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Investigation of the impact of climate change on river water temperature: possible mitigation measures using riparian vegetation

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Water stream temperature is a relevant factor for water quality since it is an important driver of water oxygen content and in turn also reduces or increases stress on the aquatic fauna.
The water temperature of streams is determined by the source and inflow water temperature, by the energy balance at the stream surface and by the hydrological regime of the stream. Main factors driving the energy balance of streams are radiation balance and air temperature which influence the sensitive and latent heat flux.
The present study investigates the influence of climate change on water temperature of streams and the potential of riparian vegetation to mitigate its effects. Within the scope of the project BIO_CLIC routine measurements of water temperature at 33 locations alongside the rivers Pinka and Lafnitz were performed from spring 2012 until autumn 2014. In addition meteorological measurements of global shortwave and longwave radiation, air temperature, wind and air humidity were carried out during this time. For the same time period, data of discharge and water levels of both rivers were provided by the public hydrological office.
This time period also includes the heat episode of summer 2013 during which the highest air temperature ever recorded in Austria was reported on 8 August at 40.5°C. In the lower reaches of the river Pinka, at the station Burg the monthly mean water temperature of August 2013 was with more than 22°C, 1°C higher than the mean water temperature of the same period of the previous years. At the same station, the maximum water temperature of 27.1°C was recorded on 29 July, 9 days prior to the air temperature record.
Analysis shows that at the downstream stations the main driving parameter is solar radiation whereas at the upstream stations a better correlation between air temperature and water temperature is obtained. The influence of riparian vegetation on water temperature, leading to lower water temperature by shading, is also detectable.
Using the extensive data set and information on river morphology, a validation of the physical based water temperature model HEATSOURCE was performed. Using regionalized climate model scenarios (scenario A1B) and assuming mean low flow conditions, the water temperature was simulated for the rivers Pinka and Lafnitz until 2100. Compared to the heat episode 2013, an increase of water temperature along the whole stream of 2.5°C during heat episodes occurring in the time period 2071 to 2100 may be expected.Simulations show that riparian vegetation may almost totally counterbalance the effects of climate change.