UDC 628.191(437.32)

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EVALUATION OF POLLUTING SOURCES AND SELF-CLEANING ABILITY OF WATER FLOW IN RELATION TO LANDUSE

SUMMARY

The aim of our research is to confirm or refute the hypothesis, which says that agriculture is the main source of surface water pollution. Nowadays, when more than 82 % of the Czech population is connected to public sewerage system, it is assumed, that the wastewater has not a significant impact on the quality of surface water, as there are waste water treatment plants and similar facilities for cleaning the sewage. Thanks to a detailed field survey and regular sampling followed by laboratory analysis of water from selected streams in southern Moravia and the Highlands it was found although municipalities are connected to the public sewerage system, which brings the sewage water into the treatment plants, deteriorating the quality of the water flow right through the village. The results of laboratory analyses of water from the monitored flows show the process of self-purification, they are seeing a significant decrease in the concentration of certain substances by water flow through the selected sections of land use. On the other hand, in urban areas or flow through the arable land the water is enriched by pollutants, this is on many places evidenced by developing of undesirable algae.

Keywords: land use, agriculture, wastewater treatment plant, water quality

INTRODUCTION

Important European watercourses origin in the territory of The Czech Republic which is also called „The roof of Europe“. Thanks to its geographic position it is a country of three important European watersheds: Labe river (North sea), Odra river (Baltic sea) and Morava river – Dunaj river (Black sea). This is the reason why the rivers running out of our country are not supposed to be excessively load by the anthropogenic pollution. Water streams are one of the most important parts of hydrological cycle; they create natural landscape character and are used as bio corridors. Even in the past the river streams presented an integral part of human life. The human settlements were mostly founded close to the rivers and other water sources. People have been using water for their own needs, as the irrigation or the cattle watering and later the river

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Paper presented at the 5th International Scientific Agricultural Symposium "AGROSYM 2014".
Note: The author declare that they have no conflicts of interest. Authorship Form signed online.

streams became the sources of the energy and also the shipment became to develop. On the other hand the river streams recipe the waste water resulting in the water pollution. The most serious anthropogenic sources of pollution are: the industry, transport, agriculture and waste water. Notable feature of water streams is the self – purification, i.e. natural removal of pollutants. It comprises physical processes – sorption and aeration, chemical and biological - oxidative and reductive processes of organic and inorganic substances. Therefore the problematic of surface and ground water protection is very important on the national and also on the European and global level.

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 CHOPAV, sensitive areas and nitrate vulnerable zones and for compliance with farming aren't also compensation. The special protection includes protection zones of water resources (Oppeltová, 2012).

MATERIAL AND METHODS

The six catchment areas and six streams were assessed for the field measurement. These are catchment areas of streams: Knínický, Říčanský, Staviště, Pernička, Trstěnický and Březanka (Fig. 1). Each selected catchment area ranges from 5 to 11 km^2. Each catchment area is characterized by a specific land use. Measured profiles were chosen in order to assess the self – purification of streams in the individual land use categories. Individual catchment areas were divided into seven categories according to the land use: Forests, Permanent grassland, Arable land, Scattered greenery, Built-up area, Water surface, Gardens and Orchards. Also certain profiles on each stream were monitored in order to analyse the water quality. Measurement and sampling are realized once a month from March to November 2014.

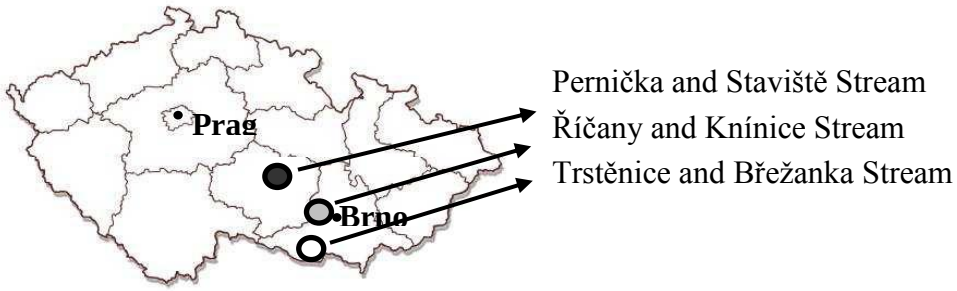

Fig. 1: Area of interest in the map of Czech Republic

The characteristics of water quality were analysed directly in situ using portable multimeter HQ30d by Hach-Lange in order to measure pH value, water conductivity, oxygen content and temperature. From the point of self – purification view the significant characteristics (P_{total}., PO_4, COD, NO_3^- N, etc.)

