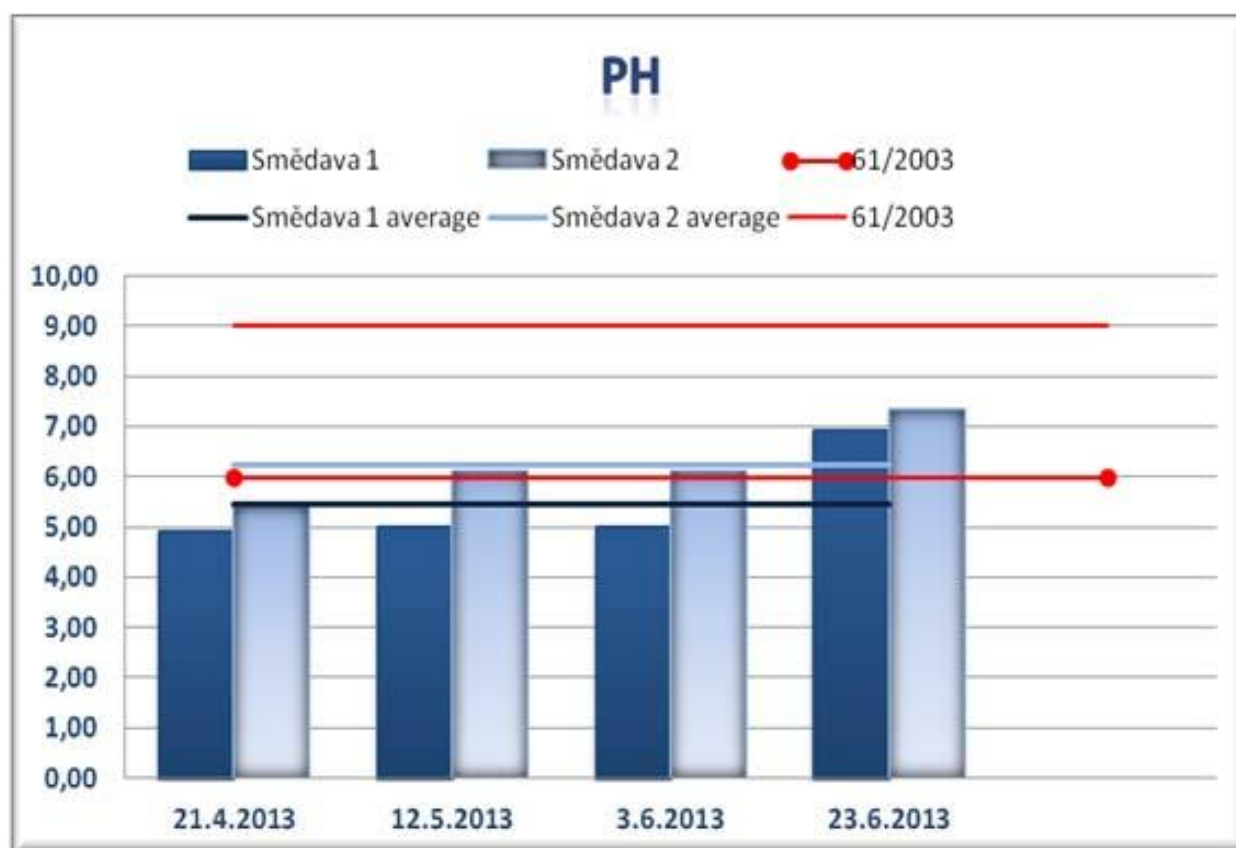


Fig. 4: pH measured on Sm dava, its average values and limits set by the legislation [2]

As results in graphs show, presence of recreation facilities has some influence on the water quality. The Fig.: 5 and 6 show increased level of some substances in March and June. High flows are cause of this phenomenon. Substances which were accumulated in the snow cover came to the flow

during the spring snow melting. Prolonged rain during June caused increase of river level. These intensive rains washed substances out of the soil.

