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Development of integrated scenarios to assess future conditions of aquatic ecosystems under water scarcity in the Mediterranean – perspectives from the GLOBAQUA project

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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 (organic and inorganic pollution, geomorphological alterations, land cover change, water abstraction, invasive species and pathogens).

Water scarcity is most commonly associated with inappropriate water management and resulting river flow reductions. It has become one of the most important drivers of change in freshwater ecosystems. Conjoint occurrence of a myriad of stressors (chemical, geomorphological, biological) under water scarcity will produce novel and unfamiliar synergies and most likely very pronounced effects. Stressors are hierarchically arranged in terms of intensity, frequency and scale, and their effects can be predicted to be from transient to irreversible. Most ecosystems are simulta¬neously exposed to multiple-stress situations.

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. Policy relevant implications will be given to ensure a best possible status of these aquatic ecosystems also under future conditions. In this context, land use and land cover as well as the meteorological 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. If the problem is not addressed correctly, negative effects on biodiversity, water supply as well as important economic consequences may arise. In Europe, many fresh water systems experience this and a worsening of the situation can be expected if actions are not taken. 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 in the end provide decision support.

To achieve this goal, 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), as established the Intergovernmental Panel on Climate Change (IPCC), and developed in collaboration with project partners and experts. Major challenges stem from the downscaling of these to the regional scale.

Projections of future climate conditions originate from the simulations provided through the EURO-CORDEX project. An ensemble of different General Circulation Models (GCMs) driving various Regional Climate Models (RCMs) is available. After a thorough investigation of these projections and an estimation of the uncertainty envelope, a small subset of models was chosen in a carefully conducted selection procedure, following a cluster analysis. These selected simulations were downscaled to better represent the regional conditions and provide the

implications of the RCPs in the storylines.

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). In a first step knowledge on past land use change is required and an analysis was carried out based on the CORINE land cover data. Extensive expert surveys have been conducted in the case study areas to determine the most important drivers of these changes, considering both, biophysical and socio-economic variables. The results of these were implemented in iCLUE taking into account dynamic changes of the climate, population and economy.

Climate and land use projections will then be applied to provide possible future conditions and various impact modeling activities within the GLOBAQUA project. This approach is favored over a non-integrated approach using only climate projections, and required to develop and test site specific Programs of Measures (PoMs). Eventually, decision support can be provided to local authorities for effective PoMs.

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