Streamflow Generation and the Importance of Atmospheric Rivers to Annual Flooding for the Coupled Wolverine Glacier-Creek System, Kenai Mountain, Alaska

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ABSTRACT

Streamflow generation in glacierized basins may be produced by physical processes including temperature-induced melt, rainfall, rain-on-snow (ROS), glacial lake outbursts, or ice jams. The timing of annual maximum flows (floods) is dependent upon a combination of ablation season meteorological, hydrological, and glaciological conditions. Here we investigate climatological aspects of the hydrology of the coupled Wolverine Glacier-Creek system located in the humid, maritime climate of the Kenai Peninsula, Alaska. Hydrological, climatological, and glaciological datasets for Wolverine Glacier and Creek were used to investigate proglacial streamflow generation, and the timing and causes of annual flooding.

Wolverine Creek's hydrologic system is a classical nival system distinguished by three distinct phases of streamflow generation: snowmelt-dominant; ice-dominant; and rainfall-dominant. Although much of the proglacial streamflow is generated by snow and ice melt, most annual floods are associated with rainfall coupled with melt, commonly in September (~45%) and August (~29%). Many annual floods occur well after the transient snow line was at or very near the long-term ELA, and after the peak contribution of ice melt-dominated streamflow. Daily and hourly re-analysis output show advection of warm, humid air into the Kenai Mountains around a center of low pressure generally situated over, or just off the coast of, south-central Alaska is linked to annual flood generation regardless of timing. Moisture advection from the northern and sub-tropical Pacific Ocean by strong low-level (850 mb) winds manifests as atmospheric rivers (ARs) of anomalously high precipitable water, which, along with orographic enhancement, provide ample moisture to trigger annual floods at Wolverine Creek and throughout the region. A review of the fragmented annual flood series for Wolverine Creek indicates that since 1980, 19 of 20 (95%) of annual floods were triggered by ARs and suggests that they need to be considered in glaciological and hydrologic studies.

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