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WATER QUALITY DEVELOPMENT IN THE SEMÍČ STREAM

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Abstract

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The aims of the work were to analyse selected quality indicators of a small water stream called Semíč and evaluate the results based on the valid legislation. Eight sampling profiles (SP) were selected and water was sampled four times a year in the period May 2013–April 2014. PH, conductivity, oxygen content and temperature were measured directly in the field. Subsequently, ferrum, nitric nitrogen, ammoniacal nitrogen, sulphates, chlorides, chemical oxygen demand tested using dichromate, total phosphorus, total nitrogen and manganese were analysed in the laboratory. Analyses of selected heavy metals – zinc, copper and aluminum – were carried out in spring 2014. The results were classified in compliance with Government Decree (GD) No. 61/2003 Coll., as amended, and Czech standard ČSN 75 7221. The results of the period 2013–2014 were compared with the results from 2002–2003 and 1992. The resulting concentrations of substances manifest considerable instability during the year, which can most likely be attributed to large changes in flow rates in different seasons. When comparing the values to older results, it can be concluded that the concentrations of a number of substances have decreased; by contrast, others have increased. An extreme increase in copper was detected, where the concentration exceeded the environmental quality standard several times.

Keywords: Semíč, water pollution, revitalization of watercourses, heavy metals, copper concentration, Government Decree No. 61/2003 Coll.

INTRODUCTION

Water pollution is a major environmental issue that should be extensively investigated. It is true that a number of developed countries have done a great deal to improve the quality of the water.

Water use/reuse is complicated by water contamination. Pollution is relative and difficult to define; for example, floods and animals (dead and alive) are polluters, but their effects are local and tend to be temporary. Today, water is polluted in many ways, and pollution exists in many forms. Pollution may be apparent as excess aquatic weeds, oil slicks, a decline in sport fish populations, or an increase in carp, sludge worms, and other forms of life that readily tolerate pollution. Maintaining water quality is important because water pollution is detrimental not only to health but also to recreation, fishing, aesthetics, and private, industrial, and municipal water supplies (Spellman, 2009).

However, surface water and groundwater are constantly polluted by a large amount of chemical substances, such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organic pesticides, petroleum substances, polychlorinated dibenzo-p-dioxins and polydichlordibenzofurans (Pavlíková, 2008). Another group of substances dangerous for water quality are those derived from dibenzo-p-dioxin, collectively called dioxins. A huge issue of many streams is the increased concentration of "heavy metals"; however, we have to take into account that these can also occur in water naturally and it is necessary to distinguish if the concentration is caused by natural factors or anthropogenic activities play a role (Nábělková, 2012). Surface water and groundwater often contain high concentrations of nutrients, especially compounds of nitrogen and phosphorus, whose sources are mainly wastewater and agriculture (pesticides, fertilizers).

Throughout the word, an increase in the sediment load of stream is on of the most widespread causes of degradation in the quality of water from agriculture, grazed, and watersheds. Higher concentration of suspended sediment are often the result of accelerated erosion caused by disturbances in drainage areas, such as urban expansion, road construction, agriculture cultivation, overgrazing by livestock, logging operations, or nature catastrophes (including floods, fires, or landslides). Other problem is pollution by heavy metals. In many instances, variation in heavy metal levels in a stream are correlated with variations in sediment concentration (Brooks *et al*., 2003). Heavy metals – zinc (Zn), iron (Fe), cooper (Cu), manganese (Mn), lead (Pb), cadmium (Cd), are major toxicant found in industrial wastewaters. The presence of any of heavy metals in excessive quantities will interfere with many beneficial uses of water because of their toxicity (Spellman, 2009).

The amount of water consumed has a direct impact on the concentration of pollutants, which is a problem especially in the periods of small flow rates. This fact gains importance if we look at the development of water consumption in the Czech Republic. The decline in consumption between 1990 and 2011 was 56.2% (Pokorný, 2012).

The Semíč stream rises above the municipality Vanovice at an altitude of 450 m. It flows into the Svitava River in the municipality Svitávka at an altitude of 300 m. The area of its drainage basin from its source to the confluence with the Svitava is 56.84 km^2, the stream length is 17.945 km. The stream is divided into two basins of the fourth order, marked 4-15-02-036 and 4-15-02-038 (HEIS VÚV TGM, 2014). All the cadastral areas through which this small water stream flows have been pronounced nitrate vulnerable zones (GD No. 262/2012 Coll.). The entire basin has a large proportion of ploughed agricultural land, and ploughing in some parts reaches to the bank edge. Commonly, sloping areas are ploughed perpendicular to the contour line, which also concerns the lands immediately adjacent to the Semíč stream bed.

The research area is dominated by conifers, especially spruce. The forest cover percentage is about 20%. There are no major industrial pollution sources in the basin. The only wastewater treatment plants in the entire basin are in the municipalities Šebetov and Svitávka. The average annual precipitation sum in the Semíč basin in 1961–2000 was 600 to 650 mm. In this period, the precipitation in spring was in the range of 125 to 150 mm, in summer most abundant with rainfalls it was 250 to 300 mm, the autumn average was 100 to 125 mm, and in winter the precipitation was 125 to 150 mm (HEIS VÚV TGM, 2012). The entire area of the Semíč belongs to climatic zone MT7. This zone is characterized by normally long, mild to moderate dry summer (Tolasz, 2007).

MATERIALS AND METHODS

Eight sampling profiles were established in the drainage basin (Fig. 1). Seven of them were located directly on the small Semíč stream; one sampling profile was placed at the small Semíč tributary called Osaka. Four sampling profiles were selected so that comparison with results from previous years was possible. The results were compared with the results of the working group of 1992 published in Chemically Instrumented Drainage Basin of the Bělá and the Semíč. Additional data for 2002 and 2003 were obtained from Ing. Michal Lukeš who addressed the issue in the thesis "Adjustments in the drainage basin of the Semíč stream".

