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A meta-analysis of the drivers of irrigation in the West African Sudan Savanna

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Irrigation is vital for humans, critical in the management of land and water resources, and functions as an important environmental forcing. While irrigation systems are largely framed by environmental conditions, actual irrigation activities are determined by human decision-making. The types of irrigation systems can vary in technology and management and in turn influence water resources and the hydrological cycle differently. To date we lack an understanding of the drivers of establishing different irrigation systems in the Sudanian Savanna ecoregion of West Africa, and how land use decisions are made at the farm level. Insights on decision-making in water management contribute to the understanding of anthropogenic impacts on human-water systems and can help to identify strategies to adapt to ongoing and future risks. This paper aims to identify the heterogeneity of irrigation systems in our study region, and their drivers, as well as provide a qualitative assessment of their sustainability. Here we systematically analyze literature published between 1980 and 2020 which provide evidence of irrigation activities in the study area, we selected 188 publications documenting more than 100 cases of irrigation. For each study we identify each type of irrigation system, as defined by the water source, lifting and distribution type. We then clustered each case into ‘driver types’ based on external conditions, required resources, irrigation season, proximate causes and utilization. To assess the sustainability we identified environmental, governance, social and economic variables which we then coded on a 5-point Likert-scale. Our results show that irrigation systems in the West African Sudan Savanna are highly diversified in terms of techniques and organization, but that drivers are relatively similar. The decision making and management within an irrigation system is strongly influenced by its organizational structure. The type of technology depends on the available capital, and again impacts the efficiency, longevity and environmental impact of irrigation systems. We observed that economic factors, the access to water sources and markets, as well as restricted female technology adoption constrain the potential of existing irrigation schemes. The main causes to irrigate are to provide food security and raise more income in order to adapt to climate change and to increasing demands due to population growth. We detected that the cases are largely located in or in the vicinity of formal irrigation schemes. There is an increase in irrigation schemes in the study region over time, however, we found little information on why irrigation is not more widely adapted compared to similar ecoregions such as southern India, despite the growing demand. In respect of India, irrigation in West Africa is relatively new. We conclude that further research on organizational structures, and financial support can contribute to a sustainable

expansion of irrigation in the West African Sudan Savanna.