Popular Science Summary

Water temperature plays a crucial role in a number of biological and chemical processes that occur in rivers. It is one of the main factors that determine both biodiversity of aquatic ecosystems and the possibility of economic and recreational development of river systems. As climatic changes seem to be no longer a question of the future, but empirically verified fact (also in Poland) that affect the environment today, the problem of future thermal regime of rivers is getting especial importance.

Future climatic conditions of particular region of our planet may be projected by means of global and regional atmospheric circulation models. However, to get any insight into hydrological conditions, including thermal regime of rivers, additional models are required. The aim of such models is to describe relations between meteorological and hydrological variables, what for future climatic conditions is not as trivial as one may wish to expect. As physically-based models require large number of data that are frequently unavailable even for historical or present conditions, for projecting streamwater temperature in case of climatic changes often much simpler empirical models are used. The most trivial among such models, linear regression, has been applied to water temperature modeling for decades. However, it inappropriately describes relation between air and stream temperatures, especially for cold and very hot periods. At the end of 1990-s Mohseni and co-authors proposed and quite deeply justified similarly simple but nonlinear model describing air-water temperature relation. This model have a few parameters which require calibration and was introduced specifically for weekly data, but its variants have been more or less successfully applied also for monthly, daily and even hourly data. Because the relation between stream temperature and its inducing factors, not only air temperature but also river flow or solar radiation, are frequently not as trivial as assumed by Mohseni et al. model, in recent years a number of more developed, even if still quite simple empirical approaches have been tested, including artificial neural networks and stochastic transfer functions. Recently a few simplified physically-based models have been proposed, that do not require much information on various hydro-meteorological variables, and hence are hoped to be suitable tools for stream temperature projections in future climatic conditions – a good example of such model is air2stream, developed in Italy and Switzerland.

In the present project streamwater temperatures in selected Polish and, for comparison, foreign catchments are to be projected for future climatic conditions by means of empirical models mentioned above. A number of methodological features of such models will be addressed and some novel methodologies proposed. Even if methodological details may be boring from reader's point of view, methodological part of the research frequently play a crucial role in the final quality of the results. In this project, according to our best knowledge for the first time in hydrology a specific method called "dropout", that aims at helping artificial neural networks to avoid harmful behaviour known as overfitting, will be used and a novel variant of this method is planned to be developed. Also a new variant of models proposed by Mohseni and co-authors will be proposed, to allow using additional information for streamwater temperature modeling, which was missing in the original approach. As the basic version of air2stream model uses Particle Swarm Optimization method, that has been proposed during mid 1990's, to parameter calibration, within the project a more effective optimization method will be proposed.

Often in the research aiming at streamwater temperature projections for future climatic conditions a single hydrological model is used. In this project a number of models and its variants will be applied together to this task. This enables both comparing their performance on historical data, and verifying the discrepancies in the projected future stream temperatures obtained by various methods.