were determined in laboratory. Hubačíková (2014) deals with the similar theme. According to measured values the impact of individual land use and the self – purification were assessed on individual sites of observed streams. For now it is not possible to evaluate the impact of individual land use categories. This paper is focused only on the evaluation of certain indicators of water quality for chosen streams.

RESULTS AND DISCUSSION

Evaluation of the results of the laboratory analyses was conducted according to the valid legislation. The limit for phosphorus is resulting from Government regulation No. 61/2003 Coll., about the characteristics and values of acceptable pollution of surface water and wastewater as amended by the Government Regulation No. 23/2011 Coll.

The results of NO_3^-N content, PO_4^{3-} content, water conductivity, pH value, and chemical oxygen demand are presented in this chapter. Each characteristic was processed in graph for individual measurements and the development of indicator values.

Knínice stream rises in the woods north west of the village Veverské Knínice and firstly flows through woodland. The forests are mixed up to coniferous. The topmost part of the flow is often dry, therefore the profile is situated under the confluence with the first tributary – the same size flow. The second section is located on the border of the aforementioned forest and gardening area that hovers in the urban village Veverské Knínice. The third profile was situated flow stream communities and under a stand of purified water from local wastewater treatment plant (WWTP). The fourth and fifth sites are located between the agriculturally cultivated areas.

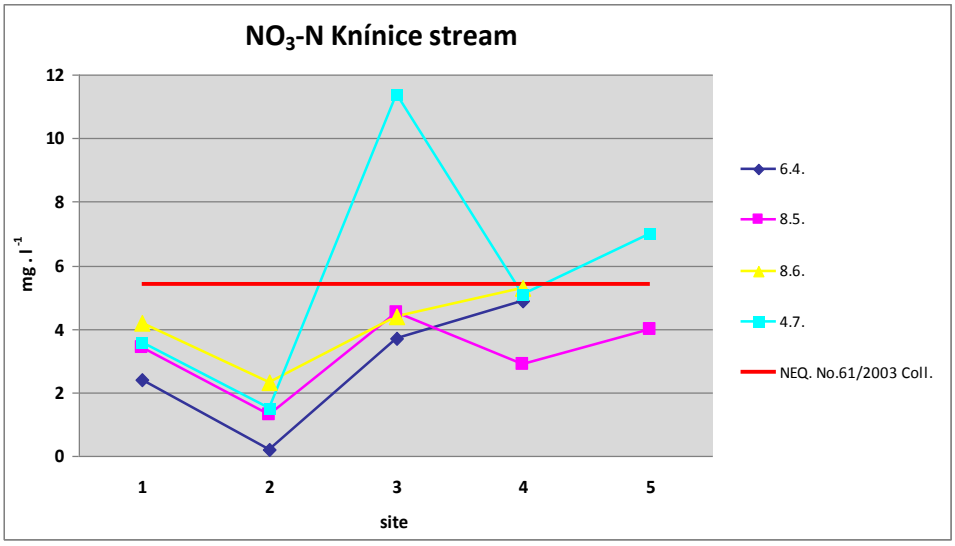

Fig. 2: NO_3^-N content in Knínice stream

From Figure 2 it is evident the influence of waste water treatment plant on the nitrogen content in the water. The third site is placed down the flow of WWTP and we can determine higher concentration of nitrate nitrogen in water samples from this site. By the self-cleaning processes of the aquatic ecosystem in the stream the negative action of this inefficient WWTP is decreased.