At each sampling profile, the level of dissolved oxygen in [mg.l^{-1}], conductivity in [mS.m^{-1}], the temperature in [°C], and water pH were measured and recorded. The measurements were performed using the HQ30d from the HACH LANGE company. Each sample was taken as a one-time sample and put directly into a polyethylene container rinsed at least once with a sample of water. The samples were placed in the refrigerator and processed within 24 hours.

Sampling profile 1 is located at the source of the Semíč, profile 2 is at the Osaka tributary, which flows through Šebetov, profile 3 is situated just above the village Knínice u Boskovic, profile 4 is located under the municipality Vážany, profile 5 is next to a second class road 374 above Panina louka pond (the pond was built in 2011, it does not appear in the map), profile 6 is located at the Semíč behind the Sudický potok stream mouth, on which breeding ponds have been established, profile 7 is located above the village Svitávka at the former swimming pool, and profile 8 lies in front of the Semíč confluence with the Svitava River in Svitávka (Fig. 1).

Sampling took place on May 13, 2013, July 16, 2013, October 17, 2013, January 21, 2014, and March 9, 2014; the pH, electrolytic conductivity, oxygen saturation, and temperature were determined in the field using the portable multimeter HQ30d and particular INTELLICAL probes from the HACH LANGE Company, fabricated in USA. Ferrum, nitrate nitrogen, ammoniacal nitrogen, sulphates, chlorides, chemical oxygen demand tested using dichromate, total phosphorus, total nitrogen and manganese were analysed on May 13, 2013, July 16, 2013, October 17, 2013, January 21, 2014 (manganese was not analysed on January 21, 2014 due to a lack of chemicals in the laboratory). Zinc, copper, and aluminium were determined on March 9, 2014 and March 30, 2014.

Samples were processed in the Water Management Laboratory of the Department of Applied and Landscape Ecology of Mendel University in Brno. The analyses were performed by spectrophotometer DR/4000 from HACH LANGE Company. Heat treatment of samples was carried out using the mineralization thermostat DRB 200 from HACH LANGE Company, fabricated in USA.

I: *Limit values of chosen indicators according to Czech standard ČSN 75 7221*

Indicator	Units	Class Czech standard ČSN 75 7221				
		I.	II.	III.	IV.	V.
conductivity	$mS.m^{-1}$	< 40	< 70	< 110	< 160	≥ 160
oxygen saturation	$mg.l^{-1}$	> 7.5	> 6.5	> 5	> 3	≤ 3
COD_{Cr}	$mg.l^{-1}$	< 15	< 25	< 45	< 60	≥ 60
nitrate nitrogen	$mg.l^{-1}$	< 3	< 6	< 10	< 13	≥ 13
total P	$mg.l^{-1}$	< 0.05	< 0.15	< 0.4	< 1	≥ 1
ammoniacal nitrogen	$mg.l^{-1}$	< 0.3	< 0.7	< 2	< 4	≥ 4
sulphates	$mg.l^{-1}$	< 80	< 150	< 250	< 400	≥ 400
chlorides	$mg.l^{-1}$	< 100	< 200	< 300	< 450	≥ 450
ferrum	$mg.l^{-1}$	< 0.5	< 1	< 2	< 3	≥ 3
manganese	$mg.l^{-1}$	< 0.1	< 0.3	< 0.5	< 0.8	≥ 0.8
copper	$\mu g.l^{-1}$	< 5	< 20	< 50	< 100	≥ 100
zinc	$\mu g.l^{-1}$	< 15	< 50	< 100	< 200	≥ 200

II: *Limit values of chosen indicators according to GD No. 61/2003 Coll.*

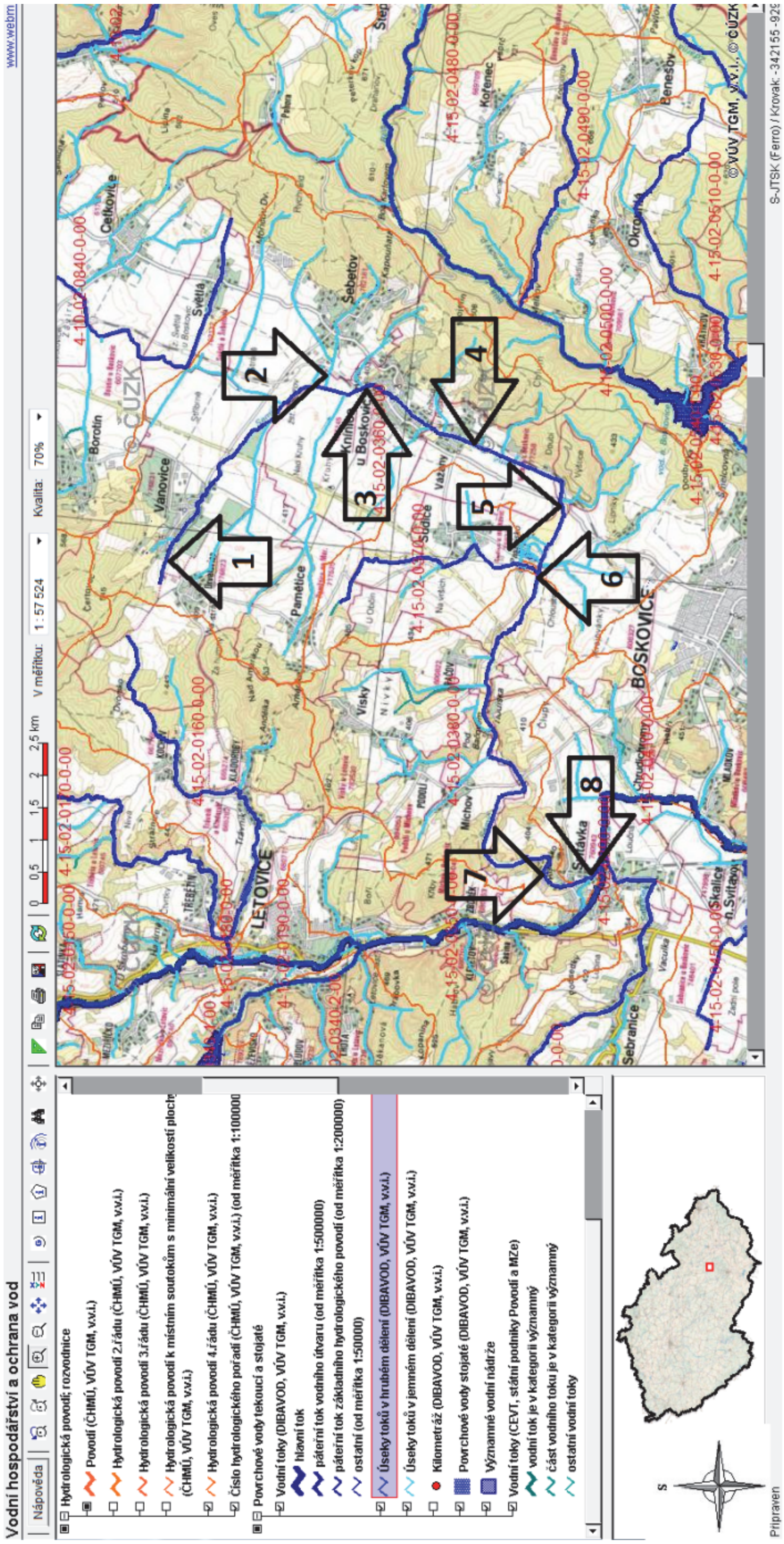
Indicator	Units	Environmental quality standard GD No. 61/2003 Coll.	
		Average value	Maximum limit
oxygen saturation	$mg.l^{-1}$	> 9	
COD_{Cr}	$mg.l^{-1}$	26	
total P	$mg.l^{-1}$	0.15	
total N	$mg.l^{-1}$	6	
nitrate nitrogen	$mg.l^{-1}$	5.4	
ammoniacal nitrogen	$mg.l^{-1}$	0.23	
ferrum	$mg.l^{-1}$	1	
manganese	$mg.l^{-1}$	0.3	
sulphates	$mg.l^{-1}$	200	
chlorids	$mg.l^{-1}$	150	
temperature	°C		29
pH	-	6–9	
aluminum	$\mu g.l^{-1}$	1000	
copper	$\mu g.l^{-1}$	14	
zinc	$\mu g.l^{-1}$	92	

