ECOHYDROLOGY – FRAMEWORK FOR IMPLEMENTATION OF ECOLOGICAL BIOTECHNOLOGIES IN INTEGRATED WATER RESOURCES MANAGAMENT

M. Zalewski

International Institute Polish Academy of Sciences
European Regional Centre for Ecohydrology u/a UNESCO, Łódź, Poland
mzal@biol.uni.lodz.pl

The dynamics of the water cycle in the given river basin depends on climate, geomorphology, specific of plant cover, freshwater ecosystems typology and modifications of the ecosystem by agriculture, urbanization, industrial development and hydro technical infrastructure.

The water management until the end of the 20th century was dominated by a mechanistic approach focused on elimination of threats such as floods and droughts and provision of water to societal needs. Biological structure of ecosystems at that time was mostly used as an indicator of ecological status. Declining water quality at the world scale and increasing progress in predictive potential of ecology and limnology provided the background for the development of Ecohydrology – an integrative environmental science, which started from the formulation of the question on what is the hierarchy of factors which regulate dynamics of hydrology/ biota interplay, and further - how it can be used for problem solving in IWRM.

The reduction of point source pollution is dependent on technology, monitoring and law enforcement. However, the reduction of the impact of non-source pollution without lowering food production is dependent first of all on understanding the complexity of the whole range of ecological processes, among which the primary importance interplay between water and biocenosis – both in terrestrial and aquatic phases of hydrological mesocycle.

Ecohydrology, a trans-disciplinary science, which has been developing in the framework of the International Hydrological Programme of UNESCO (IHP V;VI, VII) is a sub-discipline of hydrology focused on biological aspects of hydrological cycle, provides not only scientific understanding hyrology/ biota interplay but also systemic framework on how to use ecosystem properties as a new tool for IWRM complementary to already applied hydrotechnical solutions. The novel element of this approach is the assumption that to reverse degradation of aquatic ecosystems there is a need not only protect it, but also to regulate ecosystem performance from landscape to molecular scale. This means that biocenotic processes can be regulated by hydrology, and vice versa - hydrological processes by shaping biocenotic structure and interactions. The idea is based on understanding the imprinted by evolution, ability to adopt of terrestrial and aquatic organisms to water quantity and quality dynamics in the catchment and aquatic ecosystems. The integration for synergy of those two aspects at the river basin processes regulation (H-B and B-H) was named "dual regulation" and is becoming the key element of ecological biotechnologies. Biotechnology is the science of conversion of various forms of the matter using organisms. As a consequence the major implicit goal of Ecohydrolgy for IWRM is the regulation of water biota interplay from top of the basin up to the costal zone towards the change of allocation of excess nutrients and pollutants in to non-available pool such as soil, sediments, wood, biomass/bioenrgy, fodder or at least from more dynamic-opportunistic (e.g. toxic cyanobacteria) to less dynamic pool within organisms (zooplankton, fish, macrophytes).

Due to complexity of knowledge to be applied the development of mathematical models for decision support systems, should be a useful tool for testing alternative scenarios and for the implementation of EH methodology for sustainable water, ecosystems and societies.

CHEMICAL COMPOSITION OF STREAM WATER IN THE WINTER LOW FLOW PERIOD IN SMALL CATCHMENTS OF THE TATRA MTS.

M. Żelazny[1*], M. Kasina[1], M. Kot[2], J.P. Siwek[3], J. Siwek[1]

[1]*Jagiellonian University, Institute of Geography and Spatial Management, Cracow, Poland*
[2]*Tatra National Park, Zakopane, Poland*
[3]*Academy of Physical Education, Institute of Tourism and Recreation, Cracow, Poland*
[*]*m.zelazny@geo.uj.edu.pl*

Chemical composition of surface water in small catchments is determined by two main factors: 1) unchanging in time – e.g. bedrock geology and 2) changing in time – i.e. seasonal weather conditions, biological activity of organisms etc. The aim of the study was to recognize the spatial differentiation of the chemical composition of stream-waters draining small mountain catchments during low flow periods of winter season. Research carried out in such a period can give us precious information about the influence of bedrock lithology on the chemistry of surface waters.

