North Slope Decision Support System

Project Overview

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Background

Ice roads are used on the North Slope of Alaska to support oil exploration and production. They are used to transport heavy loads across long distances because, when built properly, ice roads cause little disturbance to the underlying tundra. Ice roads are built through sensitive habitats, and large quantities of water are required to construct and maintain them. On average, an ice road requires one million gallons of water per lane per mile to construct from water that is typically extracted from the tundra lakes that dot the landscape (see figure 1).

The ice road planning and permitting processes begins well before the winter work season. Optimizing potential ice road routes that meet the industry's need for transporting heavy loads to work sites while protecting the underlying tundra and avoiding sensitive habitat can be a complex task. Multiple agencies are involved in approving an ice road route. The NSDSS project is designing a web-based interface to facilitate the process of identifying a potential ice road route that meets multiple objectives, aids in providing transparency in the planning process, and could eventually be used to help facilitate the permitting review process as well.

North Slope water use can present a reporting challenge as well. Different oil companies and their contractors sometimes permit for and withdraw water from a common set of tundra lakes. Consequently, there exists a potential for water volumes from any single lake to be withdrawn in excess of permit limits for that lake. While excess water withdrawals are rare, there is a perceived need for transparency in the water use reporting process, and the NSDSS system could help meet reporting requirements as well as help facilitate during the planning process.

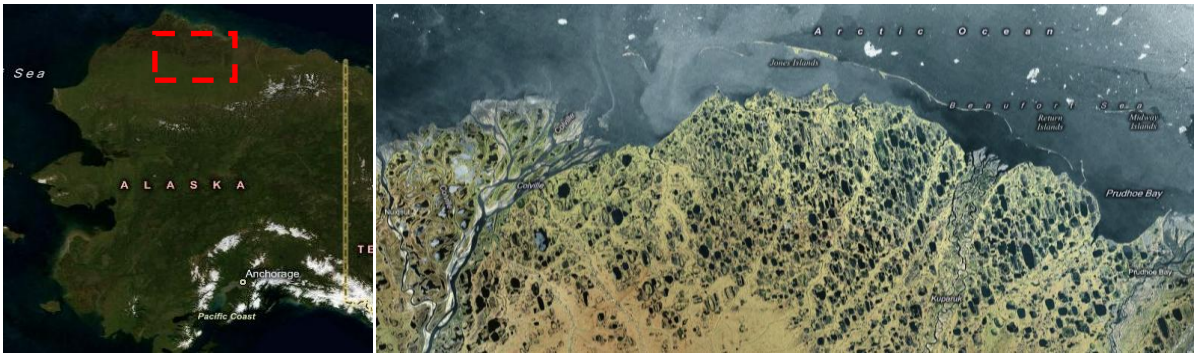

Fig. 1. Alaska's North Slope tundra landscape is dotted with thousands of lakes, some of which provide water for ice road construction.

Project Description

Under a grant from the National Energy Technology Laboratory of the U.S. Department of Energy, the North Slope Decision Support System (NSDSS) is being developed for potential use in the ice road planning and permitting process. Development of the NSDSS is a collaborative effort of academic and industry personnel with significant stakeholder involvement from multiple agencies of local, state, and federal government, private energy companies, and nongovernmental organizations.

The NSDSS is a web based application for ice road planning and related water resource management (see figure 2). It is designed to allow various parties to reach consensus on ice road routes and water use plans. Using the NSDSS web portal, an industry planner can create ice road plans by specifying the start-, end-, and way-points of their ice road and possible lakes to be used as water sources. Using the NSDSS optimal road alignment algorithm, the planner can then search for road alignments that minimize road length, construction costs, construction time, and water used while avoiding endangered species habitat, sensitive tundra, and culturally significant regions. Through lake water budget analysis, the planner can estimate the risk of insufficient water supply. Through a lake dissolved oxygen model, the planner can understand the impact that water use will have on lake water quality.