For determination of total N, total P, COD_{Cr} the samples are not filtered and must be treated in the mineralization thermostat (total N 105 °C, 30 min; total P 150 °C, 30 min; COD_{Cr}, 150 °C, 120 min;). For determination of other chosen indicators (ferrum, nitrate nitrogen, ammonia nitrogen, sulphates, chlorides, manganese, zinc, copper, and aluminium) the samples are filtered and subsequently treated according to manual of HACH LANGE Company. Laboratory work mainly consisted of the precise uptake (the blank sample and the sample) and subsequent adding of reagents, then mixing, keeping of given time intervals and inserting both samples into the spectrophotometer according to Hach Lange company method (Hach-Lange, 2003).

Results obtained were evaluated in compliance with the Czech standard ČSN 75 7221 (Tab. I) and Government Decree No. 61/2003 Coll., as amended (Tab. II).

RESULTS

The resulting concentrations of substances under research manifest considerable instability during the year, which can most likely be attributed to large changes in flow rates in different seasons. The comparison of results from 1992 and 2002–2003 and 2013–2014 shows a decrease in concentration of a lot of indicators (nitrates – on the Osaka, sulfates, chlorides, manganese, ferrum); on the other hand, concentrations of other substances rose (copper, zinc). At the same time, the concentrations of indicators observed fell at some of the sampling profiles, but rose at others.



1: *Sampling profiles on the Semíč stream and its tributary Osaka*
source: heis.vuv.cz modified by authors

The concentrations of sulphates did not exceed the limit of the environmental quality standard of 200 mg.l^{-1} at any of the sampling profiles; also the values of chlorides ranged in concentrations up to 45 mg.l^{-1} (the environmental quality standard sets 150 mg.l^{-1}).

The pH value increases constantly in the direction from the source to the mouth, with occasional fluctuations. Government Decree No. 61/2003 Coll., as amended, stipulates an average pH between 6 to 9. The pH average value did not exceed this environmental quality standard at any of the profiles observed. However, the average pH value at sampling profiles 7 and 8 was close to 9. This increase in pH at the sampling profiles is probably caused by a higher photosynthetic activity, which is supported by the fact that also the average oxygen saturation at these sampling profiles was higher.