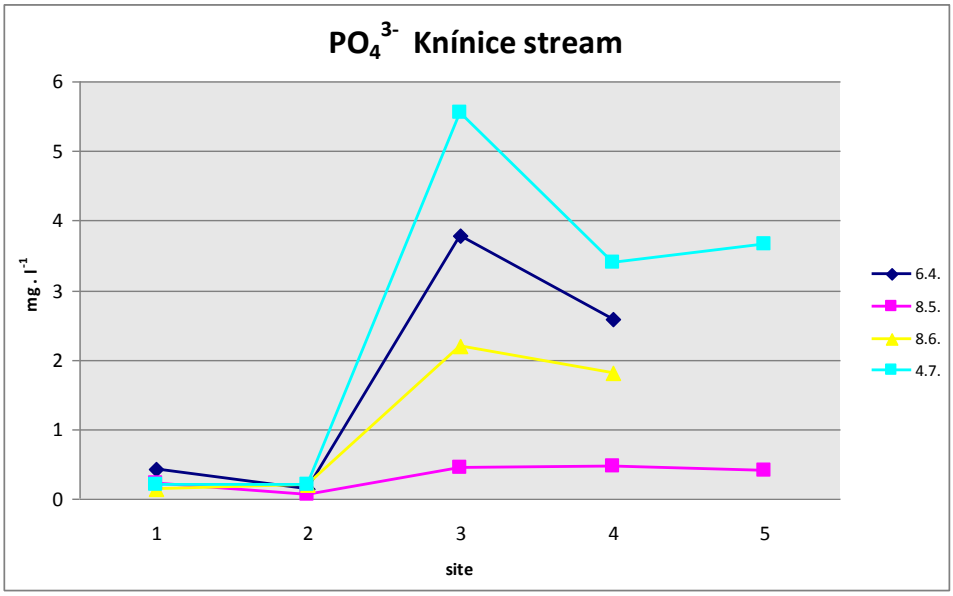

Fig. 3: PO_4^{3-} content in Knínice stream

As in the case of nitrate nitrogen when viewing the content of phosphates the negative influence of WWTP is evident as well as the self-cleaning process, which is clearly visible on the Figure 3.

Based on the field study it was found that there is a deliberate discharge from wastewater treatment plant of sewage sludge with high content of precipitated Phosphorus. Such sludge was mixed up with the water in the riverbed and also with household wastewater which flow from the houses not connected to the public sewerage. This leads to a huge impact load flow which significantly changes the quality of water in it.

The first site of Říčany stream is permanently dry during the period of this research, so it was impossible to get any data of water quality. The second profile is situated on the edge of the forest and arable land, above this point the stream flows through agricultural land and is sparsely flanked by tree vegetation. Between the second and the third site Říčany stream flow continuous mixed forests. The fourth site shows the status of water quality in the flow through villages Říčany and Ostrovačice. Further stream flows between blocks of arable land.

