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Significance of reservoir operation during extreme rainfall event in flood mitigation and water demand management in a metropolitan city of India: a case study

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Increasing water demand and climate change poses a great challenge in managing water resources availability. Reservoir operation during heavy rainfall events in an urbanized region is crucial in terms of decision making. The objective of this study is to assess the significance of reservoir operation during extreme rainfall events on flood mitigation and future domestic water supply. One of the major water supply reservoirs in Chennai city was chosen for this study. Rainfall record of recent four decades were analyzed and a major flood event occurred in 2015 was chosen. A combined model of hydrologic-hydraulic processes was carried out using Hydrologic Engineering Centre-Hydrologic Modelling System (HEC-HMS) and a box model based on input-output parameters. These models were calibrated and validated with historical flood events with good performance indications. Four different scenarios were framed for the analysis by targeting reduction in outflow and higher storage in the end of the event. Reducing the reservoir storage in advance and releasing with its maximum capacity at the beginning of the event will reduce the outflow from 5 to 27% and increase the time to peak by 11 to 16 hours. Available hydraulic facilities for higher storage at the end of the event were analyzed. It reveals that with the available facilities, reducing the initial storage from 75 to 50% will help to store 27 to 40% of inflow at the end of the event. Whereas the available hydraulic facilities will not allow to have a 75% of the reservoir storage at the end of this event. New gates can be provided for the safe operation during extreme rainfall events associated with the higher initial storage in the reservoir. Increased storage capacity combined with additional provisions of gates will reduce the outflow by 30% and increase the time to peak by 20 hours with the actual condition. By adapting these reservoir operation strategies, flood mitigation and fresh water augmentation during extreme events can be achieved to a significant extent. The developed combined modelling approach can be used to simulate various combinations of reservoir operations to assess the significance of timely decision on release during extreme rainfall events.

Keywords: flood mitigation, reservoir operation strategies, urban water supply, modelling