

The aim of the project is to determine the temporal and spatial variability of allometric relationships between abiotic and biotic components of selected lake-catchment systems. Temporal and spatial (between objects) variability of allometric relations between ionic load delivered to the lake basin and ionic retention in lake waters will be determined. Hydrological processes (runoff, underground recharge, flushing time..) and their role in shaping the chemical state of lake waters will be established. In addition, a range of hydrochemical influence of streams supplying and draining lakes will be calculated. Project also aims to investigate an impact of the aforementioned hydrochemical processes on biomass and condition of selected aquatic organisms.

It is planned to determine cause-effect relationships, affecting water quality of selected Ł czna-Włodawa Lakes: U ciwierz, Bikcze, Rotcze and Sumin. The project involves gathering a broad spectrum of basic research that will significantly broaden a knowledge about the functioning of lake-catchment systems in Polesie region.

The study plan envisages a two-year cycle of field measurements, during which the following basic data will be obtained and archive a) hydrological data: daily water levels and flow rates of all the tributaries and outlets, the daily lake water levels, the daily volume of water stored in the lake basins b) physical-chemical data obtained in bimonthly cycle of measurements: concentration of total phosphorus, orthophosphate, ammonium, nitrate, nitrite, total organic carbon, sulphate, total hardness in the waters of lakes and 12 streams feeding and draining the lake, lake water temperature, pH, redox, water oxygenation, PEW, Secchi depth, c) hydrochemical: fortnightly values of the loads transported to lake basin and carried out of the catchment area, the values of ion retention (positive or negative) in studied lakes basins d) hydrobiological: concentration of carbon, nitrogen and phosphorus in aquatic organisms, biomass and abundance of zooplankton. The collected material will allow to determine the power of the relationship between different parts of the lake-catchment system.

Several factors decided that proposed research project seemed to be interested. Firstly, the planned research focuses on the recognition of water bodies and their catchment areas in approached as one lake-catchment system, not classically understood as two separate parts: catchment and lake basin. Ł czna-Włodawa Lakes are very poorly known in terms of hydrological and hydrochemical information, so detail-ranging research program will constitute a significant contribution to knowledge about the region. The use of well-known and recognized in the biological literature allometry (which advantage is simplicity and objectivity of results) in studies of the relationships of lake-catchment may be a contribution to the allometry implementation in other lake district areas.

Lake-catchment systems are complex areas of matter and energy exchange. This distinctive two-dimensional system is composed of parts: terrestrial (area feeding the lake) and aquatic (lake basin). A coastline is a boundary of these two subsystems. Hydrochemical dynamic of a lake catchment area makes up an external load, shaping the direction and intensity of ionic translocation. These processes are consubstantial and effect each other. The power of connections between individual parts of lake-catchment systems subject to the scaling laws, and for the first time in Polish lakes will be presented with allometric theory. In-lake processes dominate in aquatic part of the system (autonomous and forced). They determine the level of ionic transformation of water. The most important in shaping water chemistry are biogens (which are the cause of progressive eutrophication) (Klein, Koelmans 2011) and fluvial dynamic of a catchment which is a driving force of in-lake processes, eg. Flushing time, the degree and rate of ionic transformation (Muller et al. 1998, Lee et al . 2009, Liu et al. 2011). The process of ions transformation and translocation in lake-catchment systems is also modified by various conditions on the border of hydrochemical systems, open and closed, and fluvial and aquatic. Another factor affecting the degree of ion transformation and translocation in lake-catchment system is hydrogeochemical susceptibility of the rocks forming the catchment to denudation processes.

Due to complexity of lake-catchment systems they are often investigated as separate parts: catchment or lake basin. The proposed study is based on estimation of allometric relations between different parts of lake-catchment systems. It is a novel approach to the concept of allometry which is known in the literature. Allometry will be used in a new, wider sense in the proposed study. Thus, the planned research will be pioneering in the discipline of Earth Sciences. The proposed research program will allow for multidimensional analysis of the allometric relationship and identify factors that distinguish qualitatively and quantitatively studied lake-catchment systems.

For the first time a power of scaling between hydrological, hydrochemical and hydrobiological parameters will be calculated, in each of the lakes in an objective manner, using the same method. The proposed approach to research of lake-catchment systems is rare in the literature. It involves a holistic analysis of the processes shaping the water quality, including terrestrial lake catchment area, lake basin as well as lake outlet and its hydrogeochemical impact (range of hydrochemical zones). For the first time for Ł czna-Włodawa Lakes: a) the value of ion retention in the lake basins will be calculated and its temporal and spatial variability will be analyzed, b) the relationship between the value of ionic retention in lake waters and condition of aquatic organisms will be determined, c) the power of relationship between ionic retention and biomass of aquatic organisms. will be established.

The proposed project will provide scientific information which significantly expand the current knowledge in the field of basic research. Studies of allometric compounds in world literature focus on identifying biological relations eg. the size of the organism and its weight or volume. There is no information on the allometric relationship between hydrological indicators and the quantity and quality of aquatic organisms.

The scope of the research will also provide all relevant information on the size and dynamics of ionic retention in lake waters as well as concentration of carbon, phosphorus and nitrogen in aquatic organisms. It is a novel approach in the literature, contributing to the development of the science of lakes - limnology.

With regard to the Ł czna-Włodawa Lakes, proposed studies should be considered as innovative. Previous studies both hydrochemical and hydrobiological were based on ion concentrations in lake waters. The concentration measure, as instantaneous absolute value, however, is not the best measure to analyze the interaction between individual components of the ecosystem, which is lake-catchment system. Therefore, the research plan is based on the ionic loads, taking into account both quantitative element (flow rate, volume of lake basin) and qualitative (ion concentration).

#### References:

Klein, L. M.; Koelmans, A. (2011) Quantifying seasonal export and retention of nutrients in West European lowland rivers at

catchment scale. *Hydrol. Process.*, 25, 2102-2111. doi:10.1002/hyp.7964.

Lee, S. W.; Hwang, S. J.; Lee, S. B.; Hwang, H. S.; Sung, H. C., 2009. Landscape ecological approach to the relationships of land use patterns in watersheds to water quality characteristics. *Landscape Urban Plan.* 92: 80-89. doi: 10.1016/j.landurbplan.2009.02.008.

Liu, W. Z.; Zhang, Q. F.; Liu, G. H., 2011. Effects of watershed land use and lake morphometry on the trophic state of Chinese lakes: implications for eutrophication control. *CLEAN—Soil, Air, Water*, 39: 35-42. doi: 10.1002/clen.20100005.