Sandy River Sediment Transport Data Collection

Oregon Water Resources Department - USGS Project Workplan, 2006

Introduction

Marmot Dam, on the Sandy River *(map)*, will be removed in early 2007, and Little Sandy Dam, on the Little Sandy River, will be removed in 2008. There is approximately one-million cubic meters of sediment. The reservoir behind Marmot Dam is filled with approximately 900,000 yd^3 of sand (~40%) and gravel (~60%) in a wedge extending a considerable distance upstream from the 47 ft concrete dam (PGE, 2000). The dam removal will result in the suspension and transport of sediment to a degree that is difficult to predict. There is a need to document the impacts of sediment released from these dams and other sources on the Sandy and Little Sandy Rivers, which provide access and habitat for anadromous fish and other aquatic organisms. The effects of dam breaching will extend from the dam a considerable distance downstream, with inputs of suspended sediment from the whole basin, including upstream bank erosion and reservoir storage. The Sandy River is on the State of Oregon 303(d) list for dissolved oxygen (2002) and water temperature (1998), and a temperature TMDL has been developed (Oregon DEQ, 2003). Assessment of sediment effects is vital to the understanding of the status of water quality in the basin.

Removal of Marmot dam will constitute a potentially large perturbation to the historically sediment rich Sandy River. The monitoring carried out in this project, together with erosion estimates and modeling proposed by other partners, will help put the sediment load resulting from dam removal in perspective with sediment transported from upstream, glacially and geologically active areas on the flanks of Mount Hood. Data collection in conjunction with the dam removal will be provided to other partners collaborating in the project, including the Oregon Water Resources Department.

Modeling of downstream sediment transport following Marmot Dam removal has indicated likely reaches for sediment deposition, in some cases predicting significantly increased amounts of bed material, but accuracy of the model predictions cannot be assessed without data on transport both before and following dam removal. Key habitat considerations include deposition of fine and coarse sediment into critical spawning areas, reduction of visual clarity by turbid water (Davies-Colley et. al, 2001; Fiksen et al., 2002), and potential geomorphic changes in both the Little Sandy and Sandy Rivers. These elements are important concerns for the USDA Forest Service in managing fisheries resources, and will also be a critical component of the Sandy River Basin Restoration Strategy, currently underway, upon which the USDA Forest Service and several other Federal, State, and county agencies and nongovernmental organizations have recently embarked.

When Marmot Dam is removed, it could be the largest dam, with the largest upstream pool of impounded sediment, to be removed to date nationally. As such, data collected in this study, as well as the precedents set for data collection, agency integration, and information dissemination, will help influence the course of scientific investigations surrounding other dam removals. The use of continuous turbidity measurement as a surrogate for suspended sediment as planned following this study will provide a methodology for complete yet manageable characterization of sediment flux both before and after removal. The success of this approach, when also undertaken with estimates of bedload, evolution of deposited sediment, and model verification as proposed by Oregon State University and Stillwater Sciences, will be directly applicable to other dam removal situations. Furthermore, the extent to which

turbidity-sediment correlations agree with those in nearby basins (similar work by the USGS is ongoing in the Tualatin, North Santiam, and McKenzie River Basins) will add to the understanding of the overall transferability of sediment-turbidity correlations to other basins. The continuous, *in-situ* measurement of turbidity is a central issue of this study. A project principal investigator is the author of the revised USGS protocol for measuring turbidity (Anderson, 2004).

Objectives

This study will provide quantitative data on suspended sediment transport and loading prior to and following the removal of Marmot Dam, which will help understand the geomorphological effects of dam removal on the reservoir pool and downstream reaches. The scope of the study will include the effects of decommissioning on both the Sandy and Little Sandy Rivers, including upstream reaches for reference conditions, and will include baseline data from prior to decommissioning as well as data from post-removal. The study's long term objectives are to:

1. Determine hourly and daily concentrations and loads of suspended sediment, including the fraction of fine (smaller than sand size, or < .063 mm) material transported both before and after dam decommissioning, from sites above and below Marmot Dam, and
2. Following dam removal, determine the relative contribution of suspended sediment loads to the lower Sandy River (below Bull Run River) from each of four potential sources: the Sandy River above Marmot Dam, sediment stored behind Marmot Dam, the Little Sandy River above the Rosalyn Lake Diversion, and the Little Sandy River below the Rosalyn Lake Diversion.

During 2006, the primary data collection objective will be to establish the monitoring network and collect data to support these long-term objectives.

Approach

The present study's approach will be, as applicable for each site (table 1), to:

- Collect hourly and daily discharge and turbidity data.
- Collect water samples for suspended sediment concentration and fraction of fine materials over a broad range of flow and turbidity conditions.

Future years of the study may include:

- To the extent possible, develop relations between instantaneous turbidity and suspended sediment for each station,
- Calculate instantaneous loads of suspended sediment using hourly turbidity data and derived turbidity-sediment regressions, and
- Provide data to Oregon State University and Stillwater Sciences as input to their larger geomorphological study of dam removal.

Table 1. Sites and proposed periods for sediment data collection associated with removal of Marmot Dam.

