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Modelling the impacts of climate and socio-economic changes on pesticide use and fate

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Agricultural use of pesticides helps control a range of pests and diseases that threaten crops, thereby avoiding yield losses and improving the quality of the food produced. However, pesticides applied on agricultural fields dissipate with time. The export of pesticides and their transformation products after application from the agricultural fields threatens the water quality of aquatic systems in many world regions.

Climate change is further expected to intensify pest pressures and potential pesticide use by affecting agriculture in many ways. Changing climatic conditions can increase pesticide leaching due to increased and frequent rainfall, higher degradation rates, or higher temperatures or soil moisture contents. The indirect effects are changes in land use, the timing of crop cultivation, selection of other crop types, new pests and changed pest behaviour, etc. Additionally, several socio-economic factors influence pesticide use at the farm and national level, including regulation and legislation, economy, technology and crop characteristics. In order to better understand the pesticide risk to surface waters in the future, we aim to understand the influence of both climate and socio-economic change on pesticide use and fate.

Various catchment-scale models are available to assess pesticides and their impacts on water bodies. However, most modelling approaches solely concentrate on the total amount or concentration of pesticide exported from a catchment and do not necessarily analyse the future change of pesticide and transformation products. We propose an integrated modelling framework to answer the research questions: What are the current significant climate and socio-economic drivers influencing pesticide use and emissions? How can climate change influence pesticide and transformation products emission trends? How will socio-economic change influence pesticide emissions?

The integrated modelling framework helps to include adapting agricultural production to climatic (e.g., temperature, precipitation) and socio-economic drivers (e.g., land use, crop type, pesticide regulation) and quantifying pesticide emissions with the Zin-AgriTRA pesticide fate model. The ZIN-AgriTra is a catchment scale reactive transport model which can simulate agrochemical and transformation products exported from agricultural catchments. We use the Eur-Agri-SSP scenarios that extend and enrich the basic Shared Socio-economic Pathways with a regional and sectoral component on agriculture to explain the socio-economic change and climate projections for Representative concentration pathways to adopt climate change scenarios.

The integrated modelling framework links the future scenario results from independent, standalone models that present crop rotation, land use, pesticide regulation and climate to the pesticide fate model (Zin-AgriTRA). The framework is applied to an agricultural catchment in Burgenland, Austria, to quantify pesticide pollution under future climate and socio-economic change up to 2050.