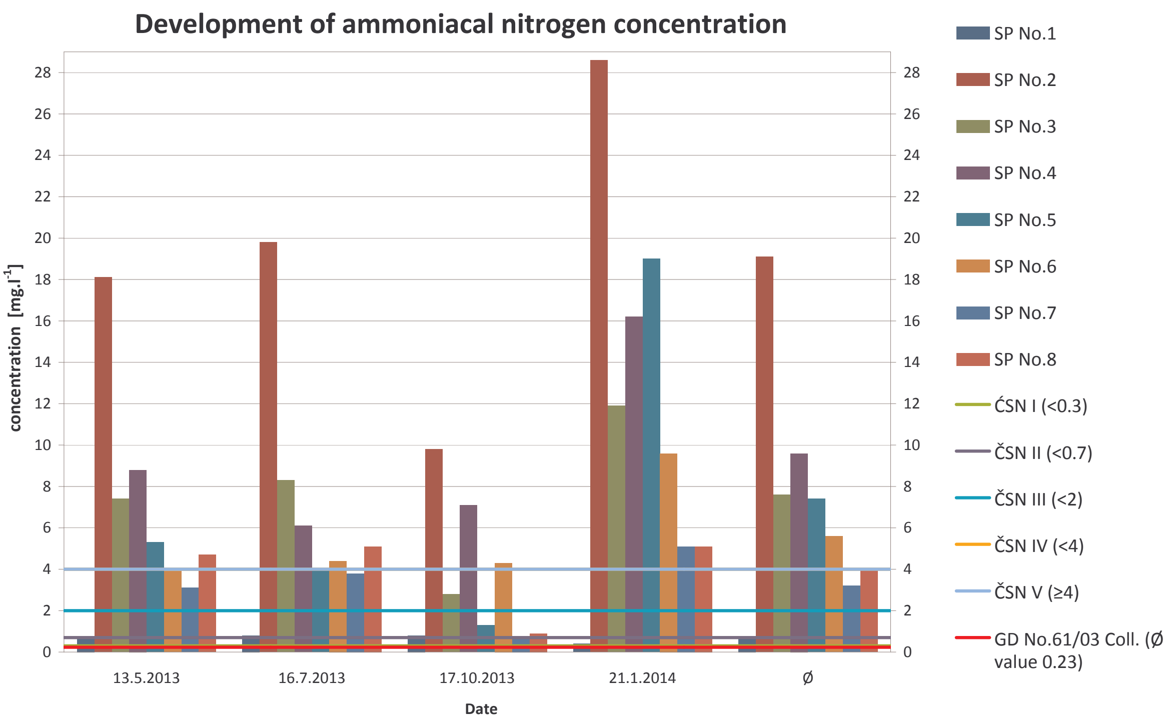
The lowest oxygen saturation values were regularly measured at sampling profile 1, i.e. the Semíč source, which is due to the fact that the underground water with low oxygen content leaks to the surface. Based on ČSN 75 7221, sampling profile 1 falls within the third quality class. Sampling profile 2, located at the tributary Osaka, manifested values corresponding to the second class – the influence of sewage water from Šebetov and pollution from the arable land. Based on the average values, the other sampling profiles ranked in the first class, even if sampling profile 4 just very closely; also, this profile manifests considerable fluctuations of oxygen saturation – influence of wastewater from municipalities Knínice u Boskovic and Vážany, which are located above the sampling profile. In compliance with Government Decree No. 61/2003 Coll., as amended, only sampling profiles 5, 6, 7 and 8 meet the oxygen saturation limit (over 9 mg.l^{-1}).

Manganese and ferrum met the limits at all sampling profiles based on GD No. 61/2003 Coll., as amended, and each of the sampling profiles were included in the first or second class based on ČSN 75 7221.

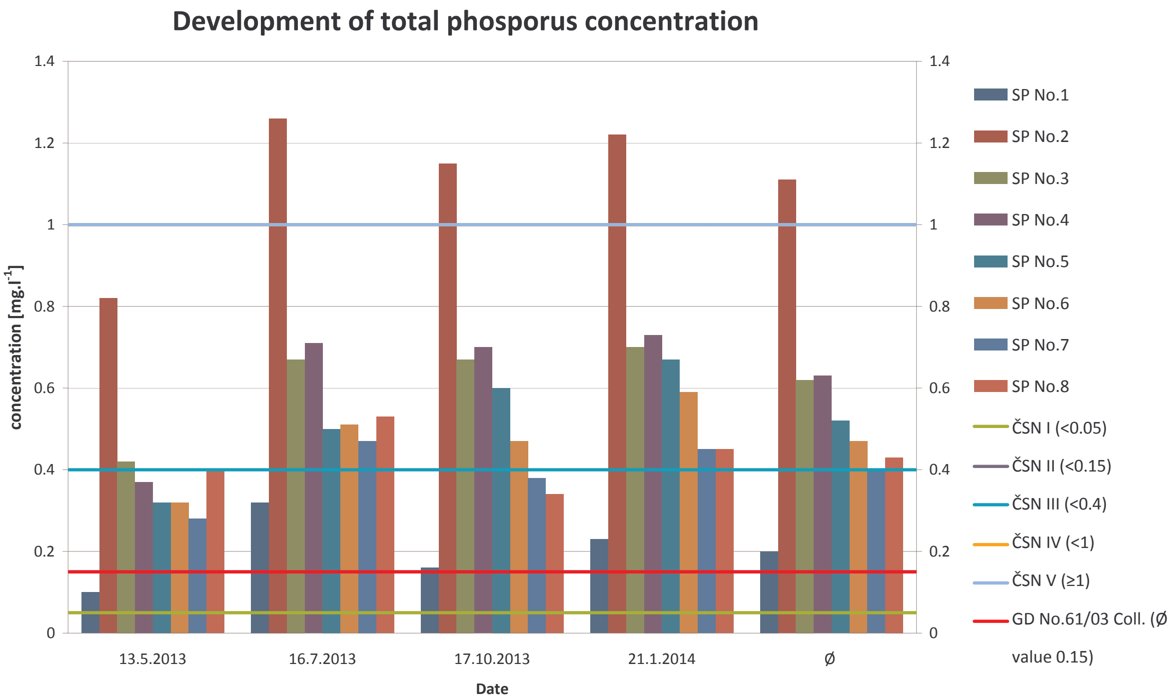
All the resulting average values of chemical oxygen demand tested using dichromate belong to the third class (below 45 mg.l^{-1}) in compliance with ČSN 75 7221. The limit of 26 mg.l^{-1} compliant with Government Decree No. 61/2003 Coll., was exceeded at all sampling profiles, except sampling profiles 1 and 5. The results indicate a high content of organic substances present in water; their source is wastewater and agriculture.

The highest concentrations of nitrate nitrogen (up to 14 mg.l^{-1}) were recorded at all sampling profiles in May 2013, when the concentrations in all profiles except the source was higher than that stipulated by GD No. 61/2003 Coll., as amended (5.4 mg.l^{-1}). This concentration increase was probably caused by fertilizers being washed out from the agricultural lands. The limits were not exceeded on any other sampling day.

Ammoniacal nitrogen concentrations have the highest values at sampling profile 2, i.e. the Osaka; however, the values at all sampling profiles exceed the maximum limit (0.23 mg.l^{-1}) stipulated by Government Decree No. 61/2003 Coll. (Fig. 2). The lowest concentrations were found at the spring area



2: *The development of ammoniacal nitrogen concentrations and the average of the measurements*
source: authors



3: *The development of total phosphorus concentrations and the average of the measurements*
source: authors

of the stream; the highest values were recorded at the tributary Osaka, which flows through lands used for agriculture and is also negatively affected by wastewater from the nearby village Šebetov.

