Impacts of climate change on river ecosystems - Case studies of the Danube and Mekong River

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Introduction

Climate change is projected to alter the flow regime of rivers on a global scale. In the northern hemisphere most of the climate models predict a significant increase in average annual runoff, while in the southern hemisphere a significant decrease is predicted (Fig.1). Global warming is causing a shift in the seasonal characteristics of the flow regime particularly in basins where the regime is characterized by snowmelt. The resulting changes in runoff and water temperature influence the chemical properties, inducing impacts on river ecosystem health and the provision of ecosystem services. Riverine ecosystems may adapt to the altering conditions and a new equilibrium might be established. There is a risk of extinction for vulnerable species during this development which might be replaced by invasive species.

As the impacts of climate change on river ecosystems differ depending on their location, each river basin must be regarded individually. The following work focuses on the study areas of the Mekong River (South-east Asia) and the Danube River (South-east Europe)(Fig. 2).

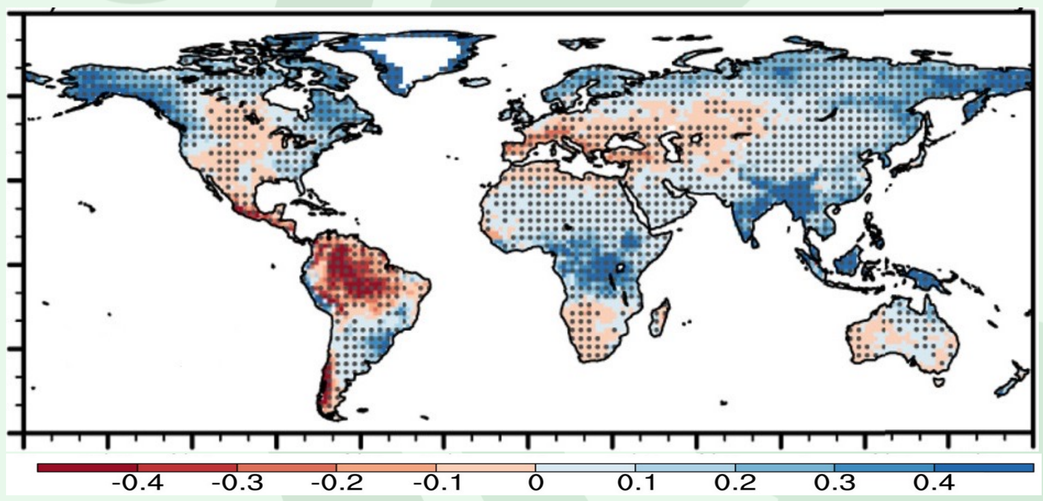

Fig 1: Projected runoff change (ΔRo in mm/day) under the SSP5-8.5 Scenario in 2081-2100 compared to 1995-2014 (Wang et al. 2022).

Results

Danube River

The mean water temperature in Danube river increased by 0.49 °C from 1931 to 2005. Depending on the climate scenario, the water temperature is expected to rise by 1.83 to 2.6 °C until 2075. The annual average discharge is projected to remain similar, but a significant change is expected in the intra-annual flow regime. The winter discharge is projected to increase while the summer and autumn discharge is expected to decrease. The number of invasive alien species in the Danube has increased in each river assessment since 2001 and already made up 40 % of all documented species in the basin in 2008.

Mekong River

Annual average temperature of the river is projected to increase by 1 to 2 °C until 2040. An incline in mean annual runoff is expected to amount 5 % in the upper and 15 % in the lower course of the river until 2065. Monsoon induced wet and dry seasons determine the hydrology of the river by seasonal variances in the runoff. Discharge values are expected to vary more significantly in the wet season than in the dry season. The increase of invasive alien species' abundance will be especially relevant in the lower Basin as it is the river section obtaining the highest species richness.

Discussion

The increase in air temperature is directly linked to an increase in water temperature. Additionally, the river discharge is influenced by higher evaporation rates and altered precipitation patterns.

Other factors such as species composition or physico-chemical traits are not only affected indirectly by climate change, but also by anthropogenic impacts.

Assessments of climate change on river ecosystems exhibit global trends but have to be viewed at basin scale in order to make management decisions and estimate the consequences on ecosystems. Studies on vulnerability at ecosystem- and species level will be valuable as there are no current solutions to state thresholds that are critical for the ecosystem health.

Fig 2: River basins of Danube River (left) and Mekong River (right) (adapted from Lehner and Grill 2013, Phouthavong 2015).

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Literature

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