232-3 - CONTROLS ON EXTREME FLOODING IN THE UPPER YELLOWSTONE RIVER DRAINAGE BASIN (Invited)

Wednesday, September 25, 2024

8:50 AM - 9:10 AM

210B (Anaheim Convention Center)

Abstract

From June 10-13 of 2022, an atmospheric river delivered heavy rain to high elevations around northern Yellowstone National Park (YNP), resulting in extreme flooding in the Yellowstone River basin below Yellowstone Lake. The extreme 2022 flood was only one of several historical events caused by high June temperatures and rapid snowmelt, with a variable component of rain on snow. Large and extreme floods on the Yellowstone River (YR) also occurred in June 1996 and 1918, allowing comparison of their magnitude, duration, and mechanisms of generation for the YR and its Lamar River and Soda Butte Creek tributaries. In 2022, peak discharge on the YR at Corwin Springs was 1550 m3/s, the flood of record and 170% of the 1996 peak, and Lamar River peak discharge was 172% of 1996 peak. In 1918, gaged discharge is only available for the YR at Corwin Springs, with significant uncertainty. On Soda Butte Creek, however, overbank gravels and indirect discharge estimates indicate that the 1918 peak discharge was conservatively 240% higher than 1996 and 127% higher than 2022. In 2022, flood duration above 700 m3/s at the YR Corwin Springs gage was only 2 days, compared to 9 days in 1996 and 14 days in 1918. In early June 1918 and 1996, snowpack was above average, and anomalously warm weather combined with relatively minor rainfall to produce long-duration flooding. In early June 2022, similarly high temperatures occurred, but snowpack was less than in 1918; early May snowpack in 2022 was 64% that of 1996. The June 10-13 atmospheric river released 5-10 cm of rain across northern YNP that added to snowmelt, producing a short duration but extremely high peak discharge. The 2022 flood caused major bank erosion especially in confined reaches but resulted in less floodplain disruption and overbank gravel deposition than in 1918 on the Lamar River and Soda Butte Creek. The potential exists for an even larger peak discharge than in 2022 if atmospheric river rainfall as in 2022 is superimposed on rapid melting of a deep snowpack, caused by the kind of unseasonable warmth that occurred in 1997 and 1918. Anthropogenic climate change is likely to increase the probability of extreme floods in YNP, as higher temperatures increase snowmelt rates, shift late-spring precipitation from snow to rain, and promote widespread intense rainfall including that from atmospheric rivers.

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