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# Viability of Small Hydropower on the Zambezi Basin under Current and Future Conditions

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Lack of access to power in rural areas of the Zambezi basin is one of the many challenges facing the region. Significant quantities of untapped hydropower resources exist in the basin and present a means of improving livelihoods through better energy access. It is, however, crucial that hydropower installations properly assess the trade-offs between the social, environmental and economic effects of hydropower projects. Large hydropower projects have a mixed track record of both negative and positive socioeconomic and environmental impacts, particularly in developing countries. Small run of the river hydropower plants are widely regarded as being more environmentally benign, although the possible cumulative environmental impacts of numerous projects have not been addressed in detail. Such schemes also lack several of the ancillary benefits of reservoirs.

A key objective of this study is to understand the relative environmental and social impacts of few large hydropower reservoirs, compared to extensive small run of the river hydropower implementation, particularly taking into account future climate and population changes. To investigate this, this research seeks to create a large-scale hydrodynamic model of the Zambezi Basin suited to small hydropower estimation and siting, analysing the trade-offs between the economic, environmental and social consequences of different hydropower configurations, as well as forecasting impacts into the future.

Calibrated, linked VIC – LISFLOOD hydrodynamic models have been constructed on multiple gauged sub-basins in and around the Zambezi River Basin. The 5km distributed VIC hydrological model is driven by satellite radar derived, bias corrected rainfall estimates from the CHIRPS dataset, and meteorological data from MERRA-2, which are regridded to 5km resolution. 1km resolution LISFLOOD hydraulic models were based on a HYDROSHEDs derived hydrographic network, with river width estimated based on multiple river width databases, and inferred estimates of bed depth based on the Manning's equation. The modelled run off and baseflow outputs from the VIC model were routed into the LISFLOOD model from each 5km VIC grid cell. Power estimates based on modelled water surface slope and flows have been used to extract the theoretical potential Q95 power outputs at every river pixel in the domain to identify locations with high hydropower potential. Further steps in the analysis will extend the modelling across the entire basin, including regionalisation to produce estimates of river flows for ungauged basins. Subsequently, small hydropower options across the basin will be modelled and assessed based on their power output, economic viability, and environmental impact, the aim being to compare the performance of small hydropower portfolios with that of larger facilities. Lastly, the project seeks to forecast these impacts into the future based on climate change and population growth predictions.