Changes in land use pose greater threat than climate change to biodiversity of rivers and streams

May 19 2015

Changes in land use pose the greatest threat to the species diversity in streams and rivers. Credit: Senckenberg

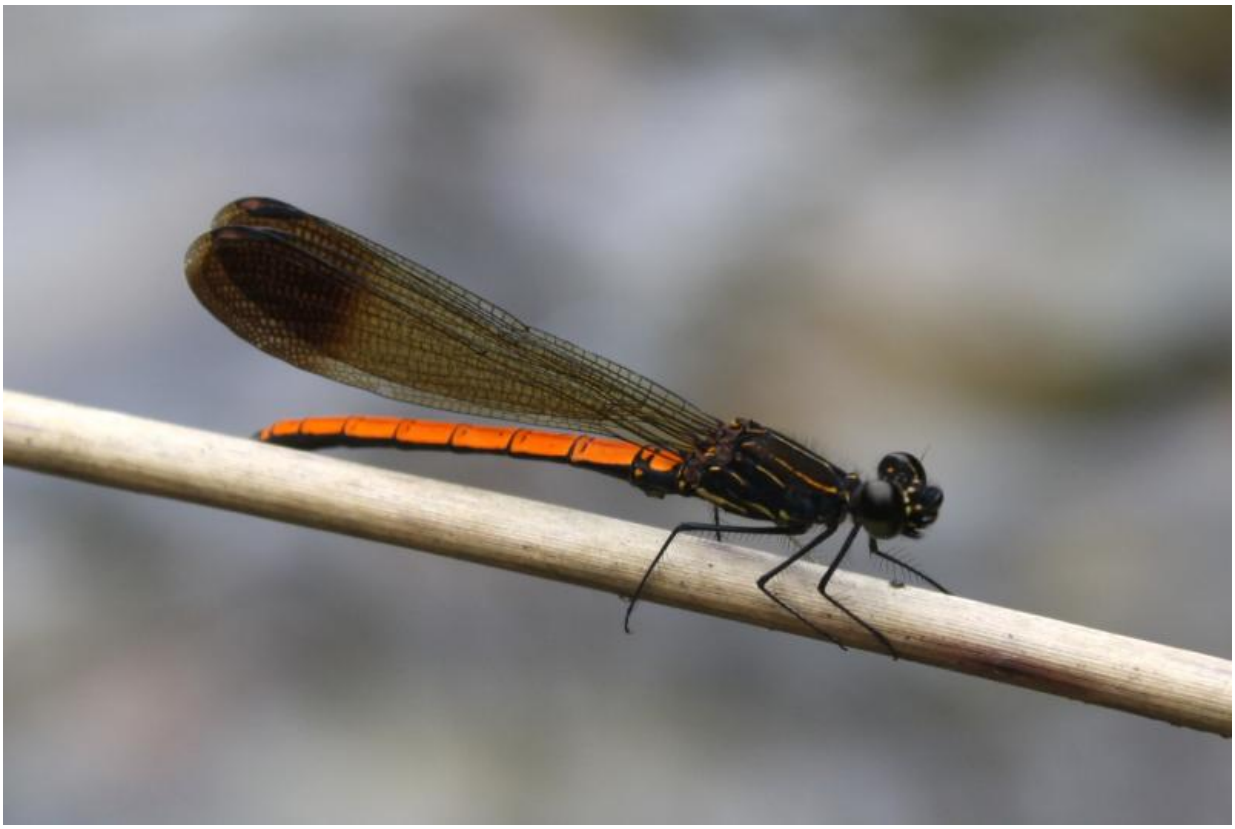
For the first time, scientists at the Senckenberg Research Center for Biodiversity and Climate and the Research Institute Senckenberg in Gelnhausen have modeled the effects of land use changes on the species diversity in rivers and streams. Their results show that the loss of biodiversity is caused to a significantly higher degree by changes in land use practices than by climate change. In consequence, conservation concepts for this valuable ecosystem and the organisms that live in flowing water should be adapted accordingly. The study was recently published in the scientific journal *Freshwater Biology*.

From their source to the mouth, rivers and streams are in constant motion and count among the world's most dynamic ecosystems. Although they only cover a small percentage of the land area, in their natural state these ecosystems are home to a multitude of living organisms: insects, fish, algae, bivalves and daphnias are but a few of the denizens of streams and rivers. "At the same time, however, rivers and streams are the most endangered ecosystems on a global scale," according Dr. Mathias Kuemmerlen from the Department of Freshwater Ecology and Nature Conservation Research at the Research Institute Senckenberg in Gelnhausen. He adds, "Rivers and streams are more sensitive to environmental changes than any other biotope."

Together with colleagues from China and Germany, the biologist from Gelnhausen studied the rivers and streams in a catchment area of approx. 1,700 square kilometers in Southern China, which is part of the drainage basin of the Yangtze River. "For the first time, we modeled a future

projection of the species diversity in connection with land use changes," explains Dr. Sonja Jähnig, who conducts research at the Leibniz Institute for Freshwater Ecology and Inland Fisheries in Berlin and who initiated this study. She adds, "The loss of biodiversity is often studied in relation to climate change. Other important anthropogenic impacts on the environment – such as changing land use practices – are frequently neglected in this context."

Therefore, the team of scientists around Kuemmerlen modeled three scenarios for the development of freshwater-dwelling macroinvertebrates – animals without a vertebral column easily recognized with the naked eye – for the years from 2021 until 2050: the climate change, the change in land use, and a combined climate change and land use change scenario. "Our results will help us to better understand future changes in the invertebrate communities," according to Jähnig.



Damselflies (Zygoptera) are typical inhabitants of rivers and streams. Credit: Senckenberg

The 72 aquatic organisms that were studied display a wide range of different behaviors in the models. Thus, in the course of land use changes, the aquatic stonefly Togoperla sp. stands to lose 85 percent of its distribution area in the studied drainage basin and is locally threatened with extinction, while damselfly species of the family Protoneuridae gain an additional 9 percent of potential habitat. "In all of our models, there are 'losers' and 'winners,' both in the land use and climate change scenarios. However, across all species, it can be said that the changes in land use have the strongest negative effect on the species diversity in rivers and streams – in this model, the local biodiversity decreased by 20 percent," explains Kuemmerlen.

In the scientists' models, the effect of climate change on the biodiversity in rivers and streams is only of secondary importance. According to Kuemmerlen, "There is a close interaction between flowing water and the landscapes in the drainage basin. Therefore, the species diversity is strongly affected by land use practices." In addition, the modeling results show that the combined effect of changes in land use and climate may lead to a general decrease in local species diversity. Moreover, a shift in the distributions of many aquatic invertebrates can be expected.

Although changing land use practices, e.g., the clear-cutting of forests for agricultural use, represent the most obvious change within an ecosystem, according to Kuemmerlen this factor is frequently neglected in the development of conservation concepts. "In order to preserve the species diversity, we must consider both changes in climate as well as in land use," he summarizes.

More information: "An attack on two fronts: predicting how changes in land use and climate affect the distribution of stream macroinvertebrates." *Freshwater Biology*. DOI: 10.1111/fwb.12580

Provided by Senckenberg Research Institute and Natural History Museum