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On the spatial and temporal scales of a semi-distributed hydrological model of the Zambezi River basin

José Pedro Matos (1,2), Théodora Cohen Liechti (1), Maria Manuela Portela (2), and Anton Schleiss (1)
(1) Laboratoire de Constructions Hydrauliques (LCH), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, (2) Instituto Superior Técnico (IST), Lisbon, Portugal

The study focuses on the development of a hydraulic-hydrological model for the optimization of water resources management in the semi-arid Zambezi River basin. It is part of the African Dams Project (ADAPT) which aims to adjust planning and operation of large dams to social needs and environmental constraints.

The Zambezi basin has about 1.4 Mio km2. With a mean rainfall in the order of 850 mm/year, ranging from 400 mm in the South, in the vicinity of the Kalahari Desert, to 1400 mm in the North, near Lake Malawi, the runoff at the outlet to the Indian Ocean is, on average, under 10 mm/year. Due to the basin size and being shared by eight countries (Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe), preparing an homogeneous input dataset is difficult, being this difficulty specially constraining with respect to discharge data, to which there are no remote sensing alternatives. Also, the semi-arid character of the Zambezi implies great spatial and temporal heterogeneity in both rainfall and runoff, as well as on the sub-catchments' responses, more sensitive to the vegetation state of growth and soil moisture conditions than those of temperate areas.

One of the most relevant challenges related to the hydrological modeling of the Zambezi is to find a balance between model scale and data availability, with direct implications on calibration strategies and procedures and model validity. In this sense, impacts of modeling scale – both spatial and temporal – on model performance are addressed for the Routing System platform, a continuous semi-distributed conceptual hydraulic-hydrological modeling tool developed at the Ecole Polytechnique Fédérale de Lausanne (EPFL). The comparison is made in terms of classical criteria such as Nash–Sutcliffe efficiency and lag-based variations, water volume ratio and peak flow ratio, each computed for different periods in order to classify model adequacy during peak, but also during base flows.