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Adaptation to floods and droughts in (semi) arid transboundary basins: insights, barriers and opportunities drawn from socio-hydrogeological research in the Limpopo river basin, Southern Africa

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The Limpopo river basin (LRB) is water-stressed and highly susceptible to floods and droughts. The impacts of floods and droughts on water availability and quality is increasing as a result of their increase in magnitude and frequency. The LRB encompasses a large diversity of physical and socio-economical characteristics spread across four Southern Africa countries (Botswana, Mozambique, South Africa and Zimbabwe). This dictates highly heterogeneous physical and human responses, coping mechanisms, and policy frameworks from local to transboundary scales.

Understanding the multidimensional connections that exist between and within flood and drought events and cycles, between various regions across the basin, between physical and social impacts, and between users and decision-makers, is critical to sustainable water resources management and long-term resilience to hydrological extremes.

The Connect4 Water Resilience project has brought together an international multidisciplinary team of hydrologists and social scientists from academia, policy, and practice to investigate the drivers and impacts of floods and droughts, and to promote solutions towards adaptation. In our research we deployed hydrological and geological investigations alongside community and governance interviews and workshops across the LRB to jointly feed in the application of a large-scale transboundary hydrological model of the LRB. Model assessment and future management

scenario definition and analysis were implemented collaboratively with stakeholders across the basin, through iterative workshops at local, national, and transboundary scales.

Results so far revealed: (1) the high complementarity of physical (hydrological and sedimentological) and social (community narrative) data to reconstruct spatiotemporal dynamics and impacts of events, which has been crucial to model application in the basin affected by highly fragmented monitoring; (2) the observed increase in floods and droughts magnitude and frequency is not responsible for significant changes in groundwater recharge, suggesting that the general observed groundwater level decline is to be related to increasing abstraction, which in turn amplifies droughts; (3) flood severity and impacts are higher after droughts regardless of rainfall magnitude; (4) mitigation, through anticipatory action and preparation for floods and droughts at policy, user and community level is uneven and inadequately resourced, with generally some forms of preparation to droughts but little for floods; (5) the uptake of forecast and management recommendations from governments is patchy, while extension officers are playing a key role for communication and NGOs for training; (6) local stakeholder expertise and experience brought in during stakeholder workshops were critical to groundwater model conceptualisation, and management scenario definition and analysis; (7) preferred scenarios of management strategies, as collaboratively defined with stakeholders, were highly variable across the LRB countries and sub-regions, including preference for local water management (e.g. temporary flood water storage for subsequent droughts) in upstream upland regions vs large scale strategies (e.g. storage in dams) in downstream floodplain regions; however, hydrological model outputs showed that local/regional strategies have basin-scale (transboundary) impacts emphasizing the importance of transboundary cooperation and management of water resources and extreme events.

Research outcomes are being translated into tailored guidance for policy and practice including feeding in ongoing early warning system development and sustainable water resource management.