The Effect of Varying Soil Characteristics on an Arctic Groundwater Model

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Arctic permafrost degradation is occurring as global temperatures increase. In addition, recent evidence shows the Arctic is shifting from a sink to a source of carbon to the atmosphere. However, the cause of this shift is unclear, as is the role of newly exposed organic soil carbon leaching into groundwater and transported to surface water. This soil carbon may be photo-oxidized to CO2 or microbially respired to CO2 and methane, adding greenhouse gases to the atmosphere. Ultimately, the fate of carbon in permafrost is determined by the length of time spent in transport and the surface or subsurface route it follows. And yet, groundwater flow within shallow active layer aquifers overlying permafrost is poorly understood.

The goal of this term project is to use the ArcHydro tools to construct a GIS model that can illustrate how different soils will be expected to transmit water, immitating climate change scenarios in which the permafrost melts and the aquifer shifts further below the surface. Other possibilites to be explored include potential aquifer response to wetter or dryer years, which would be reflected in the saturated thickness of the aquifer.

This project focuses on Imnavait Creek watershed, a 1st-order drainage on the Alaskan North Slope underlain by continuous permafrost. Soil samples have been collected at this site during August of 2016 and August of 2017 at a range of depths. The porosity, hydraulic conductivity, and mineral/organic makeup of the soils had been determined in a laboratory setting. This data will be used to paramaterize the model and inform the soil characteristic inputs of porosity and transmssivity.

The DEM I am working with was aquired from the Polar Geospatial Center which was created from the ArcticDEM project. It has a 5-meter resolution. Thus far, I have deliniated the watershed of interest by creating a pour point determined by a flow accumulation raster an based soley on the DEM. The main stream was created as a vector, also derived from the flow accumulation raster. My next steps will be to construct the model that will calculate groundwater flow with variable inputs of saturation thickness and porosity. I will be using the Darcy Flow tool. In order to more accurately simulate the topography and variabillity in the soil, I will creat a raster that has different properties in the riparian zone and on the hillslope. Arctic soils are extremely heterogeneous and I will be unable to account for the microtopographic effects in the model, but a variable permiablity raster can perhaps address this with broad strokes.

Ultimately, the appeal of this model will its application to large Arctic watersheds. Overlooking small scale topography, there is much value in predicting potential climate change effects on groundwate flow in this region.

