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Why should structural solutions for flood control be adapted to climate change?

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The combined impacts of climate change and anthropogenic activities have altered runoff generation and flood regime in many regions, worldwide. While hydraulic structures have been successfully operated to control flood for decades, their expected performance may be currently less certain under the augmented frequency of extreme precipitation events. The goal of this study was to examine the above hypothesis by utilizing both remote sensing and field data on the Imamzadeh Davood catchment in the northern Iran, which experienced a devastating flash flood in the summer of 2022. To this end, we surveyed the main river path to collect data on river morphology, structural characteristics of check dams, and sedimentation patterns. We also processed satellite imagery to extract and temporally trace back land-use land-cover change in the study area. Finally, we used recorded data from synoptic stations to explore the distinct role of extreme precipitation in intensifying the flood hazard. The results proved the occurrence of unprecedented precipitation with a return period of over 100 years, supporting the climate change effect in the region. In-situ observations revealed that all 18 check dams were destroyed between 20% and 100% during the flood event, while higher degree of destruction was observed towards upstream. The sliding and overturning stability analysis demonstrated that all check dams were stable with respect to sliding, while 30% of them were prone to overturning. Given the destruction of all check dams during the flood event, as well as the observed high deposition depth of sediment in the river corridor, we concluded that the shock imposed by the debris flow was responsible for the cascade failure of check dams from upstream to downstream. The findings of this study highlight the need for revisiting the design principles of hydraulic structures, such that they are adapted to the ongoing impacts of climate change in order to increase the resiliency of flood control systems.