Columbia River Suspended Sediment Monitoring

Motivation

Although the Columbia River carries relatively low sediment loads for its size, sediment occupies important ecological functions. It impacts water clarity which greatly. Suspended matter appeared to have noticeably faster settling velocity past 75 years has likely changed suspended sediment concentrations and temporal variation.

Location

The Beaver Army Terminal Pier at river mile 52 offers an excellent location for instrument deployment. It is downstream of major tributaries yet upstream of any salinity intrusion. The natural constriction in the river promotes mixing and minimizes both vertical and lateral variation in suspended sediment concentration. The LISST-floc measures flow velocity (ADCP), stage, and turbidity directly across the river from the pier. The pier, which Portland General Electric generously allows us to use, provides a secure mounting, easy access to instruments, and shore power.

Method

Monitoring relies on a LISST-floc. This instrument measures volume concentration of particles with sizes between 5 and 1500 microns, although sediment with particle sizes greater than 500 microns is uncommon at Beaver. The LISST-floc collects a burst of 4 measurements every 15 minutes. During each field visit we collected water sample for filtering. It is often assumed that the fixed material is mineral and the volatile is organic. Suspended settling velocity appears to increase less. These could be caused by increased phytoplankton or increased aggregation, possibly with biological causes. Aggregates have have lower fractal dimension (are fluffier) than in winter.

The deployment is designed to capture both water high events and the spring freshet. The discharge plots show daily average (red) discharge in this tidal portion of the river. The years 2003 and 2004 offer an interesting contrast with different wetland patterns. The year 2003 started off dry followed by a rainy spring. The year 2004 began following a wet fall of 2003 but led into a dry spring. Although 2004 had one high flow event in February, it was not much higher than the sustained spring flow in 2003. The rainfall pattern also caused an earlier freshet peak in 2003.

2003

The figure to the left shows settling velocity compared with collection of flow velocity, stage, and turbidity made by the USGS monitoring station on the other side of the river. The LISST receives a cleaning and data download during a site visit approximately every 15 days. During site visits water is collected in a Niskin bottle. After allowing the bottle to sit for 200 hours, we siphon off the top half of the water and filter both this water and the bottom half of the bottle. This allows calculation of a representative settling velocity.

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2004

The LISST-floc using small angle scattering of laser light to determine volume concentration. Some calibration issues are still being addressed for the 2004 data. Nevertheless, the high flow events show increased concentrations in both fine and larger size classes. In later spring the freshet produces higher volume concentrations increase less. These could be caused by increased phytoplankton or increased aggregation, possibly with biological causes. Aggregates have have lower fractal dimension (are fluffier) than in winter.

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Daily variation

On Nov 21 2003 we collected water samples approximately hourly from 8:00 am to 2:00 pm. During this time flow velocity was decreasing from maximum ebb at 6:00 am to slack water about 10:00 am through reversed flow to another slack water about 2:00 pm. Turbidity decreased as discharge decreased and stayed relatively constant during reverse flow. The fraction volatile (organic) matter did not vary greatly. Suspended material appeared to have noticeably lower settling velocity during periods of greater discharge.

TSS from filtering

Settling Velocity

Considering that discharge varies greatly and even reverses over the course of the day raises the question of whether variation in samples depend more on seasonal, event, or daily changes. The figure to the left shows 2003 data and indicates that the settling velocity result in small changes in TSS except during high flow events. Settling velocity appears to vary more than TSS and appears more closely correlated with discharge.