Significant anthropogenic pollution is also indicated by the development of total nitrogen – concentrations that meet the environmental quality standard in compliance with GD No. 61/2003 Coll. (6 mg.l^{-1}) were only found at the source on all sampling days. In contrast, the highest concentrations (up to 15 mg.l^{-1}) were recorded at sampling profiles 2 and 3. The other profiles manifest a regular decline in the total nitrogen concentration, which is indicative of the self-cleaning ability of the stream.

The concentrations of total phosphorus at some sampling profiles reach severalfold higher concentrations that the limit allowed by GD No. 61/2003 Coll. (0.15 mg.l^{-1}) (Fig. 3). As in the case of ammoniacal nitrogen, the source of phosphorus is probably the outwash from agricultural land and wastewater.

The copper concentrations (up to 2 mg.l^{-1}) recorded in 2014 seem to be alarming; however, we have to consider that the average value for 2014 was only obtained from two measurements. The concentrations are an order of magnitude higher than those measured in the years before (Fig. 4) and than the limit compliant with GD No. 61/2003 Coll. (14 µg.l^{-1}). Low concentrations meeting the legislative limit were only found at sampling profile 1, i.e. the source (Fig. 5).

Some of foreign regulation focused on the copper level in water usher stricter limits. E.g. the United States Environmental Protection Agency (USEPA) action level for cooper is 1.3 mg.l^{-1}, the World Health Organization (WHO) guideline is 1.0 mg.l^{-1}, and the goal is less than 0.2 mg.l^{-1} (Nemerow *et al.*, 2009).

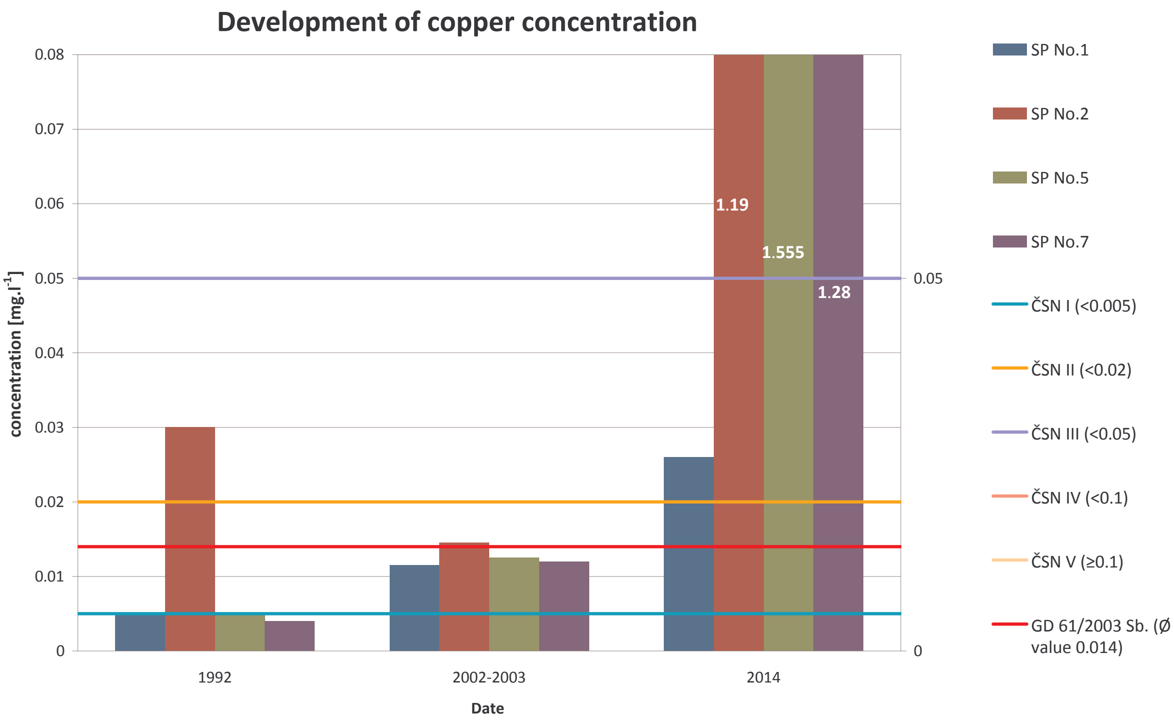
Additionally, the development of zinc concentrations is disturbing (Fig. 6). The concentration in 2014 amounted to values higher than allowed by Government Decree No. 61/2003 Coll. (0.092 mg.l^{-1}) in many cases. The rising concentrations can likely be attributed to burning of fossil fuels, application of pesticides, or the increased use of zinc for the surface treatment of metals.

Fig. 7 shows a negative development of the zinc concentration in 2014, when there was a multiple increase in the concentration compared with previous years.