The study area and methods

Research was carried out in 28 Tatra Mts. streams, draining high-mountain catchments of different geology (Figure 1). All of them are situated in the Tatra National Park (southern Poland).

Water sampling was carried out in the winter season of 2007/2008. On 27-29 December 2007, 28-29 January and 11-12 February 2008 84 samples were taken. Stream water levels, water temperature and specific conductance of water (SC) were measured in field. SC and pH were measured again in the laboratory. Chemical analysis was performed with the chromatographic system DIONEX ICS 2000 with analytical column AS 18 together with two protective columns AG 18 for: HCO_3, SO_4, Cl, NO_3, and with the column CS 16 together with two protective columns CG 16: for Ca, Mg, Na, K.

Results

The stream water was slightly acidic or slightly alkaline with total mineralisation varied from over a dozen to several hundred $mg \cdot dm^{-3}$. More acidic and less mineralised waters occurred in the catchments built of crystalline rocks, whereas the mineralization of waters in the catchments built of carbonate rocks was many times higher. In the stream waters, regardless of geology and catchment area, HCO_3^- dominated among the anions (42-94% mval), whereas Ca^{2+} dominated among the kations (52-91% mval). Among other cations only Mg^{2+}, and among anions SO_4^{2-} and sometimes NO_3^- share more than 20% mval. In all of the waters very small absolute values of biogenic compounds were observed what evidenced their low level of eutrophication. In all of the streams flowing out of the postglacial lakes nitrates contribution in anion totals was higher than 20% mval.

