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Effects of Seasonal Changes and Different Land Use Types on Nitrogen and Phosphorus Concentrations in the Carpathian Catchment

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Extended Abstract

Intensive urban or agricultural land use practices contribute to the contamination of aquatic ecosystems, primarily through diffuse nutrient inputs, mainly nitrogen and phosphorus. Variations in their concentrations, whether increasing or decreasing, are influenced not only by anthropogenic activities but also by natural processes resulting from prevailing climatic conditions. Consequently, seasonal changes play a crucial role in influencing the chemical characteristics of surface waters [1]. For this study, two rivers with different land use characteristics in a Carpathian catchment (southern Poland) were selected. Approximately 55% of the Raba River catchment is covered by forest, and balanced with crops, pastures, and buildings, while nearly 85% of the Wolnica River catchment is covered by arable land and crops [2].

The study aimed to determine the effects of seasonal changes and different land use types on nitrogen and phosphorus concentrations in the catchments of these rivers over a three-year research period (2016-2018). Soil samples corresponding to the 4 different land uses were collected by hand from the surface layer (0-5 cm). Furthermore, samples of the suspended sediment and bottom sediments were also considered. Suspended sediment samples were retained using the time-integrated sampler [3]. Bottom sediment samples were taken in the vicinity of the time-integrated sampler. Samples were studied for the: total nitrogen (TN), and total phosphorus (TP).

In the Raba River catchment, TN concentrations were from 0.09 to 8.015 mg/g, and TP ranged from 0.082 to 1.486 mg/g. Comparatively, in the Wolnica River catchment, TN was observed in a range from 0.212 to 4.69 mg/g, while TP levels varied between 0.013 to 2.196 mg/g. The results showed that the concentration of TN and TP in studied catchments were characterized by a clear seasonal variation and land use types. The highest average concentrations of TN and TP were observed in soils from residential areas. Housing with a significant number of people, livestock and inadequately stored animal excrement pose a substantial risk to the environment. Contaminants from these areas can gradually infiltrate the ground and surface water, contributing to increased nitrogen and phosphorus compounds in these catchments [4].

A decrease in TN concentration was observed in the soils of both catchments during the growing seasons, followed by an increase in autumn. Nitrogen concentration in soils usually decreases during the growing season due to plants' intensive uptake of this element. However, an increase in TP concentration was noted in the spring, likely due to the intensive decomposition of organic matter, one of the primary sources of phosphorus in natural catchments. There was also a noticeable increase in suspended sediment and sediment concentrations of TN and TP during the spring seasons. This could be linked to agricultural activities and increased precipitation, a trend consistent with findings from other studies in Carpathian sub-catchments [5, 6, 7].

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References

[1] G. Weigelhofer, T. Hein and E. Bondar-Kunze, "Phosphorus and nitrogen dynamics in riverine systems: Human impacts and management options", *Riverine Ecosystem Management. Aquatic Ecology Series*, vol. 8, pp. 187-202, 2018.

[2] CLC, Corine Land Cover, 2012 [Online]. Available:http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012

[3] J. M. Phillips, M. A. Russell and D. E. Walling, "Time-integrated sampling of fluvial suspended sediment: a simple methodology for small catchments", *Hydrological Processes*, vol. 14, no. 14, pp. 2589-2602, 2000.

[4] J. Pawlik-Dobrowolski, "An attempt to assess the contribution of diffuse pollution to the total load of chemical constituents" (in Polish), in *Zlewnia Raby jako obszar alimentacji wód i zanieczyszczeń dla zbiornika retencyjnego w Dobczycach*, Cracow University of Technology, Monography 45, Krakow, 1993, pp. 207-249.

[5] J. Pawelek, M. Spytek, "Biogenic compounds in inflow for the Dobczyce Resrvoir" (in Polish), Infrastruktura i Ekologia Terenoow Wiejskich, Komisja Technicznej Infrastruktury Wsi, *PAN*, vol. 4, pp. 99-113, 2005.

[6] E. Szarek-Gwiazda, "Factors influencing the concentrations of heavy metals n the Raba River and selected Carpathian dam reservoirs" (in Polish), Studia Naturae 60, Instytut Ochrony Przyrody, Krakow, 2013.

[7] G. Zemelka, "Analysis of the suspended sediment contamination sources on the Dobczyce reservoir tributaries example with use of the geochemical markers (sediment fingerprinting method)" (in Polish), PhD thesis, Cracow University of Technology, Krakow, 2020.