ESTIMATE OF THE EMISSION OF VARIOUS FORMS OF PHOSPHORUS FROM INUNDATION AREA OF A FUTURE ACCUMULATION LAKE

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Abstracts

The emission of phosphorus from various ecochemical types of soil (arable land, forest, meadow and orchard) was investigated in order to preserve the quality of water in future accumulation lake Rovni near Valjevo (Serbia and Montenegro). All samples were taken from different depths: 0-10, 10-20 and 20-30 cm. Samples were submitted to sequential extraction according to the method of Chang and Jackson. The following solutions were used: 1 M solution of ammonium-chloride (available phosphor), 0.5 M ammonium-fluoride (Al-P), 0.1 M sodium hydroxide (Fe-P), 0.3 M sodium citrate and sodium dithionite (reducible phosphor), 0.1 M sodium hydroxide (occluded-phosphor) and 0.25 M sulfuric acid (Ca-P). Most of phosphor was binded for iron (the first extraction with sodium hydroxide). In all studied samples this fractions contained more than 80% of total inorganic phosphor. Relatively low content of available phosphor was the consequence of a long rainy period before the collection of samples. The content of all other forms of phosphor did not exceed 10%. The exception is the relatively high reducible phosphor which was extracted from the top layer of the forest soil (14.60%, 0.34 mg/g). The content of occluded and Ca-P was lower than 2%. The content of all forms of phosphor decreased with depth. These results are important for the provision of good water quality in the future accumulation lake (54 millions cubic meters and 230 ha) Rovni near Valjevo (Serbia and Montenegro).

Introduction

Eutrophication is becoming one of the main problems in water deterioration in Europe. It makes the production of drinking water more complex with consequent negative economic effect. Phosphorus is considered as the key factor responsible for eutrophication of lacustrine waters (1,2). Its concentration in lakes originates from the external input as well as from the emission from sediment and inundated land (3). Both contributions could have the similar order of magnitude. The emission of phosphorus depends mostly on its form present in the sediment. From the ecochemical point of view the most important is available or “bioavailable phosphorus” which could be mobilised easily from the sediment. The resulting increase of phosphorus concentration in water could in turn stimulate the growth of algal plants with consequent eutrofication of the lake. Therefore it was important to apply sequential extraction in order to estimate the “bioavailable phosphorus” and define its substrates in the soil from the inundation area. This research was carried out in order to minimise the emission of phosphorus from the inundation area of a future accumulation lake (54 millions cubic meters of water) Rovni near Valjevo (Serbia and Monte Negro).

Methods

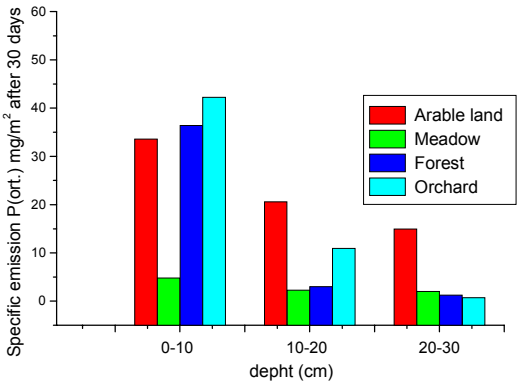
Soil samples were taken from the entire area of future accumulation lake (about 230 ha) at different depths: 0-10 cm, 10-20 cm and 20-30 cm. Different ecochemical types of soil (forest, orchard, meadow and arable land) were taken in proportion with their share in the inundation area. The sample of sediment from the profile of future dam was also taken for comparison. All samples were divided in two portions. One portion of each sample was transferred to 10 L beaker and left in contact with river water. The experiment lasted months and aliquots were taken periodically for determination of the orthophosphate. Another portion of each sample was submitted to six-phase sequential extraction according to the method of Chang and Jackson (4). The following solutions were used: 1 M solution of ammonium-chloride (available phosphor), 0.5 M ammonium-fluoride (Al-P), 0.1 M sodium hydroxide (Fe-P), 0.3 M sodium citrate and sodium dithionite (reducible-P), 0.1 M sodium hydroxide (occluded-P) and 0.25 M sulfuric acid (Ca-P). The content of phosphorus in extracts was determined by molybdenum blue method (5). Due to the complexity of samples the technique of standard addition was used.

