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## DESIGN OF THE EQUIPMENT FOR THE LONG-TERM MEASUREMENT OF THE CONCENTRATION OF PHOSPHATES AND NITRATES IN SURFACE WATERS

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### ABSTRACT

This paper deals with a possibility of using Anion Exchange Resin in special equipment (probe) for the determination of phosphates and nitrates in surface water. Furthermore, this work presents the first results from a long-term measurement of the concentration of major pollutants in surface water, which are located in the area of our interest (CHKO Jizera Mountains). Six special probes were prepared and placed in this area. These probes contained AER (AER – Anion Exchange Resin, Type A520E – Macroporous Strong Base Anion Exchange Resin with total capacity 0.9 eq/l), which were placed into special pockets. Each probe contained one pocket. This pocket was monthly changed. After the exchange, the concentration of nitrates and phosphates was determined. For the quantification of nitrates and phosphates trapped by the resin, the AER was dried at room temperature. Captured nitrates and phosphates were extracted from resin using 100 ml of 1.7 M NaCl. Released nitrates were determined by distillation and titration method. Released phosphates were determined by spectrophotometric method (Hach Lange No. 8048 in accordance with USEPA). Based on the findings, we can conclude that the application of AER to plastic probes is suitable for a quick and inexpensive measurement of the concentration of nitrates and phosphates in surface water. Moreover, differences in concentration of nitrates and phosphates were measured between individual probes. Concentration of these pollutants was significantly higher in watercourses that flowed through the villages than in water courses that flowed across the open country.

**Key words:** soil hydrophobicity, mineral nitrogen, organic carbon, microbial activities

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## INTRODUCTION

Nitrogen (N) and phosphorus (P) are important plant nutrients that are often applied to highly managed biotic systems (Rice & Horgan, 2013). N and P represent the main problem for quality of surface water in the Czech Republic. Understanding of the nitrogen and phosphorus cycle is necessary to predict the potential impact of their higher concentration on water biodiversity in CHKO Jizera Mountains.

Surface water quality refers to the physical, chemical, and biological characteristics of lakes, rivers, and estuarine waters. Water quality differs depending on season and on geographic area. The background chemistry of river and lake water is determined by the soil, geologic formations, terrain, and vegetation in the drainage basin (Coote & Gregorich, 2000). Input of P and N to freshwater systems can originate from external and internal sources e.g. from agriculture, industry, wastewater etc. (Coote & Gregorich, 2000; Valero et al., 2007; Rice & Horgan, 2013). Therefore, measurement of N and P concentration in surface waters is necessary to identify the source of contamination. Finding the source of contamination is the basis for the implementation of nature in CHKO Jizera Mountains.

The N (nitrate nitrogen) and P (phosphate) concentration was measured at selected locations in CHKO Jizera Mountains. During the experiment, usability of Anion Exchange Resin for the determination of nitrate and phosphates concentration was tested. Moreover, concentration of these pollutants was measured at these locations.

## MATERIAL AND METHODS

The experiment is a part of a larger project (IGA reg. no.: IP23/2013) that is focused to monitor important indicators of pollution in surface waters.

### Experimental design

This experiment is carried out in CHKO Jizera Mountain. Concentration of phosphates ( $\text{PO}_4^{3-}\text{-P}$ ) and nitrate nitrogen ( $\text{NO}_3^- \text{-N}$ ) was performed using special probes. These probes were placed at the six experimental sites. These sites are located in the cadastral territory of three municipalities (Rynoltice - R, Smědá - SM and Jizerka - J). Individual sites were always chosen above (R1, S1, J2 and below (R2, SM2, J2) the village.

Nitrate nitrogen and phosphate were captured by Anion Exchange Resin (AER), which were placed into special pocket. Pocket was made from nylon fiber (grid size of about 0.2 mm). This type of AER was applied: Macroporous Strong Base Anion Exchange Resin – A520E with total capacity 0.9 eq/l. Quantification of trapped ion is described below. Pocket with AER were placed into special probe (see the Figure 1).

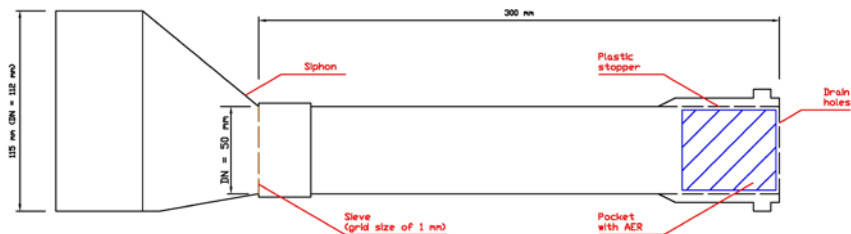


Fig. 1 Probe for measuring the concentration of  $\text{NO}_3^- \text{-N}$  and  $\text{PO}_4^{3-}\text{-P}$

These probes were placed at individual experimental site. The pockets with AER were monthly changed. The Figure 2 shows the location of the probe in the watercourse.



