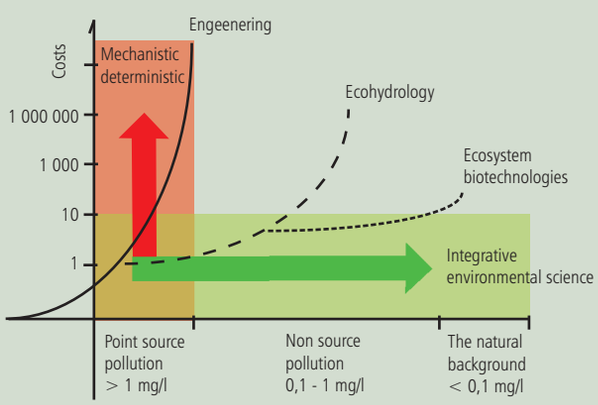
Ecohydrology, biotechnology and engineering – a cost-efficient tool for "Nature Based Solutions" and "Circular Bioeconomy"

"The engineering knowledge is fundamental to mitigate strong of cumulative impact and for enhancement ecosystem services in sustainable catchment management. Such knowledge has developed methods for water supply, irrigation, and sewage treatment, and technical measures for prevention of water disasters, thus contributing to security of human settlements, and technology for water retention (dams and reservoirs).

On the other hand, this advanced engineering knowledge is not sufficient for sustainable basin management. The reason is that river basins are 'superorganisms' (Zalewski, 2000): complex self-organizing systems of biotic and abiotic components that are in constant change and with mutual dependencies. Their potential for providing ecosystem services, and sustaining ecosystem resilience is determined to a great extent by their biological structure and dynamics, established during the course of biological evolution. It is worth remembering that the consequences of human impact on the biosphere, combined with rising human populations, global climate changes and economic mechanisms that force an avalanche of consumption, generate increasing demand for ecosystem services and create increasing pressures on the environment.

That is why the understanding the complexity and multitude of the water–biota interactions (ecohydrology), especially the role of ecosystems as important stabilizers of components of the hydrological cycle, is important. These are major determinants of nutrient cycles, which are crucial for humanity's persistence on Earth, but which have been modified to huge extents by people.

The burning issue of reversing biosphere degradation depends not only on improved efficiency of the remediation measures, based on new paradigms and methods, but also on reducing the costs of achieving sustainability. This has been especially addressed in water management in the face of demographic changes and increasing climate instability. Experience from the past provides evidence that attempts to solve environmental problems without restitution of the complexity of ecosystem services, i.e. by purely engineering solutions, can be one order of magnitude more expensive than maintaining good ecological status of ecosystems (e.g. New York City's water supply system; National Research Council, 2000). However in many situations, it is necessary to combine both measures. Statzner and Sperling (1993) first suggested that integration of technical and biological measures for improvement of water quality should increase efficiency and reduce costs. This idea can be profitably translated into basin scale management (IWRM) by integrating engineering solutions with ecohydrological 'dual regulation' and biotechnology" (Fig. 4) (Zalewski M., 2014).



The intensity of the human impact in catchment scale expressed in phosphorus concentration

As far as ecohydrology covers a broads spectrum of environmental processes from molecular to catchment scale which has been resulting in development of ecohydrological biotechnologies (currently dubbed "Nature Based Solutions"), thus becoming the fundamental element of the emerging Sustainability Sciences and a complementary component of "Circular Bioeconomy".

Fig. 4. Enhancement of efficiency and cost reduction by integration of the ecohydrology engineering and biotechnology

KEY PUBLICATIONS

- Zalewski M., 2000. Ecohydrology - the scientific background to use ecosystem properties as management tools toward sustainability of water resoutces. Guest Editorial Ecological Engineering 16:1-8.
- Zalewski M., 2013. Ecohydrology: process-oriented thinking towards sustainable river basins. Ecohydrology & Hydrobiology 13 (2013), 97-103.
- Zalewski M., 2014. Ecohydrology, biotechnology and engineering for cost efficiency in reaching the sustainability of biogeosphere. Ecohydrology & Hydrobiology 14 (2014), 14-20.
- Zalewski M., 2014. Water as the backbone of quality of life in the cities of the future. Sustainable Development Applications Series 5/2015 (Water in the City).