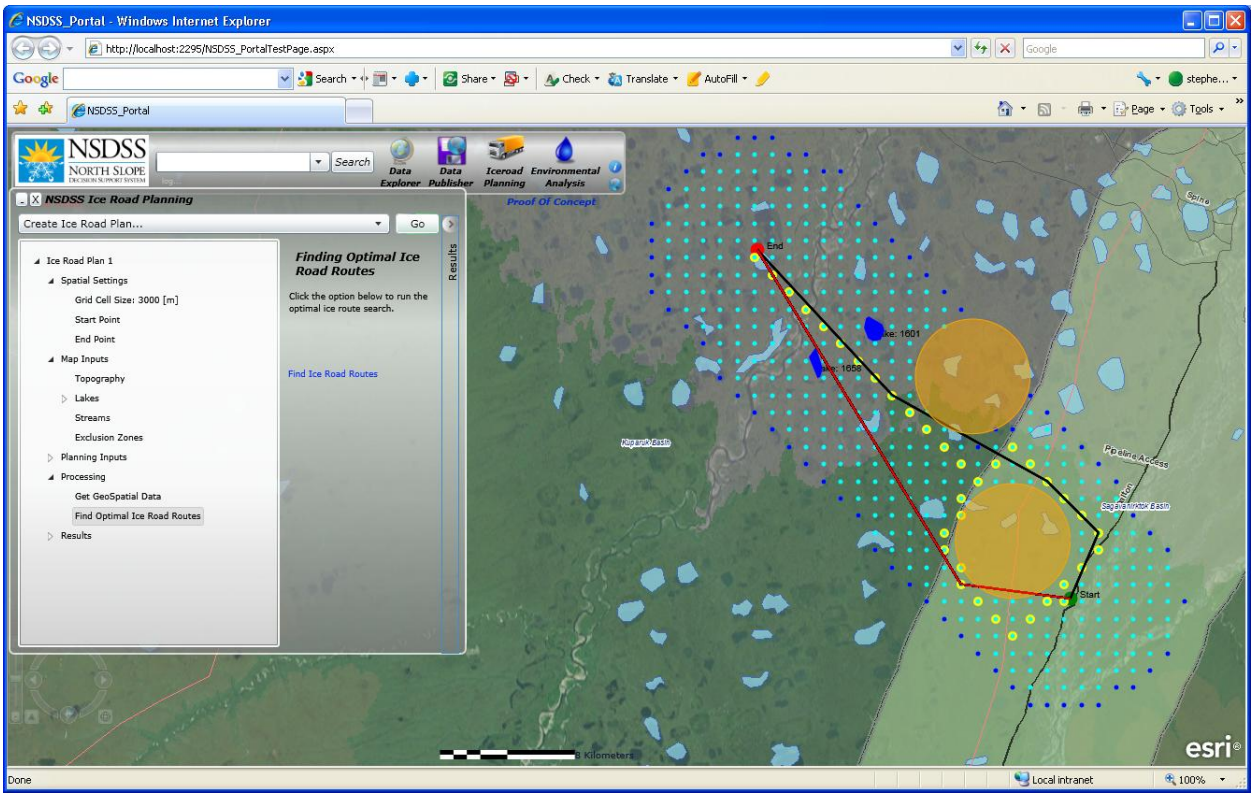

Fig. 2. The NSDSS ice road planning tool allows users to specify the start and end point of the ice road (green and red dots on the map respectively), the lakes that may possibly be used (indicated in darker blue), and exclusion zones where the ice road should not go. Exclusions are found in two ways; first through user specification (orange circles), and second through a web service developed through the NSDSS project that evaluates whether the intended route passes through suitable habitat for species such as polar bears. The optimal route alignment algorithm then attempts to identify ice routes that minimize costs of construction and operation, as well as minimize the distance travelled through sensitive ecosystems.

Through a permitting assessment tool, the NSDSS presents the planner with the list of regulatory agencies that may be required to review the permit and provides the requirements they may have in order to allocate the permit or authorization (see figure 3).

When the planner is ready, he or she can publish the ice road plan and all its related analyses to the NSDSS system and invite other stakeholders to review it. While a user may opt not to publish the plan and analyses to the system, publication could benefit the user by allowing the stakeholders reach consensus on the plan before the winter exploration seasons starts.