Fig. 2 Location of the probe in the watercourse

### Determination of nitrates nitrogen

After the measurement, pockets with AER were removed and dried at 18 °C (laboratory temperature) for three days. Captured  $\text{NO}_3^-$ -N was extracted from AER using 100 ml of 1.7 M NaCl according Novosadová et al. (2003). Released  $\text{NO}_3^-$ -N was measured by distillation-titration method (Peoples et al., 1989). Nitrate nitrogen was determined in an alkaline solution after the addition of MgO and Devard's alloy. The results obtained from the AER were expressed in  $\text{mg of N}_{\text{min}}$  per  $\text{dm}^3$  of resin.

### Determination of phosphate

After application, pockets with AER were dried at 18 °C for three days. Captured  $\text{PO}_4^{3-}$ -P was extracted from resin using 100 ml of 1.7 M NaCl (eluate). Released  $\text{PO}_4^{3-}$ -P was determined by the spectrophotometric method Hach Lange No. 8048 (in accordance with USEPA). The results obtained from the AER were expressed in  $\mu\text{g}$  of  $\text{PO}_4^{3-}$ -P (in eluate). Figure 3 shows relationship between the amount of  $\text{PO}_4^{3-}$ -P in the eluent and the amount of  $\text{PO}_4^{3-}$ -P trapped by AER. This relationship is expressed by the regression equation, which was used to calculate the amount of  $\text{PO}_4^{3-}$ -P.

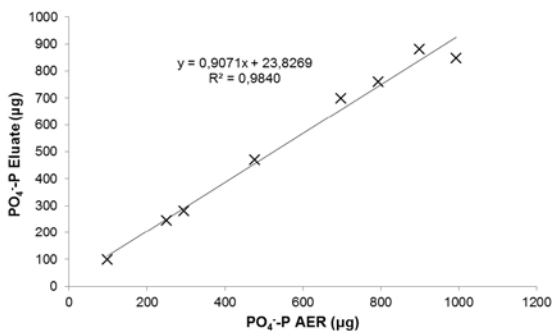


Fig. 3 Released P- $\text{PO}_4$  from the AER after elution

## RESULT AND DISCUSSION

This work presents first results of concentration of  $\text{NO}_3^-$ -N and  $\text{PO}_4^{3-}$ -P, which were determined by Distillation-titration Method and Spectrophotometric Method from May to August 2013. The Figure 4 displays the concentration of  $\text{PO}_4^{3-}$ -P in the surface water at the individual sites. The highest concentrations were always measured at the locations with the most developed settlement. Negative effects of human settlement on water quality are confirmed by Coote & Gregorich, (2000).

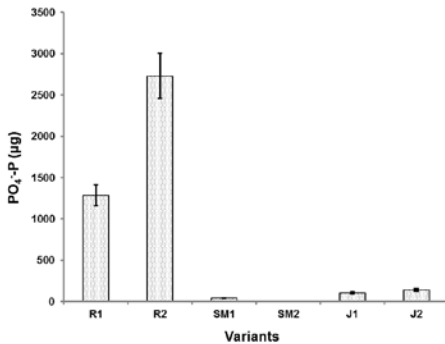


Fig. 4 Detection of  $\text{PO}_4^{3-}$ -P in surface water

Detection of  $\text{NO}_3^-$ -N is illustrated in the Figure 5. Consider Figure 4 and 5, which show impact of human settlement on the concentration of pollutants in surface water. Experimental sites R1 and R2 are the most populated. The highest concentrations of pollutants ( $\text{NO}_3^-$ -N and  $\text{PO}_4^{3-}$ -P) were measured here. The differences between R1 (R2) and other locations are significant (ANOVA,  $P < 0.05$ ).

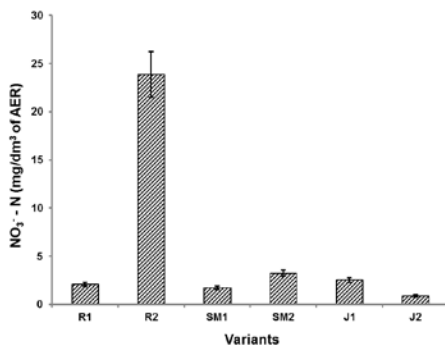


Fig. 5 Detection of  $\text{NO}_3^-$ -N in surface water

## CONCLUSIONS

Our experiment showed the possibility of using AER for measuring the concentration of  $\text{NO}_3^-$ -N and  $\text{PO}_4^{3-}$ -P in surface waters. Based on the results we can conclude that the AER are suitable for measuring the concentration of these pollutants in surface waters. Moreover, differences in concentration of nitrates and phosphates were measured between individual experimental sites.

## ACKNOWLEDGE

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