Assessment of groundwater contribution to surface water quantity, quality and temperature in rivers of northern Quebec

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Abstract

Surface water-groundwater (SW-GW) interaction has an important role on quantity and quality of water resources as well as health of aquatic systems. Since the temperature of groundwater and rivers are different, the movement of water means transport of heat. Due to presence of permafrost and freeze-thaw cycle of active layer in northern Quebec, the physics controlling SW-GW interaction varies from one pint to another as well as from one season to another. SW-GW interaction in these regions is highly controlled by temperature dependent parameters. Climate change can have noticeable effect on future of SW-GW interaction and aquatic systems in these regions.

1. Introduction

The research questions that are going to be addressed are:
I) At what locations the groundwater-surface water interaction is present?
II) What parameters control this interaction?
III) To what extent the rivers' thermal budget can be affected by groundwater?
IV) Can permafrost help reduce contaminant transport to the rivers?
To see the effect of permafrost and climate on movement of water, contamination and heat from groundwater to rivers, two sites on two different river located on different climates and permafrost condition have been selected for detailed studies.

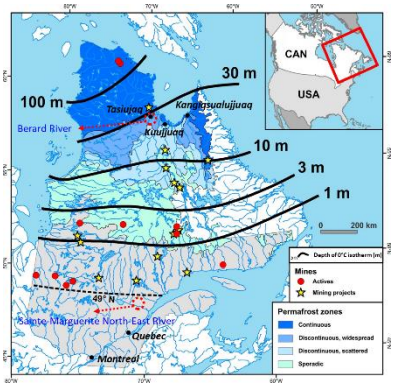

Fig. 1 Location of two selected rivers on permafrost map of Quebec.

2. Methods and techniques

The methodology can be summarized into two main parts: field measurements and modelling. Field measurements are required since there are no hydrological data available for the selected sites. Moreover, the detailed continuous data will be used for model calibration and history matching in order to have a more reliable prediction from the models. Modelling will be done using COMSOL software. The model will combine free flow (flow in the river), groundwater flow (saturated and unsaturated flow) and heat transport to simulate water and heat circulation in the system.

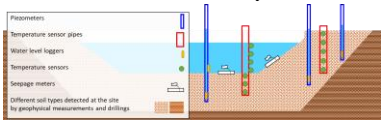

Fig. 2 Summary of all field measurements on the study site in cross-section view.

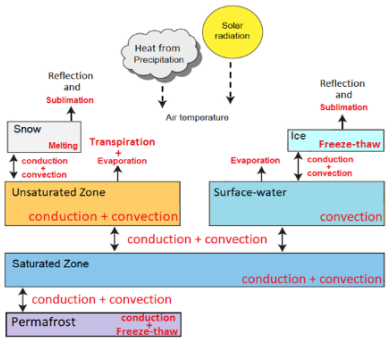

Fig. 3 Schematization of water circulation (black arrows) and methods of heat transport (in red) in the system.

3. Discussion

Change in the flow pattern modulates the temperature distribution in the system; since heat transport due to convection is significant in surface water-groundwater interaction modelling.
Even a small section of permafrost (sporadic) can significantly change the groundwater flow system. The freeze-thaw cycle of permafrost and active layer (layer on top of permafrost) causes the quantity of surface water-groundwater interaction to vary in summer and winter. Therefore, considering all terms of conduction, convection and phase change as methods of energy transport is important.