IWRM2018-106
8th International Water Resources Management Conference of ICWRS

Centralized versus distributed reservoirs: an investigation of their implications on environmental flows and sustainable water resources management

Nishadi Eriyagama (1), Vladimir Smakhtin (2), and Lakshika Udamulla (3)

(1) International Water Management Institute (IWMI), Colombo, Sri Lanka (n.eriyagama@cgiar.org), (2) UNU Institute for Water Environment and Health, Ontario, Canada (vladimir.smakhtin@unu.edu), (3) Open University of Sri Lanka, Nugegoda, Sri Lanka (lakshika0807@hotmail.com)

Storage of water is widely regarded as a form of insurance against rainfall variability. Anthropogenic climate change is expected to increase current rainfall variability, in terms of its total quantity, intensity, and duration, resulting in increased frequency of floods and droughts. Consequently, storage of water will continue to play a pivotal role in ensuring adequate water supplies as well as detaining excess flood water. Although the debate over the most appropriate forms of water storage continues, historically, the "natural" first choice among water planners and managers has been surface storage. This is evidenced by the ancient tank irrigation systems that existed in Sri Lanka from around 300 B.C., as well as multiple large dams that were constructed all over the world, during the latter half of the twentieth century. It is likely that impounding surface water will remain a popular choice for managing basin water resources in the foreseeable future. However, creation of surface storage often endanger the functions of natural river ecosystems, and, in turn, ecosystem services that benefit humans. The issues of optimal size, placement, and number of reservoirs in a river basin – which maximizes sustainable benefits from storage – remain subjects for debate. This study examines the above issues through the analysis of a range of reservoir configurations in the Malwatu Oya river basin in the dry zone of Sri Lanka. Optimal sustainable limits to surface storage development for water supply, and the differences between centralized large reservoirs and distributed small reservoirs, are examined, by studying the changes in a set of indicators, with increasing storage, under each configuration. The study produced a range of surface storage development pathways for the basin under different scenarios of environmental flow (EF) releases and reservoir network configurations. The EF scenarios ranged from "zero" to "very healthy" releases. It is shown that if the "middle ground" between the two extreme EF scenarios is considered, the theoretical maximum "safe" yield from surface storage is about 65-70% of the mean annual runoff (MAR) of the basin. It is also identified that although distribution of reservoirs in the river network reduces the cumulative yield from the basin, this cumulative yield is maximized if the ratio among the storage capacities placed in each sub drainage basin is equivalent to the ratio among their MAR. Results also suggest that distribution of reservoirs in the river network is a useful strategy to ensure the maintenance of sufficient environmental flow releases. This finding also provides a certain scientific basis for the extremely high level of distribution observed in the ancient tank irrigation systems which evolved in the dry zone of Sri Lanka (including in the Malwatu Oya basin). The study suggests a framework to identify drainage regions having higher surface storage potential, to plan for the right distribution of storage capacity within a river basin, as well as to plan for EF allocations.