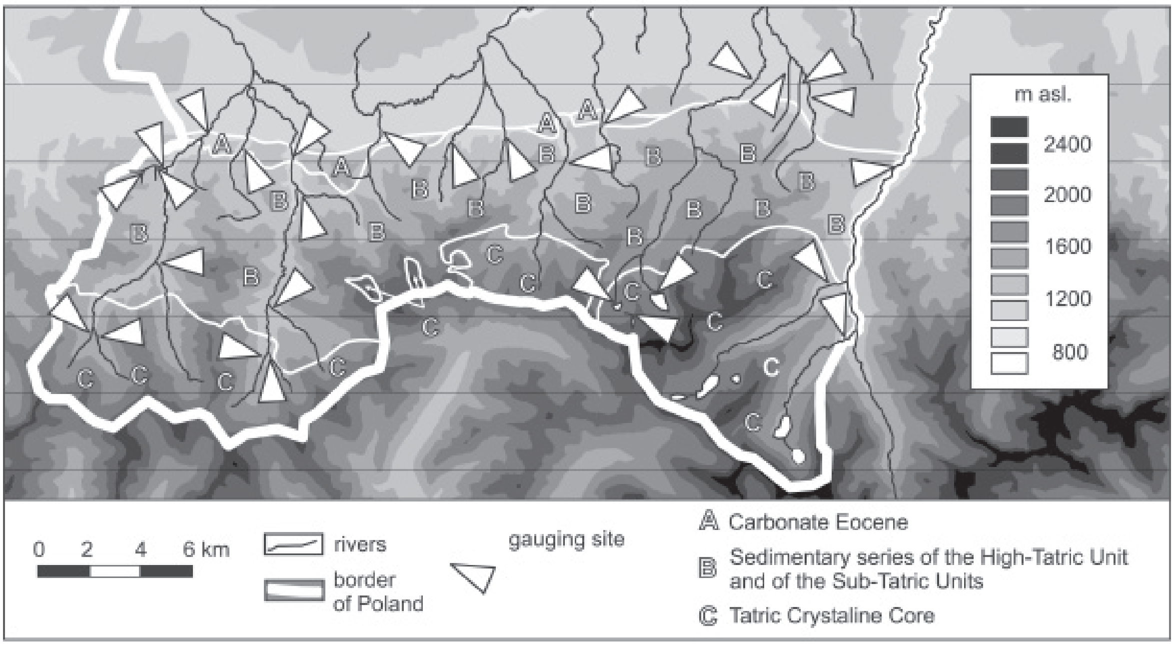

Figure 1. Sampling points and main geological units in the Tatra National Park

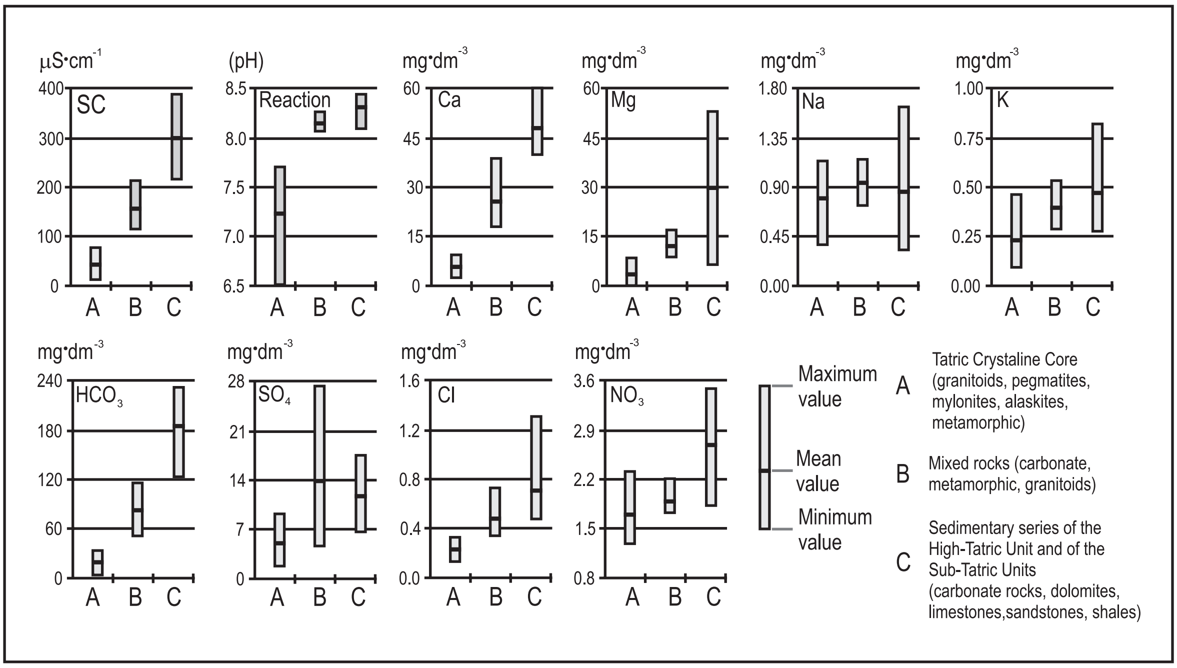

Figure 2. Basic statistics of chemical composition of stream waters in different geological units

