



# Rates and Effects of Climate Warming and Permafrost Thawing in the Yukon River Basin: An Arctic Benchmark



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Climate change is a global phenomenon, but the magnitude of change and the significance of the effects on earth systems will vary across the globe. Arctic and subarctic regions are considered to be particularly sensitive to the effects of climate warming. Permafrost thawing, and the resulting enhancement of both water infiltration and the decomposition of large stores of frozen organic material, will radically affect northern ecosystems of the Arctic region and the rate at which carbon is exported from those landscapes to the atmosphere, rivers, and the Arctic Ocean. In particular, the potential permafrost thawing could significantly increase the rate of warming globally. These conditions make arctic and subarctic ecosystems important areas for deciphering the potential effects of global warming on natural resources.

The <u>US Geological Survey (USGS)</u> and the <u>US Forest</u> <u>Service (USFS)</u> are leading a developing consortium of US and Canadian federal agencies, university scientists, and tribal organizations in implementing a prototype environmental monitoring and research strategy in the Yukon River Basin. The collaboration will link air, water, soil, and forest information across the Yukon River Basin to track and understand regional changes in carbon flux and storage. International collaboration with Canadian partners in the Yukon River headwaters will be critical to the success of the project.

The Arctic and subarctic are critical regions for understanding the effects of climate on carbon storage and flux

### Why the Yukon Basin?

It is the nature of global warming that changes will be most prominent near the poles and least near the equator. The interior of Alaska and Yukon Territories is a critical region for understanding the effects of climate on carbon storage and flux because:

(1) Permafrost in interior Alaska and Canada is warming and is thawing in many locations.

(2) Interior Alaska contains large carbon stores that are vulnerable to emission to the atmosphere and / or export to the Bering Sea.



(3) The occurrence and size of fires in the Yukon River Basin appears to be intensifying and may accelerate C release and permafrost thaw.

(4) The circumpolar sensitivity of currently frozen soil organic matter to decomposition upon melting is a poorly understood process that is critical to developing future climate models.

### Initiative Design

The key to a successful multi-scale carbon study in the Yukon Basin is the leveraging of existing science infrastructure and data collection. To accomplish this integration, investigators will apply the "Framework for Environmental Monitoring and Related Research" first proposed by the Office of Science and Technology Policy (OSTP) and the Committee on Environment and Natural <u>Resources (CENR)</u>. The Yukon framework will begin by linking existing intensive ecological research and monitoring stations, regional surveys and inventories, remote sensing programs, and fixed-site monitoring networks. These "foundation" programs will then either be enhanced, or new data-collection programs will be initiated, to fill the gaps in existing data collection that are critical to the assessment goals. The result will be a collaborative network capable of tracking complex environmental changes occurring at the full range of spatial and temporal scales.

A recurrent question that arises whenever new science initiatives are proposed is "what are you doing with all the data that is being collected now?" The collaborative framework makes unambiguous use of existing data collection, and shows a clear role for each existing program or research project within the broader research and monitoring objectives. The strategy can therefore provide both clear justification for new research initiatives and justification for maintaining key existing research and monitoring, while enhancing the overall capabilities of both to address regional and global environmental issues. The collaborative strategy will thus provide the American people with a cost-effecting system for tracking the health of Arctic ecosystems.

## Intensive Research Sites

Intensive research sites are already operating within the Yukon Basin where research on carbon flux and storage can be implemented. These are (see figure above):

(1) Bonanza Creek Long-Term Ecosystem Research Station (NSF and USFS)

(2) Caribou-Poker Flats Experimental Watersheds.

(3) Wolf Creek Research Basin in Yukon Territory (Environmental Canada and Indian and Northern Affairs Canada)

Additional research sites are under consideration and will be established as the collaborations develop.

### Foundation Programs in the Collaborative Network

Besides the intensive research stations described above, the Yukon study will also link programs collecting regional databases. For some programs existing network data collection will be enhanced, while for others new data collection programs will be developed. For example, the USFS Forest Inventory and Analysis (FIA) program is planning the addition of soil and permafrost measurements to their standard field plan, and the USGS is designing a survey of Yukon tributaries that will result in a map of river carbon concentrations.

## **Issue-Based Studies**

Several issue-based studies will provide the foci for the collaborative strategies that develop among the participating monitoring and research programs. The primary science question driving the initiative will be: What processes control water, carbon and energy exchange in the Yukon River basin, and what are the effects of changes in those exchanges on the global climate, arctic landscape, coastal ocean, and natural resources of the Yukon Basin?



Based on this question, four "consequence themes" will be used to drive the research and monitoring design:

- (1) How will increases in temperature affect water and energy budgets and how will these changes affect watershed biogeochemistry, net ecosystem exchange, and hydrologic export of carbon?
- (2) Will carbon flux "feedbacks" to warming resulting from changes in the land cover, soil active layer, and basin hydrologic regime potentially influence global climate change?
- (3) What are the effects of climate change on the abundance, quality, distribution and access to subsistence resources?
- (4) What strategies are needed to adapt to the likely effects of climate change on subsistence resources to enhance human resilience?

The studies will each include assessment of long-term trends for multiple ecosystem components and at multiple scales.

## For more information contact:

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