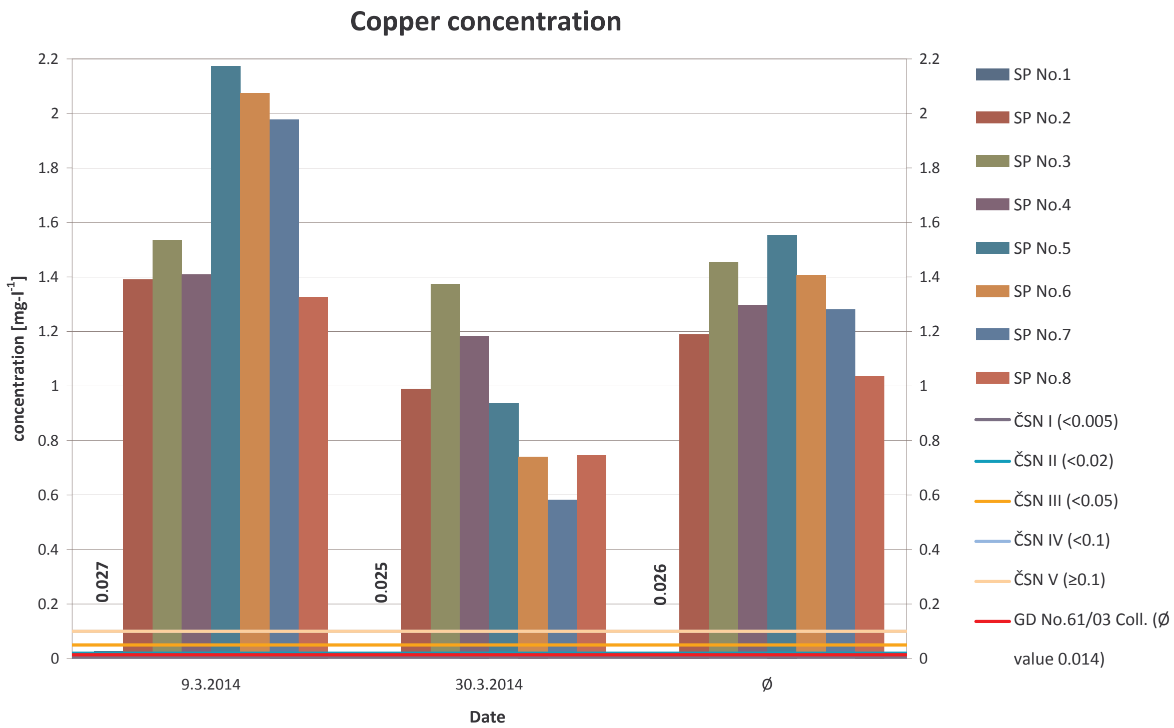
The measured concentrations of aluminium at all sampling profiles on all sampling days are lower than the environmental quality standard stipulated by Government Decree No. 61/2003 Coll. (1 mg.l^{-1}), but sampling profile 2 has significantly higher values than the other sampling profiles. This difference implies an anthropogenic source of pollution, unlike the other profiles, where the aluminium concentrations correspond with natural effects.

DISCUSSION

Comparing the development of all the selected surface water quality indicators in time, we can see partial success as some quality indicators have improved; however, other indicators are unsatisfactory. In addition to the high pollution by nitrogen and phosphorus compounds, there is



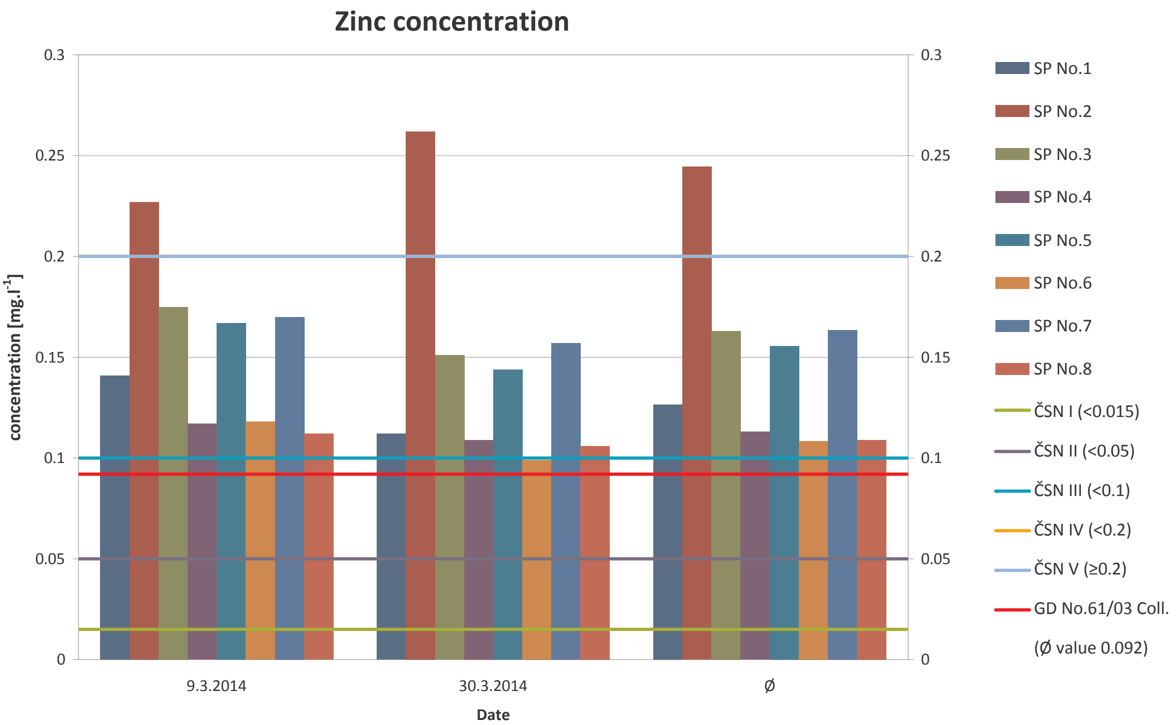
4: *The development of copper concentrations in years*
source: authors



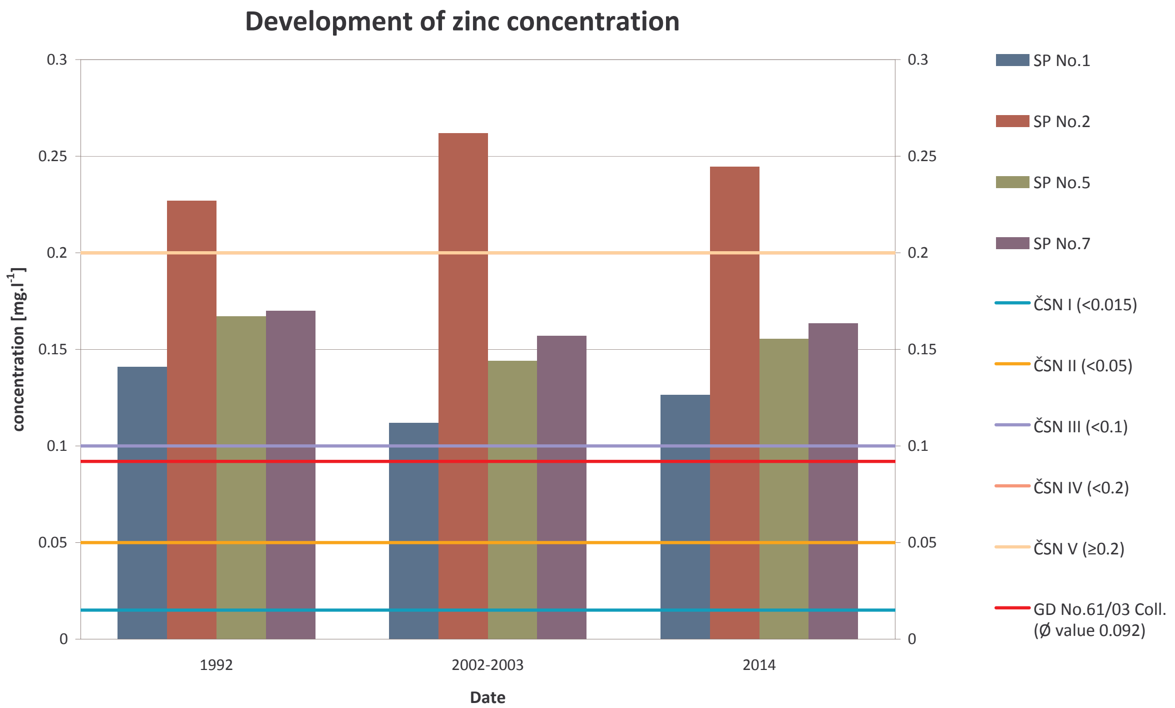
5: *The development of copper concentrations and the average of the measurements*
source: authors