[Dates assume that the dam will be removed during water year (WY) 2007 (winter of 2006–2007). Continuous turbidity collection by PGE was done during WY 2004–2005 at two sites and will be collected again for 2 years following dam removal at all five sites. Discharge is collected at all sites except Sandy River above Marmot Dam. Data collection by USGS in WY 2007 and 2008 is contingent upon securing funding. SSC, instantaneous suspended sediment concentrations; PGE. Portland General Electric; USGS, U. S. Geological Survey]

Study Reach	Water Year	Data Collected	Collection entity
Sandy River above Marmot Dam	2004–2005	Continuous turbidity	PGE
	2006	Instantaneous turbidity, SSC samples	USGS
	2007–2008	Continuous turbidity, SSC samples	PGE, USGS
Sandy River below Marmot Dam	**2006**	Continuous turbidity, SSC samples	USGS
	2007–2008	Continuous turbidity, SSC samples	PGE, USGS
Little Sandy River above Rosalyn Lake Diversion	2007–2008	Continuous turbidity, SSC samples	PGE, USGS
Little Sandy River below Rosalyn Lake Diversion	2007–2008	Continuous turbidity, SSC samples	PGE, USGS
Sandy River below Bull Run River	2004–2005	Continuous turbidity	PGE
	2006	Continuous turbidity, SSC samples	USGS
	2007–2008	Continuous turbidity, SSC samples	PGE, USGS

Methods

Turbidity data and samples for suspended sediment concentration will be collected from discharge gaging stations (Rantz and others, 1982; Edwards and Glysson, 1999; Wagner and others, 2006) as indicated in table 1.

Turbidity Monitoring

Turbidity monitoring by USGS will be performed according to standard USGS protocols (Wagner and others, 2000). All turbidimeters used in the Sandy River Basin will use near infra-red light sources, with a single detector at 90 degrees to the incident light beam. On the basis of this configuration, turbidity data will be reported in Formazin Nephelometric Units (FNU), as specified for USGS by Anderson (2004). This reporting unit provides traceability and specificity to the instruments used to make the measurements, helping to reduce uncertainty in data analysis; however, FNU may be considered equivalent to the more traditional Nephelometric Turbidity Unit (NTU) for purposes of comparison with older data. Continuous monitors will use SDI-12 compatible Analite 395 probes from McVan Instruments Pty Ltd. During sediment sampling, YSI 6920 multiparameter sondes equipped with a model 6026 turbidity probe will be used for instantaneous readings and cross sectional profiling of turbidity. The 6026 probe also is manufactured by McVan Instruments, and recent work has shown a near 1:1 comparison between the Analite and YSI 6026 turbidity probes (USGS, unpublished data).

Monitored turbidity data will be recorded every 30 minutes. Values will be reported as the median of 100 readings during a period of about 1 minute. Signal processing in this manner, which is a feature of the Analite probes used, helps to reduce the often high variability of turbidity data. Data will be maintained in the USGS' National Water Information System (NWIS). Where possible, data will be available in near-real time online at *http://waterdata.usgs.gov/or/nwis/rt*.

During sampling for SSC (see below), cross sectional measurements will be made for turbidity from the cableways, in order to evaluate the cross sectional variability of turbidity and to compare with the monitored value. Where cross sectional turbidity is highly variable or is significantly different from that measured at the monitor location, monitor values may need to be adjusted to compensate. Data collection at the site on the Sandy River above Marmot Dam, which experiences high velocities and is not far above the dam's spillway, will be done as instantaneous measurements near the right bank, without cross-sectional sampling, because no bridge or cableway is available. Occasional cross sections may be measured pending safety considerations. Both turbidity and SSC will be collected in this manner.

Suspended Sediment Sampling

Samples for suspended sediment concentration (SSC) will be collected using standard USGS methods for depth and width integrated (EWI) sampling (Edwards and Glysson, 1999) except where otherwise noted. Samples will be collected from cableways, if available, or from bridges otherwise, using a USGS D-74 sediment sampler with pint glass bottles, suspended with a B-reel (Edwards and Glysson, 1999). SSC samples will be analyzed at the USGS Sediment Laboratory in Vancouver, WA. Samples will be analyzed gravimetrically, and data reported in milligrams per liter (mg/L) of dried sediment and the percent of SSC in the fine fraction (diameter < 0.063 mm).

Deliverables

We anticipate that the study outlined in this funding agreement will be one of four years of work to document conditions before and after dam removal. Deliverables from the present study will include:

- Instantaneous data on SSC and percent sediment finer than .063 mm, and corresponding instantaneous turbidities, for each site.
- Continuous turbidity data, delivered in real time when possible.

Future Studies

For 3 years after the present study, it is anticipated that data collection will follow as in year 1, with the deliverables described above. In addition, future years of the study may include interpretation of the data, which will be vital to understanding and use of the raw data by resource managers. Interpretive aspects of future studies may include:

- Calculation of regression coefficients between turbidity and suspended sediment concentration (SCC) for each site.
- Estimation of hourly SSC, based on regressions with hourly turbidities for each site.
- Estimation of hourly and annual loads of SSC, based on regressions with hourly turbidities for each site.

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