Results and discussion

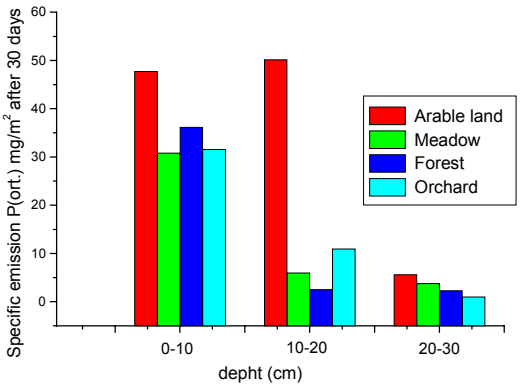
The amount of extracted phosphorus as well as its distribution in various phases depended of the ecochemical type of soil and the depth of the samples. The fraction Fe-P was dominant in all samples and it represented more than 80% of total inorganic phosphorus. Relatively low content of available phosphor (max. 1.36 $\pm$ 0.14 μg/g) for soil samples from the forest) was the consequence of a long rainy period before the collection of samples. The content of all other forms of phosphorus did not exceed 10%. The exceptions were relatively high reducible phosphorus which was extracted from the top layer of the forest soil (14.60% or 122.66 $\pm$ 14.93 μg/g) and the content of Al-P in the sediment sample (14.60% or 31.6 $\pm$ 1.72 μg/g). The content of occluded and Ca-P was lower than 2%. The content of all forms of phosphorus decreased with depth.

Results of all simulation experiments indicated that the concentration of the phosphorus emission (determined as ortho-P) reached the maximum after 30 days and later remained constant. Specific emissions of the ortho-phosphate after 7 and 30 days were presented in Figures 1 and 2.

Fifure 1. Specific emission of P after 7 days



Fifure 2. Specific emission of P after 30 days



The emission of ortho-P to water decreased with depth. For the sample of arable land taken from the depth 20-30 cm , the emission was decreased for 88%. Similarly, for the meadow, depth 10-20 and 20-30 cm, it was decreased for 80 and 87 % respectively. Corresponding values for the forest land were 93 and 94%, while those for orchard were 65 and 97%.

The changes of the share of different forms of inorganic phosphorus with depth (forest land) were presented at Figures 3, 4 and 5.

Figure 3. Emission of inorganic forms of P (forest land, depth 0-10 cm)

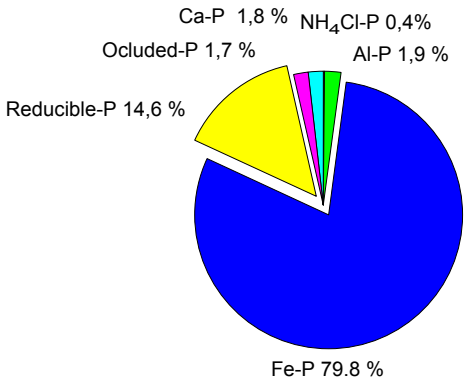


Figure 4. Emission of inorganic forms of P (forest land, depth 10-20 cm)

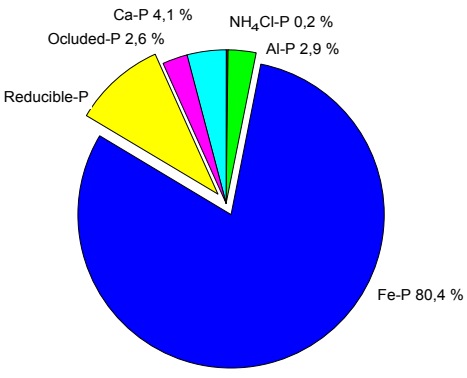
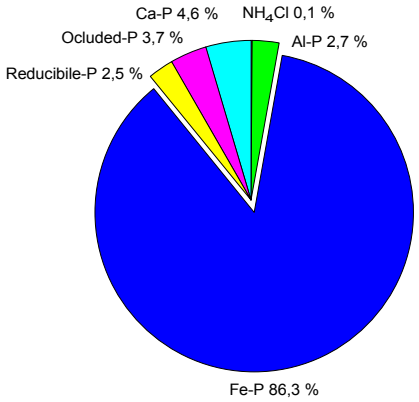


Figure 5. Emission of inorganic forms of P (forest land, depth 20-30 cm)



The trend of diminishing of the share of reducible phosphorus with depth of forest land is obvious (Figures 3, 4 and 5). It could be explained as the result of diminishing the concentration of organic carbon with depth. The dynamic of reducible phosphorus is therefore dependent of the content of organic carbon in the soil.

Conclusions

On the basis of simulation experiments it could be concluded that the dynamic of phosphorus in the accumulation lake will be closely interrelated with the dynamic of iron. However, the role of Al and Si, as well as Zn should not be neglected. Beside the reduction of the external input, the emission of phosphorus in lake water should be diminished by removing of the upper 20 cm of the arable land and upper 10 cm for other soil types. Due to the important role of biota in biogeochemical cycles of phosphorus, it should be removed completely from the inundation area.

References

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