an extreme concentration of some heavy metals, mainly copper.

Phosphorus and the nitrogen belong to the most important macro biogenic elements, they belongs to the group of nutrients, which are necessary for progress of microorganisms. Phosphorus is getting into the water naturally by dissolving of some minerals, weathered rocks and soils. Contain of the phosphorus in the soil is usually in range from 400 to 1200 mg.kg^{-1}. Anthropogenic origin of inorganic



6: *The development of zinc concentrations and the average of the measurements*
source: authors



7: *The development of zinc concentrations in years*
source: authors

phosphorus is from applying of phosphate fertilizers in agriculture and using of some cleaning and washing lotions. Both organic and inorganic phosphorus are a content of animal excrements. Decomposition of the biomass of phytoplankton and zooplankton from the reservoirs and rivers bottoms are the source of organic phosphorus (Nábělková, Nekovářová, 2010 and Pitter, 2009).

High concentrations of nitrate in water can stimulate growth of algae and other aquatic plants, but if phosphorus is present, only about 0.3 $mg.l^{-1}$ of nitrate nitrogen is needed for algal blooms. Some fish life can be affected when nitrate nitrogen exceeds 4.2 $mg.l^{-1}$. High nitrates concentration in drinking water can affect the human health (the blue baby disease). Drinking water standards in the United States for nitrate nitrogen concentration is 10 $mg.l^{-1}$. In the Czech Republic the marginal limit for nitrogen according to the Regulation No. 252/2004 Coll. In drinkable water 50 $mg.l^{-1}$ (i.e. 11.3 $mg.l^{-1}$ of nitrate nitrogen).

Contamination of nutrients was found although in Žlutice reservoir drainage area (Karlovy Vary district). Strong relationship between density of inhabitants and specific P emissions from individual watersheds was found (Duras *et al.*, 2014). Although the catchment of Švihov reservoir is in the long term influenced by phosphorus and nitrogen originated from point and surface source pollution. Important problems with soil erosion and high degree of eutrophication are generated as a result of a high amount of an arable land and lack of grassland and forests. The main sources of nutrients are waste waters and nitrogen pesticides (Liška *et al.*, 2010).

Problems of increased concentration of nitrogen and phosphorus compounds are important not only in the Czech Republic.

According to the European Environmental Agency EEA occurs in the European Union to a slight improvement in water quality. At European level, river nitrate concentrations have declined steadily over the period 1992–2012. The trend is the same for the time period 2000–2012, and the larger selection of stations shows a lower average concentration. Agriculture is the largest contributor of nitrogen pollution and, due to the EU Nitrate Directive and national measures, the nitrogen pollution from agriculture has been reduced in some regions over the last 10–15 years. This reduced pressure is reflected in lower river nitrate concentrations. The average concentrations of orthophosphate in European rivers more than halved over the period 1992–2012. In many rivers the reduction started in the 1980s. The marked decline is evident also for the time period 2000–2012, but the average concentration is somewhat higher when including more river stations. The decrease in river orthophosphate is due to the measures introduced by national and European legislation, in particular the Urban Waste Water Treatment Directive, which involves the removal of nutrients. Also, the switch to phosphate-free detergents has contributed to lower phosphorus concentrations.

The Ammonia nitrogen is the primary product of the decomposition of most organic nitrogenous substances animal and vegetable origin. Waste waters are primarily anthropogenic source of ammonia nitrogen organic origin (Pitter, 2009).

Cooper appears to be essential for all forms of life, but excessive amounts are toxic to fish. The estimated adult daily requirement is 2.0 $mg.l^{-1}$, coming mostly from food. Cooper deficiency is associated with anemia (Nelson *et al.*, 2009). However, acute poisoning can develop when inhaled (Nábělková, Nekovářová, 2010). Copper deficiency in children manifests physical and mental retardation. High doses of copper cause gastric and intestinal pain, liver and kidney damage and anaemia. Some copper compounds irritate the skin, after repeated exposures can cause inflammation. They can also cause conjunctivitis (www.irz.cz, 2014).

The copper concentration increase may be caused by a variety of factors, which may include the use of fungicidal substances in agriculture, an increase in the area of copper roofs, gutters and drainpipes (Pitter, 2009).

It is also possible that the concentration increase was caused by a single and temporary effect, i.e. an intentional or accidental surface water contamination by a foreign substance with a high concentration of copper. The concentrations measured were lower at the repeated samplings, which could indicate the one-time effect, but this is a speculation that would have to be confirmed or refused by repeated analyses. Due to the lack of industry in the drainage basin, it is hard to find a significant source of copper. The basin administrator, i.e. Povodí Moravy, s.p., has been informed on the results. The administrator is going to monitor the Semíč more carefully next year. At the same time, Semíč tributaries and other streams in the surroundings are going to be monitored in the context of other research carried out at the Department of Applied and Landscape Ecology. Water quality, including the troublesome heavy metals will be analysed. Further, soil analysis is planned with the purpose of finding out whether the heavy metals appear in the soil. Then it will be possible to better identify the source of copper in the Semíč and propose remedial measures.

