Regional Scale Modelling

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In this presentation I would like to move from national scale down to the regional and local scale. We are using the same model (TTOP) as Mike Smith and his colleagues as our preferred model. However, there are different issues at the regional scale. We are not concerned about the broad permafrost distribution, but are much more concerned about specific locations, primarily because of the kinds of issues that we address:

- Terrain stability
- Engineering design
- Municipal planning
- Route selection
- Traditional activities

The biggest difference in the approaches is that at the local scale we deal with the landscape at the scale of individual terrain units. The spatial resolution of national scale modeling is on the order of one half degree of latitude at the national scale, compared to about 30 m resolution at the regional scale with current satellite technology. Regional scale climate change detection and prediction also involves shorter time scales (compared to the time scale required to shift boundaries on the permafrost map, for example), whereas permafrost distribution in local areas (such as the active Mackenzie delta) can be expected to respond relatively quickly.

There is a general scarcity of information in support of development and validation of regional scale modeling:

- Climate data coverage is poor for the areas that we are interested in.
- Ground temperature data are even scarcer.
- Field observations of permafrost distribution are often limited to a few geotechnical observations.

By the time we detect climate change, many impacts will already have occurred. Models will be useful, therefore, to help predict changes to permafrost. In lieu of monitoring, we will need to capture the variability of change at regional and local scales, as well as the time frame for realization of the predicted changes.

The monitoring stations that Mark Nixon and I operate go some way toward addressing these limitations in the Mackenzie valley, although there are still few ground temperature cables. We hope to move toward the establishment of a series of ideal monitoring sites consisting of:

- Air Temperature screen
- Near surface ground temperature logger
- Ground temperature cable
- Thaw tube
- Snow stake

We have elements of these throughout the Mackenzie valley transect, but we rarely have all of them together at a single site. These are all important to some degree in supplying data to the model or in validating the model results. Using information from the Norman Wells pipeline geotechnical survey and monitoring program, the model has been about 85% accurate in predicting the presence or absence of permafrost. However, the model is assumed to be less reliable for predicting the current thickness of permafrost, since the model does not take into account the long-term thermal history of the site, which is almost certainly cooler than contemporary conditions.

Mike Smith gave some examples of the sensitivities of some of the TTOP model parameters. At the national scale, he suggests that the model sensitivity to vegetation is relatively low, while there is a much higher response to changes in vegetation cover at the regional scale. Combining vegetation effects and snow cover effects, modeling in the Fort Simpson region suggests that permafrost can persist in some sites having mean annual surface temperatures as high as $+4^{o}C$.

Spatial variability is very important at regional scales. In regions of relatively uniform surficial geology, the variability is a reflection of variations in vegetation and associated changes in soil moisture content. Topography and slope aspect are also important. Combining all of these elements, we are able to generate a regional scale map of permafrost for areas such as Fort Simpson.

Any monitoring program that we develop should take account of those elements that modeling tells us are important. It will be important to design a monitoring network based rationally on different regional conditions, rather than attempting to be simply geographically representative. This will afford the best opportunity for maximizing results while minimizing costs.