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Storing and sharing water in sand rivers: a water balance modelling approach

D. Love (1,2), P van der Zaag (3,4), S Uhlenbrook (3,4)

(1) Waternet Zimbabwe, (2) ICRISAT Zimbabwe, (3) UNESCO-IHE, Netherland, (4) Delft University of Technology, Netherlands

Sand rivers and sand dams offer an alternative to conventional surface water reservoirs for storage. The alluvial aquifers that make up the beds of sand rivers can store water with minimal evaporation (extinction depth is 0.9 m) and natural filtration. The alluvial aquifers of the Mzingwane Catchment are the most extensive of any tributaries in the Limpopo Basin. The lower Mzingwane aquifer, which is currently underutilised, is recharged by managed releases from Zhovhe Dam (capacity 133 Mm3). The volume of water released annually is only twice the size of evaporation losses from the dam; the latter representing nearly one third of the dam's storage capacity. The Lower Mzingwane valley currently support commercial agro-businesses (1,750 ha irrigation) and four smallholder irrigation schemes (400 ha with provision for a further 1,200 ha).

In order to support planning for optimising water use and storage over evaporation and to provide for more equitable water allocation, the spreadsheet-based balance model WAFLEX was used. It is a simple and userfriendly model, ideal for use by institutions such as the water management authorities in Zimbabwe which are challenged by capacity shortfalls and inadequate data. In this study, WAFLEX, which is normally used for accounting the surface water balance, is adapted to incorporate alluvial aquifers into the water balance, including recharge, baseflow and groundwater flows.

Results of the WAFLEX modelling suggest that there is surplus water in the lower Mzingwane system, and thus there should not be any water conflicts. Through more frequent timing of releases from the dam and maintaining the alluvial aquifers permanently saturated, less evaporation losses will occur in the system and the water resources can be better shared to provide more irrigation water for smallholder farmers in the highly resource-poor communal lands along the river. Sand dams are needed to augment the aquifer storage system and improve access to water.

An alternative to the current scenario was modelled in WAFLEX: making fuller use of the alluvial aquifers upstream and downstream of Zhovhe Dam. These alluvial aquifers have an estimated average water storage capacity of 0.37 Mm3 km [U+100000] 1 of which 0.35 Mm3 km [U+100000] 1 is below evaporation extinction depth. The 137 km of aquifer could therefore conceivably store some 50 Mm3 of water, 0.38 of the capacity of Zhovhe Dam. This would be sufficient to irrigate 3,000 to 4,500 ha: a belt 100 to 180 m wide along each bank for the full the length of the river, the range depending on irrigation efficiency. Such a system would be decentralised, farmer or family owned and operated and the benefits would have the potential to reach a much larger proportion of the population than is currently served. If storage upstream of the alluvial aquifer were available – for example through the construction of a reservoir at the Oakley Block site – then the aquifer could be recharged several times per year and a much increased water supply made available. However, there is very limited information on the hydrogeological properties of aquifers upstream of Zhovhe Dam and the figure could be lower than this. Downstream impacts must also be considered.