EDITORIAL

Impact of Climate Change and Other Abiotic Environmental Factors on Aquatic Ecosystems

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Water ecosystems are very important for conservation of biosphere variety and production. EU Water Framework Directive requires the Member States to implement the necessary measures to improve and protect the status of water bodies. Consequences of climate change together with intensive use of natural resources pose a threat to aquatic animal communities, and in the future it will undoubtedly have even more significant effect. As frequency of extreme climatic events increases, aquatic ecosystems will be forced to adapt to new stressful environmental conditions. There are many investigations dedicated to assessment of climate change impact on aquatic ecosystem and analysis of this complicated process abroad. In Lithuania, such studies are relatively fragmented and not as broad and complex; despite the fact that certain narrow significant questions are analysed very well, there is still a lack of integrated research on impact of climate change and other abiotic factors on the ecosystem sustainability.

Within the framework of the National Research Programme 'Sustainability of agro-, forest and water Ecosystems' researchers from Lithuanian Energy Institute, Vilnius University, Nature Research Centre and Aleksandras Stulginskis University are working on a project 'Impact Assessment of Climate Change and Other Abiotic Environmental Factors on Aquatic Ecosystems'. The aim of this study is to evaluate changes of environmental factors (water temperature, hydrological regime and water quality elements) and their impact on aquatic animal diversity and productivity, and carry out an integrated impact assessment according to the multi-annual data and climate scenarios. Three river basins (of the Neris, the Nevėžis and the Minija) and the Curonian Lagoon have been chosen as research objects.

During the project the following activities are planned: development of the methodology for assessment of climate change impact on the state of aquatic ecosystem; projection of changes of significant for aquatic ecosystem climatic indices in 21st century according to output data from different climate scenarios; assessment of change patterns and extremes of abiotic factors using the multi-annual data and projection according to climate scenarios; impact of extreme abiotic factors on aquatic ecosystem animal diversity and productivity; complex impact assessment of abiotic factors on aquatic ecosystem animal diversity and productivity and projection under changing climate conditions; evaluation of adaptation ability of aquatic animal populations and communities in context of climate change.

In order to solve the planned tasks, databases of hydrological, meteorological and river water quality, data bank of river fish and their habitat, as well as modern digital modelling software (HBV, FYRISNP), statistical and probabilistic data analysis software packages, ArcGIS, tool for uncertainty and sensitivity analysis - SUSA, the new climate modelling and prediction tools (CMIP5), are going to be used.

Projections of abiotic factors were made for near-future (2016–2035) and far-future (2081–2100) periods according to 3 global climate models (GFDL-CM3, HadGEM2-ES, NorESM1-M) and 4 RCP scenarios (RCP2.6, RCP4.5, RCP6.0, RCP8.5) and then compared to the reference period (1986–2005) values.

Changes of the environmental factors and their impact on aquatic ecosystem animal diversity and productivity were assessed according to long-term data and climate scenarios. Under all scenarios, air temperature will continue to grow. According to different scenarios, air temperature is expected to grow by 1.5-1.8°C in 2016-2035 and by 2.2-5.7°C in 2081-2100. The greatest warming is projected at the end of the 21st century according to RCP8.5 scenario. Future changes of precipitation will depend on the climate scenario; in most cases it should decrease in summer, but increase in winter.

According to historical data, river water temperature of the warm period has increased significantly. In the future even more significant positive changes of water temperatures are projected (up to 1.56°C in 2016-2035 and 3.82°C in 2081-2100, in average), which in turn are expected to have negative impact on river ecosystems. Currently observed decreasing tendency of the studied river runoff will continue. In the near-future period (2016-2035) runoff is going to decline by 6.5%, and in 2081-2100 – by 16.3%, in average. Climate change will cause a decrease of total phosphorus and nitrogen loads in the rivers.

Water temperature and salinity of the Curonian Lagoon are projected to increase. Water temperature of the lagoon is expected to increase by 1.4°C in 2016-2035, and by 3.5°C in 2081-2100, in average. The projected lagoon water salinity is 2.0‰ for 2016–2035, and 3.0‰ in 2081–2100 (whereas a value of the reference period was 1.6‰). The future salinity changes can be related to the decrease of fresh water inflow and the increase of brackish water intrusion from the Baltic Sea. All studied abiotic factors are expected to change significantly at the end of the 21st century under RCP8.5 scenario, which projects the extreme changes.

The projected increase of water temperature will lead to changes in fish community. Under RCP2.6, the mentioned changes are expected only in far-future. In case of RCP6.0, an extinction of some stenothermic species (especially - salmon) is possible in the Neris and the Šušvė, in case of RCP8.5 – in the rest of the studied rivers. Macroinvertebrates are projected to tolerate growing water temperature. Increased abundance of individual taxonomic groups or total number of macrozoobentic organisms is expected. The projected changes of river runoff should not be a cause of significant changes in fish and macroinvertebrates communities. Future changes of nitrogen and phosphorus concentrations are supposed to be small and not significant to influence the state of fish and invertebrates.

Water temperature growth will cause significant changes in fish community of the Curonian Lagoon. According to projections, a portion of cold-water fish is expected to decrease, and at the end of the century these fishes may disappear (except in case of RCP6.0). As temperature increases, warm-water fishes will begin to prevail in the community even more, especially carp. Increase of bream portion is likely to occur as well. Correlation between indices of fish community structure and changes of salinity in the Curonian Lagoon is not statistically reliable. Results of laboratory experiments suggest that small increase of water salinity does not have direct negative impact on growth and behaviour of perch.

Long-term change projection of aquatic animal productivity and biodiversity is accomplished. The obtained results will be used to create recommendations on how to protect fish resources and species diversity in Lithuanian rivers and the Curonian Lagoon under changing climate conditions.

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