**WAT-09** ORAL PRESENTATION · WATER TRACK · SURFACE WATER HYDROLOGY & BASIN MANAGEMENT

# Assessing Flood Attenuation Services and Hydrological Resilience of Wetland Environments in the Kelani River Basin, Sri Lanka

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## Abstract

Piecemeal wetland degradation can progressively weaken watershed flood regulation, yet cumulative and path-dependent hydrological responses remain poorly understood. This study assessed wetland flood-attenuation capacity and hydrological resilience in the Kelani River Basin, Sri Lanka, using a calibrated SWAT+ model. Natural marshes and paddy fields were explicitly represented as storage reservoirs within the watershed routing structure. The model simulated 2005-2024 hydrology at daily resolution, with monthly aggregation for calibration and validation; calibration (2015-2024) and validation (2007-2013) achieved NSE values of 0.75 and 0.53 and $R^2$ values of 0.946 and 0.878, respectively. A representative major flood was defined from the 2005-2024 simulated annual peaks using the Log-Pearson Type III method, corresponding to the May 2016 Cyclone Roanu event (>300 mm rainfall over three days). Under this event, existing wetlands provided approximately $1.3\times10^8$ $m^3$ of storage, while an annual retention deficit of $2.1\times10^7$ $m^3$ was identified. Fourteen progressive loss scenarios (5-90%) were generated by rule-based spatial prioritization of wetland conversion to built-up land, reflecting urban expansion patterns. Peak discharge increased nonlinearly with wetland loss ($R^2$=0.997), with acceleration emerging at 25-30% loss; at 90% loss, peak discharge increased by 109% and lag time decreased by 47%. Equivalent restoration scenarios exhibited a Hysteresis Index of 0.66, indicating that approximately 34% of lost flood-attenuation capacity could be recovered, while a Normalized Hysteresis Area Index of 47.4% indicated substantial cumulative hydrological impact. The findings demonstrate threshold behavior and hydrological memory, supporting basin-scale cumulative-impact assessment and prioritization of wetland conservation over reliance on proportional restoration.

**Keywords:** *complex adaptive system; flood attenuation; hysteresis; non-linearity; SWAT+; wetlands*