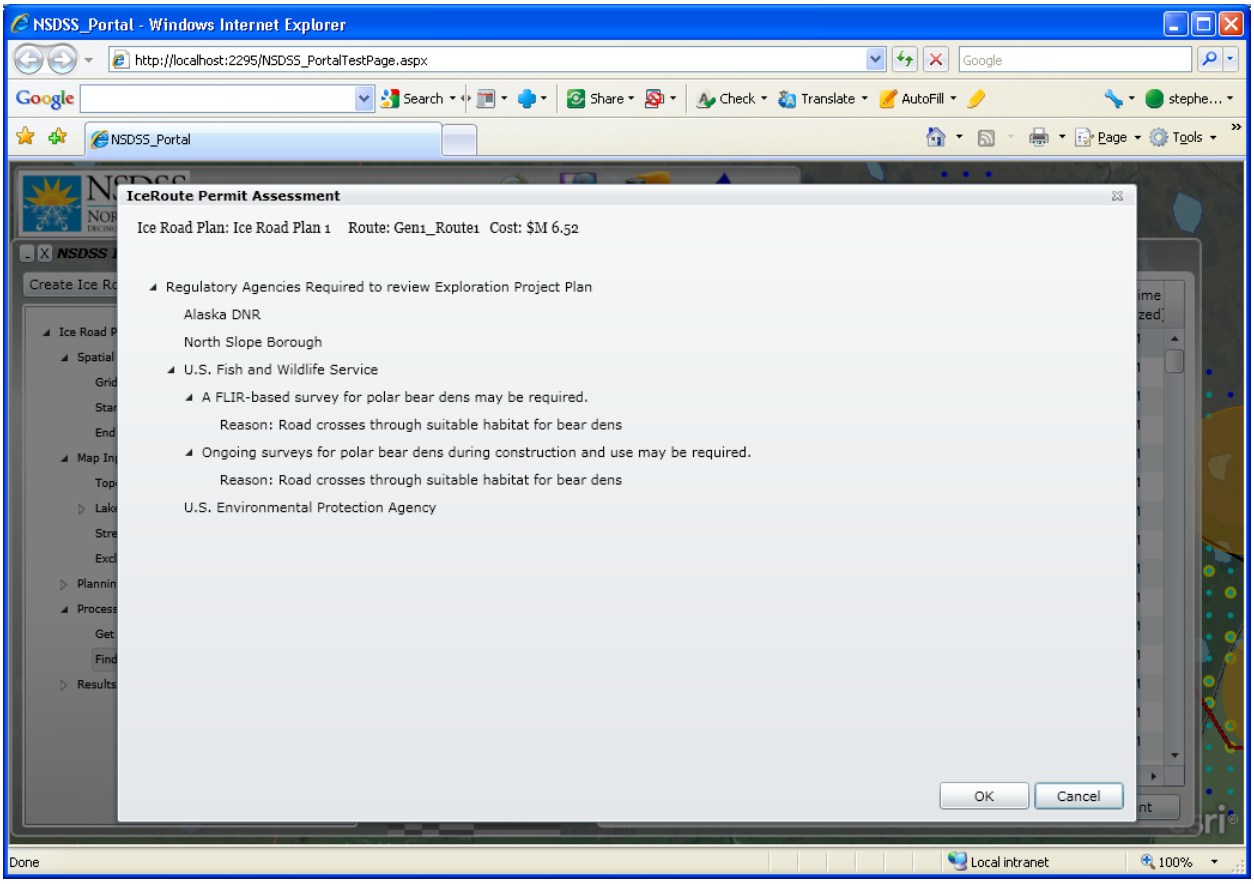

Fig. 3. The NSDSS ice road planning tool presents the planner with a list of regulatory agencies that may be required to review the ice road plan and the list of requirements those agencies may have for granting the permit or authorization.

Information Technology Advances

The NSDSS incorporates many new technological advances. The front end of the system is a Microsoft Silverlight web application (NSDSS.net) that makes it easily accessible for a wide audience and provides a powerful workbench for ice road planning. Behind the scenes, the NSDSS stores a wide array of data in a system of federated databases. Separate databases exist for 1) field data, 2) re-analysis data used in water budget analysis, 3) GIS data including a North Slope-wide lakes database, a digital elevation model, and hydrographic features, and 4) the models that are created by NSDSS users including lake water budget and water quality models and ice road plans. Data is served to NSDSS.net through an intelligent central catalog system that is automatically kept up-to-date on all data within the system and provides Google-like search tools for finding data in any of the databases. The technology incorporates emerging standards for scientific data organization and storage; new technological advances developed as part of this project are currently being documented and shared in the greater science community. The new lakes database is an especially valuable new resource, as it is capable of storing information on lake location, shape, and bathymetry, as well as past permits, fish species, and time series of past withdrawals.