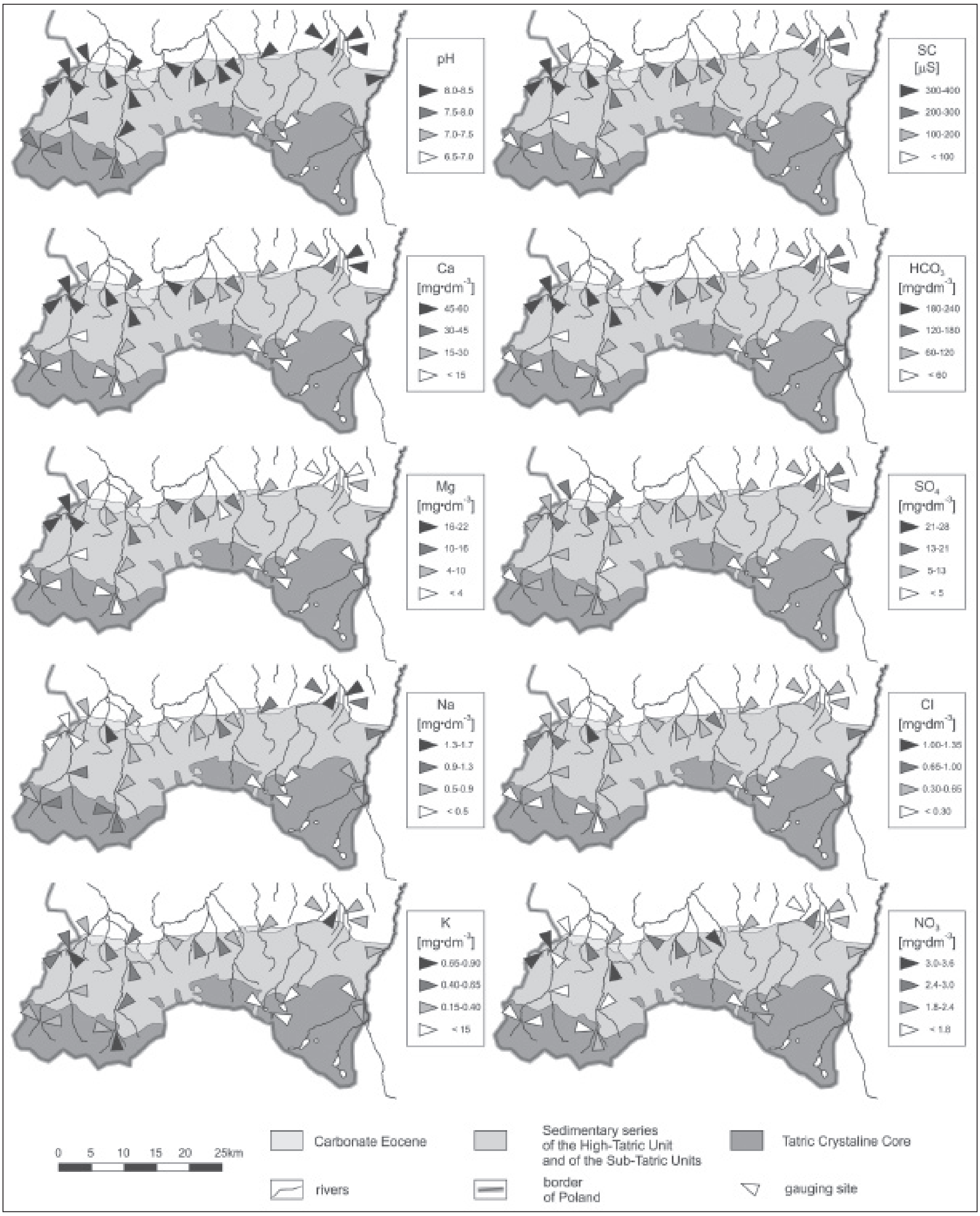

Figure 3. Physical-chemical properties of stream waters in the Tatra National Park

The significant differences in ion composition of waters draining different bedrock geology were found (SC, pH, Ca, Mg, K, HCO_3 and NO_3) (Figure 2). The lowest concentrations, as well as SC and pH, were typical for catchments built of granitoids, pegmatites, mylonites, alaskites and metamorphic rocks (Tatric Crystaline Core). The highest concentration and the highest values of pH and SC were typical for sedimentary series of the High-Tatric Unit and of the Sub-Tatric Units with carbonate rocks, dolomites, limestones, sandstones and shales. In the mixed bedrock areas (carbonate, metamorphic, granitoids) ion concentration, SC and pH were lower than in the sedimentary series and higher than in the Tatric Crystaline Core.

However the spatial pattern of chemical properties of water was rather closely related to lithology, there were also some ions that did not show a simple relation to the bedrock geology (Figure 3) in particular sampling series. That was much in evidence at nitrates and suplphates, which had the highest concentration in the northern part of the study area, in the lower parts of catchemnts and close to the border of the national park. Increased concentrations of NO_3 and SO_4 might be related to atmospheric deposition of pollutants originating from emission sources located out of the Tatra National Park.

Acknowledgements

The study is a part of the project "*Factors determining spatial variability and dynamics of water chemical composition in the Tatra National Park*" financed by Polish Ministry of Science and Higher Education (MNiSW - N305 081 32/2824).