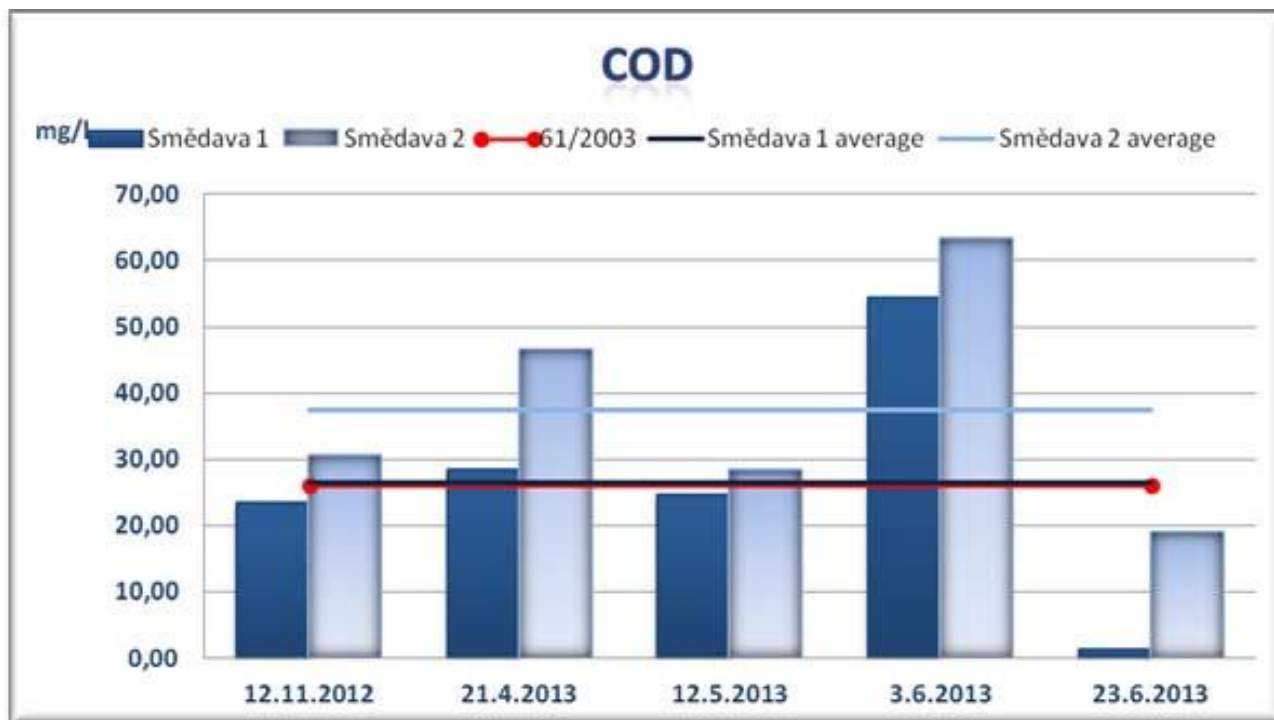


Fig. 5: Chemical oxygen demand, its average values on Smědava and limit set by the legislation [2]