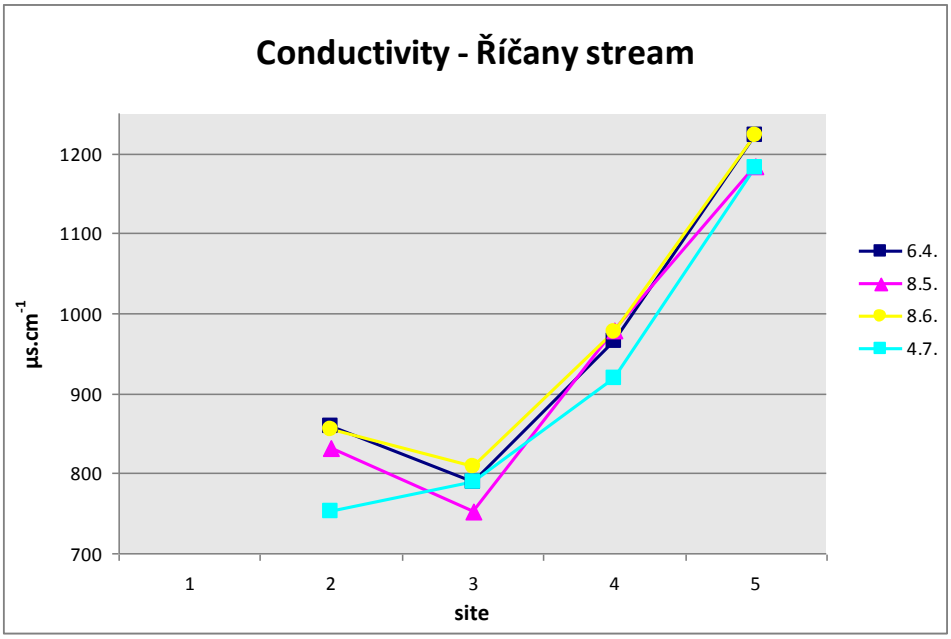

Fig. 4: Conductivity in Říčany stream

The conductivity is directly dependent on the amount of dissolved solids. Curves on Figure 4 show, show increasing quantities of these substances in the flow stream through urban area (see profile 4).

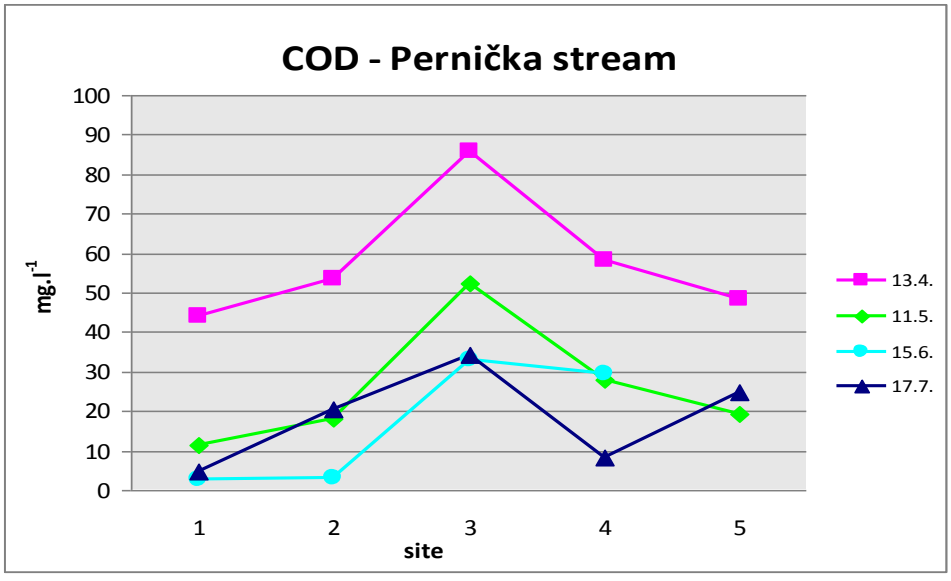

Fig. 5: Chemical oxygen demand in Pernička stream

For the sampling five profiles were chosen with following land use: 1 - origin of Pernička stream, 2 – field with livestock/village Počítky, 3 – village Počítky/field with crop production, 4 – field with crop production/ meadow, 5 – meadow/estuary to water pond.

The third profile is located under the village where the stream flows out of the small water pond. Significant grow of COD value was evident on this site (see Fig. 5). The evident decrease of COD value is evident in the fourth and the fifth profile resulting in the decrease of water pollution by organic or oxidizable inorganic compounds via water self – purification.

CONCLUSIONS

These results are only a partial output of the presented project dealing with the categorization of stream sections according to the land use. The previously measured results show that municipalities have significantly greater negative impact on the water quality than agriculturally cultivated land. In some cases, this is due to an incomplete connection of homes to the public sewerage, or lack of efficiency of wastewater treatment plants or a human error at the wastewater treatment plant processes. The measured data confirmed the assumption that the streams flowing through the less intensively managed parts of the landscape (forests and permanent grasslands) are characterized by more intensive and more efficient self-purification than in the case of intensively farmed land for either grazing and agricultural production or residential areas.

ACKNOWLEDGEMENTS

The paper was created with support of Internal Grant Agency MENDELU project TP 9/2014 "Categorization of selected streams based on their degree of self-purification capacity with respect to land use"

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Government regulation No. 23/2011 Coll. about indicators and values of permitted pollution of surface waters and waste waters, essentials permit to discharge wastewater into surface waters and sewers and sensitive areas