Name:	Ralf Ludwig	Email:	r.ludwig@lmu.de
Institution:	LMU	Type (oral/poster)	oral

Assessing global change impacts on stressors for aquatic ecosystems at the basin scale

Ralf Ludwig[1], Alberto Bellin[2], David Gampe[1], Verena Huber Garcia[1], Stefanie Lutz[3], Bruno Majone[2], Ralf Merz[3], Grigory Nikulin[4], Olga Vigiak[1,5], Janja Vrzel[1]

[1] Ludwig-Maximilians-Universitaet Muenchen (LMU), Munich, Germany
[2] University of Trento (UNITN), Trento, Italy
[3] Environmental Research Center (UFZ), Leipzig, Germany
[4] Swedish Meteorological Hydrological Institute (SMHI), Norköpping, Sweden
[5] Joint Research Center (JRC), Ispra, Italy

Water and water-related services are major components of the human wellbeing, and as such are major factors of socio-economic development; yet freshwater systems are under threat by a variety of stressors, including climate and land use change. Water scarcity is one of the most important drivers of change and is commonly associated with inappropriate water management and resulting river flow reductions. The conjoint occurrence of multiple stressors under water scarcity will produce novel synergies and most likely very pronounced effects on freshwater ecosystems

Within the scope of the GLOBAQUA project the effects of multiple stressors on aquatic ecosystems in selected river basins across Europe with a focus on areas suffering from water scarcity are analyzed. In addition, management strategies are improved and adapted with the aim of inhibiting adverse effects on aquatic ecosystems and ensuring the supply with water for all purposes in the study areas also in the future. In this context, land use and land cover as well as climatological conditions can be seen as two main stressors for the quality and quantity of surface and subsurface water. These factors considerably affect the use and availability of water, especially in regions which already experience water scarcity. To assess future conditions, spatially distributed, integrated scenarios to drive various impact models are inevitable. These simulations then assess future conditions of aquatic ecosystems, both in water quality and quantity, and provide decision support.

The presentation illustrates some lessons learned within GLOBAQUA, especially from the work packages SCENARIOS and HYDROLGY (both embedded in the module STRESSORS). It will emphasize on a) the interactions of land cover and land use change with water resources management under climate and socioeconomic change and b) their impacts on the hydrology of the GLOBAQUA basins, including the flow regime, water quality trends and surface-subsurface interactions on groundwater behaviour. For all shown cases, projections of future climate conditions originate from the simulations provided through the EURO-CORDEX project. After a thorough investigation of available simulations and an estimation of the uncertainty envelope, a small subset of models was downscaled to better represent the regional conditions and provide the climate forcing for the selected case studies (Gampe et al. 2016).

SCENARIOS - A modeling framework is set up to develop integrated scenarios of changes in climate, land use and water management. These scenarios are based on storylines around various Representative Concentration Pathways (RCPs) and Shared Socio-economic Pathways (SSPs) (IPCC, 2014), which are downscaled to the basin scale in collaboration with project partners and local experts. The impacts of the SSPs are represented in spatially distributed land use maps developed through the land use change model iCLUE (Conversion of Land Use and its Effects) (Huber Garcia et al. 2018). Changes in land use distribution and water management are taken into account to produce maps of future water demand and availability, highlighting regions in which water scarcity is likely pronounced or critical in the future.

HYDROLOGY – The project embodies a variety of hydrological models with different spatiotemporal concepts and complexities. They are applied concurrently to provide benchmarks for uncertainty estimates in hydrological modeling of mid- to far-future periods. It is shown that while decreasing nitrate pollution was found in several investigated sites, contrasting hydro-climatic trends exist between alpine and continental river basins, with the highest risk of water scarcity and developing anoxic conditions to be expected on the Iberian Peninsula (Lutz et al. 2016, Diamantini et el. 2018). A model intercomparison study shows that a) selected hydrological indicators revealed large uncertainties which propagate into ecological assessments, b) flow ecological assessment are hampered by the lack of reliable reference flow regimes and, c) the simulation of anthropogenic alterations in hydrological models must be improved (Vigiak et al. 2018). Further, a comprehensive modelling framework is developed, which consists of the direct/indirect communication between FEFLOW 6.2 and WaSiM/MIKE 11. The hydrological modelling framework was applied for the Ljubljansko polje aquifer (Slovenia), simulating future hydrological conditions and showing, that the region is unlikely suffering from water scarcity during the period 2036-2065.

The presentation closes with a critical reflection on the usefulness, applicability and regional transferability of the presented modeling frameworks. It discusses the implications on regional water resources management under water scarcity and climate change, and reflects upon the potential and limitations of such data and methods to support policy on regional and decision making on local levels.

KEYWORDS: GLOBAQUA; integrated scenarios; water scarcity; climate change; land use change; flow-regime; water quality; groundwater; water resources management

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