Report for 2001AK3521B: Hydrological and Geomorphological Controls on Sediment Transport Processes in the Alaskan Arctic

- Dissertations:
  - Oatley, Jeffrey (2002), Ice, Bedload Transport, and Channel Morphology on the Upper Kuparuk River. MS Water Resources Engineering, Thesis, University of Alaska Fairbanks.

Report Follows:

Problem and Research Objectives

The objective of this research is to develop a better understanding of watershed morphology and to elucidate how a basin structure may evolve with the onset of climatic warming. Over the past several years, river morphology studies performed in the Kuparuk River have documented some of the changes that have occurred as a result of bedload transport. This study will provide insight into the nature of the bedload transport process. The study is being conducted in the upper Kuparuk River, near the intersection of the river and the Dalton Highway.

Objective

There are three primary goals for this study:

1) Use predictive methods to determine the total sediment load in the river for a given flow rate.
2) Compare the bedload material movement that occurs during the spring snowmelt to that which occurs in response to significant rainfall events during the summer.
3) Compare features of three arctic rivers to identify characteristics that may be symptomatic of the role of ice in arctic river morphology.

Methodology

Several field measurement methods have been, and will continue to be, used to quantify the total amount of sediment transport.

Suspended sediment is being measured directly by using an auto-sampler to collect one-liter samples at regular time intervals during the summer months. These samples will be filtered and weighed to determine the mass of solid material in each sample.

Bedload material movement is being monitored by two different methods. One method is tracer rocks; the other method is sediment traps. Scour chains, located throughout the study reach are also being used.

A total of 400 Tracer rocks are being used to study the movement of specific pieces of cobble. Both active and passive tracer rocks have been placed in the channel. The passive tracers are painted rocks. The active tracers are rocks that have a small radio transmitter implanted in them. These transmitters emit a different pulse rate at rest than during movement. This feature allows knowledge of incipient motion.

Sediment traps are being used to capture particles (greater than 3mm diameter) during motion. These traps will be fixed to the riverbed and the current will carry particles into the traps.

Extensive survey data has been gathered for the Kuparuk River, the Toolik Lake inlet stream, and Oksrukuyik Creek and these data will be used to define and compare the three stream characteristics.

Principal Findings and Significance

During the summer of 2001 the study reach was fully surveyed and field measurements of the channel material grain size distribution were made in the form of Wohlman pebble counts. This information has been used to perform the modeling task of predicting the bedload rating curve for the study reach. This prediction is shown in Figure 1 below.

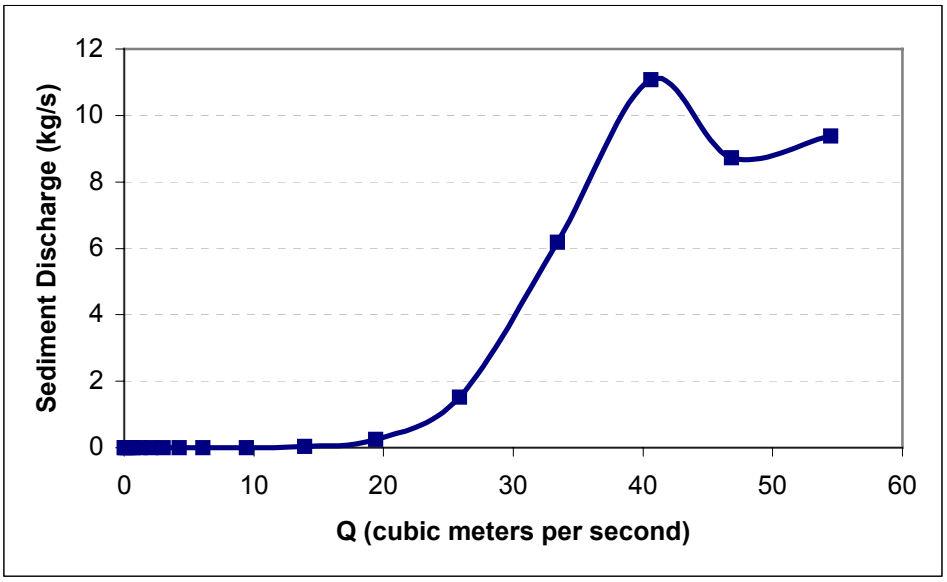

Figure 1. Bedload rating curve.

The bedload rating curve shows that the competent flow threshold for this channel is approximately 20 m^3/s. Since this study began the peak flow volume has been 16.4 m^3/s, so there has not been a significant amount of bedload movement to this point. Of the 201 tracers that were in place during the snowmelt period of 2001, 14 tracers moved a measurable distance and another 12 tracers were not recovered. The measured tracer movement is summarized in Figure 2.

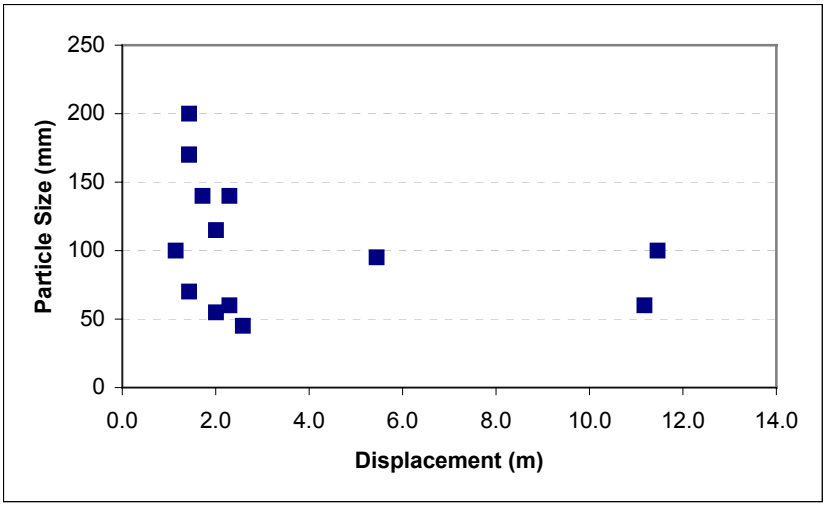

Figure 2. Particle size versus distance traveled.

Eleven of the twenty radio transmitter tracers are still functional and may provide incipient motion data in the event of a major rainfall event during the summer of 2002.

During the snowmelt period of 2002 there was an excessive amount of ice in the channel of the Kuparuk River, forcing much of the snowmelt runoff onto the floodplain. This resulted in ice remaining in the channel until well after the snowmelt peak, which prevented any movement of the tracer rocks.

In June of 2002 the Kuparuk River and the Toolik Lake inlet stream were surveyed. This data will be used to compare the morphologies of these rivers. In July of 2002 Oksrukuyik Creek will also be surveyed.