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Outburst flood evolution at Russell Glacier, western Greenland: effects of a bedrock channel cascade with intermediary lakes

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Outburst floods have produced a distinctive and widespread Quaternary record both onshore and offshore via widespread and intense geomorphological impacts, yet these impacts remain poorly understood due to a lack of modern analogues. This study therefore makes the first systematic quantification of the evolution of a bedrock-channelled outburst flood. Channel topography was obtained from digitised aerial photographs, a 5m grid resolution DEM and bathymetric surveys. Flood inundation was measured in the field from dGPS measurements. Flood evolution was analysed with application of a numerical model. Novel flood metrics, including 'rate-of-rise-to-peak' and 'persistence-above-a-value' of hydraulics were calculated. The key findings were that outburst floods; (i) that enter intermediary lakes are halted in terms of propagation whilst basin filling proceeds to the outlet level, dissipated of energy due to considerable flow recirculation during the rising stage of the flood, and after overtopping of the outlet are moderated in terms of peak discharge; (ii) may have a limited geomorphological impact if sediment supply due to antecedent geomorphological activity is limited; (iii) can have kinematic waves that are introduced to a flood via hydraulic ponding and these waves most likely account for distinctive 'hydropeaking', (iv) can have a hydrograph that evolves in shape down channel and through time in a complex manner dependant on channel topography, and (v) may develop a partitioning of flow regimes for instantaneous peak discharge, bed shear stress and Froude number that is dependent on bedrock channel topography. Normalised change in cross-sectional area and normalised change in channel slope can be used to suggest the relative magnitude of instantaneous peak discharge. Reconstructions of Quaternary outburst floods should consider the importance of including intermediary lakes. Modern hazard mitigation studies could usefully note the potential use of reservoirs as an outburst flood alleviation resource.