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ARCTIC TERRESTRIAL HYDROLOGY: A SYNTHESIS OF PROCESSES, CHANGE DRIVERS AND RESEARCH CHALLENGES

Arvid Bring (*University of New Hampshire, United States*)

Irina Fedorova (*Arctic and Antarctic Research Institute; Saint Petersburg State University, Russian Federation*)

Yonas Dibike (*University of Victoria, Canada*)

Larry Hinzman (*University of Alaska Fairbanks, United States*)

Johanna Mård Karlsson (*Stockholm University, Sweden*)

Sebastian H Mernild (*Center for Scientific Studies, Chile*)

Terry Prowse (*Environment Canada/University of Victoria, Canada*)

Olga Semanova (*St Petersburg State University/State Hydrological Institute, Russian Federation*)

Sveta Stuefer (*University of Alaska Fairbanks, United States*)

Ming Ko Woo (*McMaster University, Canada*)

arvid.bring@unh.edu

Many of the environmental changes currently under way in the Arctic involve freshwater, which also acts across boundaries within the Arctic system. As a key example, observed changes to surface and subsurface runoff partitioning and seasonality will affect terrestrial ecology, water resource use, atmospheric feedbacks, and input of freshwater to the Arctic Ocean.

This contribution will summarize results from the terrestrial hydrology component of the Arctic Freshwater Synthesis, an ongoing science integration activity with support from IASC, WCRP-CliC, AMAP, the Norwegian Ministry of Climate and Environment, and the Norwegian Ministry of Foreign Affairs. We will synthesize recent advances and state of knowledge on terrestrial hydrologic processes in the Arctic, their drivers of change, and current research challenges. We will also systematically identify linkages to other components of the Arctic freshwater system. Furthermore, we will apply a cross-regional perspective to evaluate key process drivers and differences across a range of Arctic geographical environments.

Some emerging results include the role of the near-coastal domain as an important unknown at the interface between terrestrial hydrology and the ocean. Along the coast, information shortages combine to yield great uncertainty both in surface flows, which are poorly monitored for many smaller rivers, and the interaction between groundwater, surface water, permafrost and seawater. Another change in this domain is warming of Arctic islands, which has reduced semi-perennial snowbanks that sustain local summer runoff. This in turn influences local ecosystems, as possibilities for plant growth and wetlands in the otherwise arid polar desert are altered.

The pan-Arctic drainage basin is very varied, with major rivers transporting water from low latitudes while smaller mountainous and tundra river systems originate close to the Arctic coast. Although pan-Arctic river runoff is projected to increase, regional patterns differ, with historical changes and future projections diverging for some regions. Glacier volume loss projections also indicate some contrasts, with the greatest relative reductions expected in Kamchatka and Ellesmere Island. On large scales, river runoff changes seem coupled to both atmosphere and ocean controls, such as moisture flux convergence and evaporation changes due to sea ice decline. Human interference of the natural freshwater system through such activities as hydropower development, mining and logging, is an added consideration for the vast subarctic-boreal region, with notable effects on atmospheric and hydrologic circulation and the ecosystem. Establishing a pan-Arctic picture of several terrestrial water flux and storage terms remains a challenge that will require both intensified monitoring and modeling efforts.