APPLICATION OF DIGITAL OBLIQUE PHOTOGRAMMETRY FOR MONITORING EROSION AND SEDIMENTATION AT MOUNT ST. HELENS, WASHINGTON, USA

Adam R. Mosbrucker, Portland State University, Portland, OR, and U.S. Geological Survey Cascades Volcano Observatory, Vancouver, WA, amosbrucker@usgs.gov

Abstract This study investigates the value of close-range oblique photogrammetry as a tool for monitoring erosion and sedimentation at Mount St. Helens, where the catastrophic eruption of 1980 began with a massive debris avalanche that buried the upper watershed of the North Fork Toutle River. Unconsolidated avalanche material averaged 45 meters thick and extended 25 kilometers downstream from the volcano, and was easily eroded during reestablishment of drainage networks. Following the 1980 avalanche, intensive long-term hydrologic monitoring focused on the evolution of channel morphology, bank stability, and fluid dynamics of streams in the affected area. Nearly three decades later, post-eruption sediment challenges persist at St. Helens and data collection and analysis methods continue to evolve.

Direct water and sediment discharge measurements, telemetered gaging station records, and over 150 channel cross sections provide precise and accurate parameters for erosion and sedimentation models; however, they lack appropriate temporal and spatial resolution. Repeat terrestrial and low altitude oblique photographs and videography have provided better interpolation of unmeasured areas. Quantitative techniques such as high altitude aerial photography and lidar that meet spatial requirements have also been employed, but mobilization time and expense limit the ability to respond quickly to high-flow events.

Recently, close-range, oblique digital photogrammetry techniques have provided an effective, efficient, and economical method that meets our spatial requirements. This study investigates the use of these techniques to obtain erosion and sedimentation data with high temporal and spatial resolution. Two study sites were chosen for their rapidly changing morphology, lack of vegetation cover, and potential for ground control. Handheld, low-angle oblique photographs were taken from a helicopter at approximately 460 meters above ground level with an emphasis on image overlap and diverse orientation angles. An average of 410 images was captured in 10 minutes. Consumer-grade, digital, single-lens-reflex (SLR) cameras were chosen for their high resolution, internal sensor stability, speed of image storage, optical qualities, and low cost. Images were transferred to and processed on a desktop workstation with relatively inexpensive software. The software requires precise camera calibration parameters and control points visible in the photographs to assign X, Y, and Z coordinates. Exterior orientation ties ground control points (GCPs) that have been carefully measured using Global Position System (GPS) receivers with points that are identifiable on photos. At the site near the headwaters of Step Creek, cross-section survey data (collected with a Total Station), 30 GCPs, and 2 differential GPS points were used to increase precision and provide a source of error analysis. Greater resolution is achieved by the addition of close-range terrestrial photographs. GIS software will be used to calculate volumetric change between digital elevation models (DEMs), allowing for a greater understanding of the erosion and sedimentation processes at work at Mount St. Helens.