Changing Arctic Lowland River Landscapes

Arctic warming, by causing permafrost thaw and degradation, is destabilizing the riverbanks of lowland Arctic rivers. Widespread destabilization may lead to rapid rates of change in these rivers, with riverbanks migrating up to tens of meters per year or a shift in their state to become much wider and shallower.

These changes in lowland river landscapes threaten Arctic communities as well as infrastructure essential to national security with costs reaching billions of dollars. Rapid change of rivers can also catastrophically affect flood hazards, water resources, and riverine habitats and ecosystems. Moreover, riverbank erosion liberates frozen soils, releasing stored carbon dioxide and methane, which can be transported through the river system to oceans or respired directly to the atmosphere, providing a positive feedback for atmospheric warming furthering the impacts on Arctic communities and global climate.

Koyukuk River, Alaska and the city of Huslia located at the riverbank.

Key questions are:

How are Arctic lowland river landscapes –river channels, floodplain connections, biological communities– and their flooding patterns likely to change under a warming climate?

What are the potential impacts of such changes on Arctic communities?

What are the potential impacts of such changes on biogeochemical cycles and thus global climate?

Key concepts and challenges

Lowland rivers help control the movement of terrestrial sediment and water and shape the sedimentary architecture of floodplains, surface water connectivity, and flood inundation–all of which collectively influence the structure and succession of biological communities. Lowland rivers assist in regulating the continental biogeochemical cycles that stabilize climate and help create conditions conducive to life on Earth. The geomorphology (i.e., landform characteristics) of these rivers act as an indicator as well as a driver of widespread physical, biogeochemical, and ecosystem changes.

In contrast to the growing knowledge on the changes in discharge and biogeochemistry of the Arctic rivers, the geomorphologies of Arctic lowland rivers and how they change in response to a changing climate are very poorly understood. Geomorphic expression is highly influenced by complex interactions among many factors, involving factors such as hydrology, permafrost characteristics, soil characteristics, and land cover.

Understanding the floodplain scale interactions between Arctic lowland river geomorphologies and changes in hydrology, permafrost distribution, and biogeochemistry will help contextualize the role of these rivers in global feedback systems. Such understanding necessitates the use of innovative methodologies to document, understand, and monitor geomorphic characteristics of these landscapes. The large spatial and temporal extents of investigations require big data fusion, with data coming from different sources including a range of remote sensing and field data and posing challenges for computational resources, image processing, and spatiotemporal data analyses.

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