Impact of Glacier Retreat in the Alps on Water Runoff: A Comparative Study Using the Shallow Ice Approximation Model

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All over the world glaciers provide an important source of water to mountain communities and cities outside of the mountains. As the glaciers melt during the summer their runoff flows into streams and rivers that are an important source of water for people all over the world. Since the start of the industrial revolution and the subsequent climate change that is still going on today glaciers have been melting at an unprecedented rate. This melting has caused the rapid retreat of glaciers in mountainous regions all over the world.

The goal of this paper is to see how the retreat of glaciers in a watershed in the Alps has affected the water runoff from these glaciers. I will construct a low-parameter shallow ice approximation model for each of the glaciers in the watershed and calculate how much water is melting off of them as they retreat. To fit the model, I will use numerical methods to fit the parameters to reality. When available I will use photographs from the 1800s, and further photographs and data from the 1900s to help fit the model to reality.

To construct my model I will use pre-existing topography data such as LIDAR to create the topography for the model. My model will start with no ice 1000 years ago, and then I will spin it up to ~150 years ago with the goal of it looking similar to the photos from the 1800s. In order to correctly spin up the model I will use numerical methods to calculate the necessary parameters for the model. In order to calculate the water runoff I will calculate how much ice the glacier is losing as it retreats and convert that into a volume of water.

The shallow ice approximation model is not going to perfectly model these mountain glaciers, so I will compare my model output to that of a much more advanced ice sheet model such as the Parallel Ice Sheet Model (PISM) to see just how accurate my model is. In my paper, I will discuss the shortcomings of the shallow ice approximation model compared to the PISM and answer the question “Can a shallow ice approximation model work as a reasonable approximation for mountain glaciers”.

The end goal of this paper is to accurately calculate how much water runoff these glaciers in a watershed in the Alps are providing using a shallow ice approximation model. This model will be fit to reality using data and photos from the 1800s and 1900s. The fitting of the model will be done using numerical methods to accurately calculate the parameters of the model. The accuracy of the model will be checked by using a much more advanced ice sheet model such as the PISM. Finally, the paper will determine just how accurately a shallow ice approximation model can be used to model these types of mountain glaciers and their water runoff.