A comparison of the status of surface water chemistry in the Czech Republic for the period 1984–1996 and 2007–2010 shows that there is an increase of copper concentration in surface waters. The study shows that the causes of the increase copper concentration during nowadays, which was found mainly in the Bohemian-Moravian highlands (and Moravia in general), we can only speculate. The measured concentrations of the copper for the period 2007–2010 are on average higher than in previous years and median concentrations in surface waters throughout the Czech Republic increased to 0.8 $\mu g.l^{-1}$ (Majer, 2012).

Heavy metal pollutions was detected also on Střela stream (Vltava river basin), where the comparison with data from nineties of 20^{th} century was done. Zinc concentrations have been increasing up to half of nineties. Since that time mean values significantly decreased till 2002. Mean concentration values of copper vary in the first half of nineties; the highest values were recorded at the beginning of the second half of nineties. There was a dramatic increase noticed at the beginning of 20th century comparing to previous time period (Kaplická, 2004).

As Matalová (2015) reported, elevated concentrations of copper (up to 0.3 mg.l^{-1}) were also found to Sebránek stream – it is a right tributary of Svitava River, which also flows into it in the village Svitávka.

Although a single component of the environment is primarily addressed here, it is necessary to realize that water is affected by all the environment components. It would be appropriate to raise the pressure on natural and legal persons active in agriculture to become more involved in the protection of all components of the environment.

Agriculture and wastewater from the municipalities remain the main problems in the basin and the largest Semíč polluters. Similar results show Langhammer and Rödlová, 2013. The problems in small basins are the mismanagement of facilities, lack of systematic approach, and little enforcement of environmental legislation. The key sources of extensive pollution in small streams are local pollution sources that are not connected to the sewage network, and mismanaged wastewater treatment facilities at small municipalities (Langhammer and Rödlová, 2013).

It is necessary to improve the processes used in agriculture. Hand in hand with this, pollution of surface waters will decrease. This assumption is based on the fact that the agricultural subsidies will be increasingly linked with the ways agricultural land management is performed, i.e., new conditions, controls of "cross-compliance" will be introduced and tightened.

The issue of treatment of wastewater from households in small villages, which are located not only in the drainage basin of the Semíč, will be a big challenge for the public administration. Construction of sewage systems and wastewater treatment plants is beyond financial affordability for most of the small villages. It is possible to involve smaller municipalities in the microregion and construct one wastewater treatment plant for them. Another, at least partial, solution could be domestic wastewater treatment plants; however, the cost of their purchase is relatively high and the environmental awareness of the population is not sufficient.

The self-cleaning ability of the Semíč cannot be relied on in the near future. An improvement of the status quo would require cooperation of many stakeholders and considerable financial costs.

From a long-term point of view, it would be necessary to revitalize the water stream. A significant part of the Semíč flows through agricultural land, where revitalization is possible, e.g. in connection to land reallocation.

The United States Environmental Protection Agency (USEPA) describes the nature and purpose of the eight water quality protection tools, outlines some specific techniques for applying the tools, and highlights some key choices a watershed manager should consider when applying or adapting the tools within a given watershed. Land Use Planning, Land Conservation, Aquatic Buffers, Better Site Design, Erosion and Sediment Control, Stormwater Best Management Practices, Non-Stormwater Discharged, Watershed Stewardship Programs are the eight tools.

CONCLUSION

The work aimed to monitor selected indicators of water quality in the Semíč stream in the district of Blansko. The Semíč rises above the municipality Vanovice at an altitude of 450 m. It flows into the Svitava River in the municipality Svitávka at an altitude of 300 m. The area of its drainage basin from its source to the confluence with the Svitava is 56.84 km^2, the stream length is 17.945 km. The entire basin has a large proportion of intensively used arable land, and ploughing reaches to the bank edges of the stream under research in some parts. Commonly, sloping areas are ploughed perpendicular to the contour line, which also concerns the lands immediately adjacent to the Semíč stream bed. The forest cover percentage is about 20%. There are no major industrial pollution sources in the basin. The only wastewater treatment plants in the entire basin are in municipalities Šebetov and Svitávka. Quality monitoring was conducted from May 2013 to April 2014. In total, eight sampling profiles were monitored, seven of them being directly at the Semíč bed and one at its tributary Osaka. The following quality indicators were evaluated: in the field – pH, temperature, conductivity and oxygen content; in the laboratory – total P, total N, nitrates nitrogen, ammoniacal nitrogen, manganese, ferrum, sulfates, chlorides, COD, copper, zinc, aluminium. Samples were processed in the Water Management Laboratory of the Department of Applied and Landscape Ecology of Mendel University in Brno. The analyses were performed using spectrophotometer DR/4000 from the HACH company; mineralization of samples was performed by means of mineralization thermostat DRB 200 from HACH. Results obtained were evaluated in compliance with the Czech standard ČSN 75 7221 and Government Decree No. 61/2003 Coll., as amended. The values found were also compared to the results from 1992 and 2002–2003. Based on a comparison with earlier data, we can conclude that concentrations of sulphates, chlorides, manganese, and ferrum decreased at all investigated profiles; on the other hand, concentrations of copper and zinc increased substantially. A rising or falling trend cannot be tracked concerning the other indicators as their values fluctuate considerably or were not evaluated in the past. The most troublesome indicators are ammoniacal nitrogen, total phosphorus, copper, and zinc, whose values highly exceeded the environment quality standards stipulated by GD No. 61/2003 Coll., as amended. The largest polluters of the Semíč stream are agriculture and wastewater from the nearby villages. It is necessary to improve the agricultural processes and construct wastewater treatment plants connected to the public sewage system of municipalities. The work also included a proposal for more monitoring in the field in order to identify the source of copper in surface water.

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