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NWT Cumulative Impact Monitoring Program

Snowmelt runoff – a Key Contributor to Lake Levels in the Peace-Athabasca Delta

Summary

Snowmelt runoff is well known for sustaining shallow waterbodies across cold regions. Yet, it is often overlooked in floodplains where river floodwaters are considered to drive freshwater availability. At the Slave River's headwaters, drawdown of shallow lakes in the Peace-Athabasca Delta is a long-standing concern and is widely attributed to change of the ice-jam flood patterns. While snowmelt is also recognized as an important input source to shallow perched basins, its direct contribution to lake level rise remains poorly quantified in hydrological studies. We used measurements of water depth and isotope composition to evaluate contributions from snowmelt versus river floodwaters to lake-level rise after widespread ice-jam flooding in spring 2020.

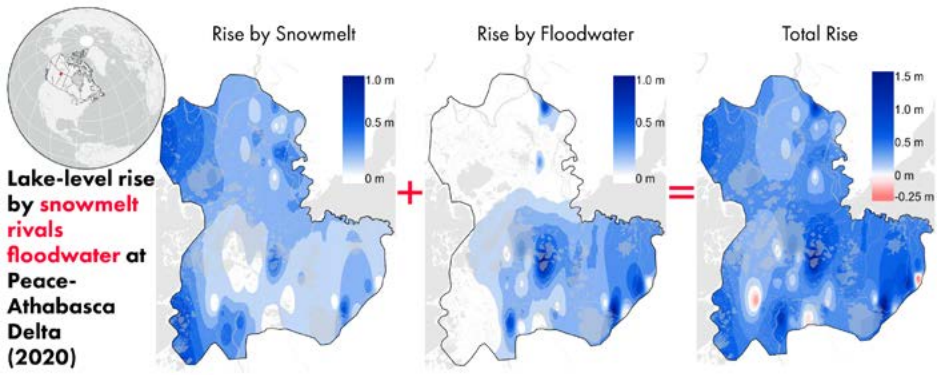
Why is This Important?

In 2014, the Mikisew Cree First Nation launched a petition that has led to UNESCO's reconsideration of Wood Buffalo National Park's World Heritage Status. Many of the concerns stem from ongoing low lake levels in the Peace-Athabasca Delta, yet the role of snowmelt runoff for maintaining lake levels remains largely unquantified.

What Did We Do?

We evaluated contributions of snowmelt and river floodwater to lake-level rise across the Delta. We combined measurements of water isotope composition and depth at more than 50 lakes to: 1) identify lakes that flooded, and 2) determine the lake-level rise by snowmelt versus floodwater. We used geospatial analyses to identify landscape features that contribute to differences in lake-level rise from snowmelt and floodwater and examined 61 years of meteorological data to assess how typical conditions were in spring of 2020, when widespread ice-jam flooding occurred.

Snow accumulated across the Peace-Athabasca Delta. (Credit: B. Wolfe)



Maps showing the distribution of lake-level rise across the Delta from snowmelt runoff and floodwaters in 2020.

What Did We Find?

- The rise of lake levels due to snowmelt rivalled that due to floodwaters.
- At the non-flooded lakes, water-level rise from snowmelt runoff was two-fold greater than the drawdown during the two prior summers.
- Snowmelt accounted for about 40% of the rise at the flooded lakes.
- The rise by snowmelt was greatest in higher elevation areas where dense forest accumulates wind-distributed snow.
- The rise by floodwater was greatest in low-lying flood-prone areas with sparse vegetation.
- Meteorological records reveal that comparable contributions of snowmelt runoff likely occurred regularly during 1963-1987, but rarely since then.

What Does This Mean?

Our findings reveal that snowmelt is just as important for maintaining lake levels as ice-jam floodwaters in some years, especially in areas of the Delta with dense forest. Drawdown of lakes during recent decades may be associated with reduced input of snowmelt.

As climate change and industrialization threaten the security of freshwater supply, mitigation may be used to prevent the Delta's lakes from drying out. Strategic releases of water from the W.A.C. Bennett Dam are being considered within the Wood Buffalo National Park Action Plan to enhance ice-jam flooding at the Delta. If successful, this will raise water levels in lakes prone to drying and offset loss by evaporation. Continued monitoring will be important to understand the importance of floodwaters enhanced by flow releases compared to snowmelt runoff on lake levels to inform decision-making.

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