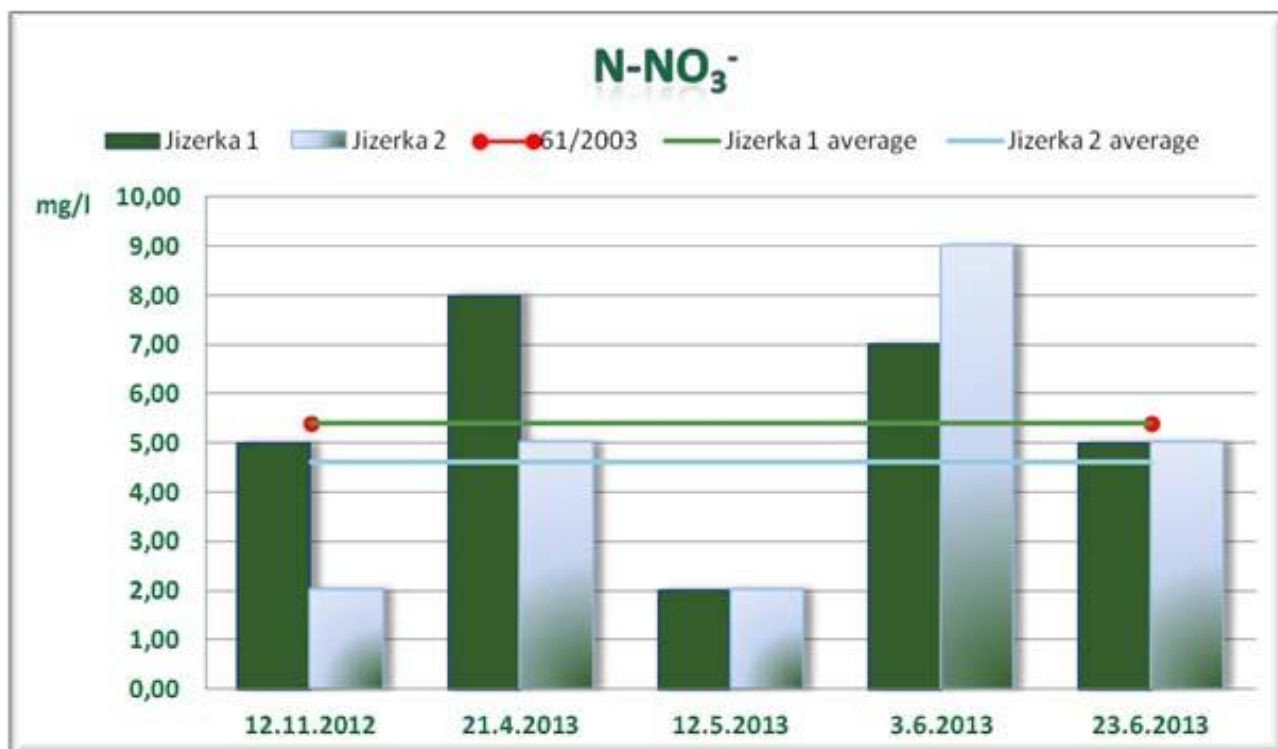


Fig. 6: Nitrate nitrogen in Jizerka, its average values and limit set by the legislation [2]

Table 1 shows a change in parameters measured above and below recreational facilities.

**Tab. 1: Percent change of water quality parameters above and below the recreational facilities**

Parameter	% of change		Distinktion Sm dava - Jizerka
	Sm dava	Jizerka	
<b>P total</b>	24,1	16,0	6,1
<b>PO<sub>4</sub><sup>3-</sup></b>	27,1	8,9	18,2
<b>COD</b>	41,7	9,0	32,0
<b>Mn</b>	25,5	6,0	19,5
<b>Fe</b>	-14,0	20,2	-34,2
<b>Cl<sup>-</sup></b>	34,7	7,2	27,5
<b>N total</b>	-38,0	-28,2	-66,2
<b>NO<sub>3</sub><sup>-</sup>-N</b>	-21,7	-14,8	-36,5
<b>NH<sub>3</sub>-N</b>	17,4	12,2	5,2
<b>O<sub>2</sub></b>	6,6	7,8	-1,2
<b>T</b>	-2,7	14,0	11,3
<b>Conductivity</b>	-16,0	-0,2	-16,2
<b>pH</b>	14,0	3,4	10,6
<b>Average</b>	7,59	4,73	-

As you can see in Tab. 1 the average percentage change in measurements is higher on the Sm dava locality. The highest change on both localities is in content of total nitrogen (38 % in Sm dá River, 28,2 % in Jizerka River), in both case it was lower bellow the settlement facilities. The highest difference between both localities is in the value of percentage change of COD (chemical oxygen demand), which indirectly shows the amount of organic and inorganic contaminants, dissolved or suspended in water. So this comprehensive indicator shows the best that on Sm dava there is the influence on water quality much higher there on Jizerka. Although on Sm dava there is just one house and on Jizerka there are about 35 houses.

Consequences of water pollution or differences in water quality are visible to the naked eye. There are changes in vegetation on the river banks on Sm dava from leaved grasses and bog species to broadleaf herbs like species of genus *Cirsium* and *Urtica*.

### Conclusion

In conclusion we can say, that results of physic-chemical analysis and measurements confirmed findings of field survey. Changes in vegetation around the water flow from chalet Sm dava and growth of algae on stones in the river basin were determined during reconnaissance. Ammonia odor is felt far from the end of pipes from chalet. Contrast, nearly no similar changes are on the second locality, Jizerka.

Proposed large-scale WTP for chalet Sm dava should solve this issue. Regular sampling and measurement is planned even for future, so it could be assessed real mitigate of negative influence of the recreational facility on the water quality in Sm dá River. This is very important not only because Sm dava is in the second water source protection zone. For preservation of water quality it's very important to strict comply all principles of water protection.

Water protection in the Czech Republic is divided into general, particular and special. The general protection is based on various legislative laws relating to the protection of individual environment components. It is obligatory for all and without any compensation. The particular protection includes protected areas of natural water accumulation, sensitive areas and nitrate vulnerable zones and for compliance with farming aren't also compensation. The special protection includes protection zones of water resources.

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