Resource Brief
Alaska

National Park Service
U.S. Department of the Interior

Inventory and Monitoring Program
Alaska Region

Permafrost and Climate Change

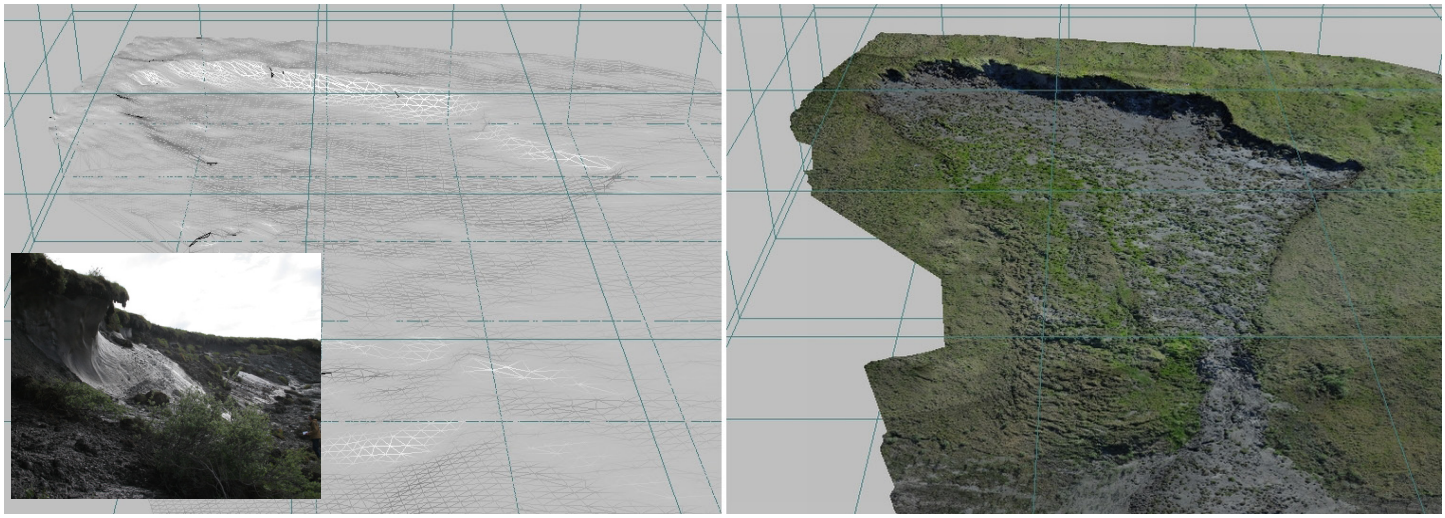

Photo: Dave Swanson/NPS

The photo and 3D model show a retrogressive thaw slump in Noatak National Preserve. Slumps result from a combination of land subsidence due to thaw of large ice masses and downhill transport of sediment by sliding or water erosion.

Background

Permafrost is ground that remains frozen longer than two consecutive years. It dominates the landscape in northern Alaska and is found in 10 of Alaska's 16 national parks. Significant thaw of permafrost is considered likely with future climate change (IPCC 2007). Permafrost has previously been identified by the Arctic and Central Alaska Networks as a vital sign in Alaska's national parks. *Current efforts are now being built upon as part of the National Park Service's expanding commitment to understand and respond to climate change and its potential effects as outlined in the Climate Change Response Strategy developed in September 2010*. The expanded efforts will combine direct and indirect measurements of temperature and landscape features and will utilize existing partnerships to increase overall understanding of status and trends of permafrost conditions in Alaska.

Photo: Nichole Andler/NPS

Muskox occur in Bering Land Bridge National Preserve and are an Arctic adapted species that may be effected by climate change.

Enhanced Monitoring

The goal of the Alaska Region's expanded permafrost monitoring effort is to understand the magnitude of thawing and the current and potential effects on ecosystems in Alaska's national parks. There are several challenges unique to permafrost monitoring, including the vast area of roadless wilderness and wide variety of responses by the landscape to permafrost thaw. With these challenges in mind, the monitoring team, which includes partners from the Arctic and Western Alaska Landscape Conservation Cooperatives and the U.S. Fish and Wildlife Service, has developed a plan that combines direct and indirect measurements to gain a better understanding of permafrost and thaw cycles. This plan utlizes existing protocols for permafrost monitoring developed by the Arctic Network and applies them to parks within the Central Alaska Network. This multi-faceted approach will result in an efficient, more robust monitoring program.

Direct monitoring will by conducted by recording near surface ground temperatures (0 to 2 m) on a continual basis. Measurements will be taken using temperature sensors located at existing weather monitoring stations as well as at new weather monitoring stations slated for installation in 2011 and 2012. Near surface ground temperatures will be monitored in all parks within the Arctic and Central Alaska Networks; monitoring is currently underway in some parks.

The dynamics of permafrost landforms will be monitored via

Putting it All Together

several indirect measurements. Models will be applied to existing soil and landscape inventories to document permafrost location and condition. Satellite imagery will then be used to inventory natural features associated with permafrost. Rapid mapping of permafrost areas using moderate resolution imagery will show features indicative of thaw such as areas covered by water or bare soil. To examine more subtle changes to vegetation and the land surface, such as formation of wet depressions, systematic point sampling on high-resolution aerial photographs will be utilized.

A third indirect measurement will apply three dimensional models of selected land features susceptible to thaw using advanced technologies such as LIDAR and stereophotogrammetry. LIDAR is used to create detailed topographic maps and, when combined with multispectral imagery, can be used to track long-term changes, such as the formation of wetlands or lakes. Stereophotogrammetry, which combines aerial photographs with ground survey information to create 3D models, will be used in focus areas where rapid thawing and conspicuous changes are occurring, such as slumping or landslides caused by melting permafrost.

Thermokarst, the term collectively applied to subsidence features related to permafrost thaw, includes the formation, enlargement or drying of lakes and other bodies of water and slumps and depressions in the landscape among other features. Effects of thermokarst include erosion, associated landslides and increased sediment loads in lakes and streams, changes in vegetation growth patterns and altered nutrient cycles.

As a result of this monitoring effort, a technical report summarizing data, status and trends of permafrost in Alaska's national parks will be developed. In addition, an interpretive document summarizing permafrost changes will be made available to park managers, policy makers, the general public and others. Data will be made available via online resources including the Circumpolar Active Layer Monitoring Network (CALM). Permafrost thaw features in many of the national parks within the Arctic Network have already been mapped, and this expanded effort will focus on unmapped parks in which areas of permafrost occur. Plans are currently being finalized and implementation of the enhanced monitoring effort is scheduled to begin in 2011.

Photo: Larissa Yocum/NPS

Photo: Larissa Yocum/NPS

Images showing two perspectives of Hook's Hole thermokarst in the Toklat Basin within Denali National Park. The large cave-like space and tilted trees are a result of thawing permafrost.

Permafrost and Rising Temperatures

Monitoring changes in permafrost condition is a high priority due to the potential for accelerated thaw rates which may fundamentally change ecological processes across major portions of the Alaska landscape. A multi-tiered approach utilizing existing partnerships, established protocols and regional support is being applied to expand this program. A combination of on-site measurements, satellite imagery and 3D modeling will provide information needed to form a baseline data set of permafrost metrics in Alaska's national parks. Continued monitoring of permafrost areas will help researchers, managers and the public understand and respond to the potential effects of climate change on permafrost. The results from this enhanced monitoring effort will be made available via online databases.

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