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Towards system scale understanding of the complex interaction of hydrologic, geomorphic and ecologic processes controlling ecosystem functioning in river corridors: Using satellite time series to assess the river network in the Aral Sea Basin

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River corridors, i.e. channel and adjacent floodplains, are hotspots of biodiversity and provide manifold ecosystem services. Their functioning and thus their ability to maintain biodiversity and to provide ecosystem services is controlled by a complex interplay of hydrologic, geomorphic and ecologic processes. These processes both affect and depend on hydrologic, geomorphic and ecologic connectivity within the river system. Today, process regimes of most (large) rivers are affected by human activities such as the construction of dams and reservoirs, flood protection measures or the withdrawal of water for agricultural irrigation. Dams modify longitudinal connectivity and thus the natural flow and sediment regime, while flood protection dikes disconnect channel and floodplain. There is a growing body of research on how hydrology-geomorphology-ecology-interactions shape river corridors and how these interactions are disturbed by humans. However, these insights tend to arise from studies at either the small river system or the reach scale. Truly understanding the impact of human interventions on rivers requires a dynamic, system scale perspective on process regimes. In our contribution, we take the river network in the Aral Sea Basin in Central Asia as an example and demonstrate the use of satellite time series to make a functional assessment of the process regimes controlling riparian ecosystem development. This river network has a total length of 75.000 km draining a catchment of 1.2 million km². We start the assessment with the delineation of the river network and the riparian zone from digital elevation models. Then, we use a novel unsupervised approach to create a map of landcover and general habitat types within the river corridors. In a second step, we create a dam and reservoir database in order to assess river fragmentation. In a third step, we use time series of Landsat and MODIS satellite imagery to assess hydrologic and geomorphic dynamics as well as vegetation development. These time series are the basis to analyze the relationship of e.g. floodplain inundation dynamics and vegetation trends or the impact of flood pulses on morphological change triggering vegetation change. The results show that the Aral Sea Basin is highly fragmented and that this fragmentation influences downstream process regimes and initiates modifications in the riparian ecosystems. Our satellite time series approach is able to

capture relevant process dynamics and their impact on ecosystem development (i) in data-scarce regions, (ii) at large spatial scales (large river basins) and (iii) at high temporal frequency as enabled by short revisit times of current satellite constellations and cloud computing. Thus, it is a promising way to generate system-scale knowledge on the interaction of hydrologic, geomorphic and ecologic processes being the basis for biodiversity maintenance and ecosystem service provision in river corridors.