Geographic Information Systems as a Tool for Watershed Analysis: Case Studies in the Upper Nehalem River Basin, Oregon

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The Upper Nehalem River Basin is the focus of a service learning project for the Earth Science program for undergraduate research at Western Oregon University (WOU). WOU Earth Science has partnered with the Upper Nehalem Watershed Council, in conjunction with Bio-Surveys, to compile GIS (geographic information systems) data layers related to rapid bio-assessment (RBA) of fish populations in the river basin. This work is funded by the Oregon Watershed Enhancement Board as part of ongoing support of assessment and habitat restoration in the Nehalem Basin. The initial RBA-related GIS work served as the catalyst for expanding ancillary studies of regional geology and geomorphology by the WOU research group. This presentation provides an overview of the WOU work with examples of student service learning products including a summary of the geologic setting (Cristina Francisco), methodology related to georeferencing of the RBA data (William Vreeland), and use of high-resolution Lidar elevation models as a tool for geomorphic mapping of the watershed (Riccilee Keller; Brandon Snook).

Presenter

Cristina Francisco, Dept. of Earth and Physical Sciences, Western Oregon University, Monmouth, Oregon [Faculty Mentor: Steve Taylor]

Title

Geologic Setting of the Upper Nehalem Watershed: Framework for Geomorphic Analysis and Habitat Assessment

Abstract

The geologic setting of the Nehalem watershed is strongly influenced by active tectonics associated with the Cascadia Subduction Zone and Oregon Coast Range. Surface elevations range from sea level to over 3,000 feet. Bedrock stratigraphy includes several formations ranging in age from Eocene to middle Miocene, in addition to Quaternary terrace gravels and alluvium. The oldest rock unit is represented by Tillamook Volcanics (Eocene age), with the youngest represented by Columbia Basalt Group (Miocene age). Early Tertiary strata were subsequently intruded by gabbroic intrusives and mafic dikes. Evidence of tectonic activity shows a major late Eocene extensional event that resulted in normal faulting. Topographic lineaments in the Nehalem basin are associated with known fold structures, faults, formation contacts and/or resistant strata. Surficial geology is characterized by parent rock and soils formed through volcanic and depositional processes. This study forms part of an undergraduate research project at Western Oregon University to characterize the geology and geomorphology of the Nehelem basin as part of broader watershed assessment efforts in the region.

Presenter
William Vreeland, Dept. of Earth and Physical Sciences, Western Oregon University, Monmouth, Oregon [Faculty Mentor: Steve Taylor]

Title
Georeferencing Rapid Bio-Assessment Survey Data: GIS Applications in the Upper Nehalem Watershed, Oregon

Abstract
Rapid Bio-Assessment (RBA) Surveys were conducted in the Upper Nehalem Watershed over three summers commencing in 2008. These surveys involved observations of fish counts, riparian pool surface dimensions and population densities at numerous locations throughout the watershed. The data gathered were georeferenced using linear referencing tools available in ArcMap and subsequently used to generate a series of salmonid distribution maps. These materials were created to provide assessment information to stakeholders in the upper Nehalem Watershed, and support additional research on the geology, geomorphology, and riparian habitat conditions in north coastal Oregon. Georeferenced RBA map products are available at *wou.edu/las/physci/taylor/nehalem/nehalem_rba_maps.htm.*

Presenter
Riccilee Keller, Dept. of Earth and Physical Sciences, Western Oregon University, Monmouth, Oregon [Faculty Mentor: Steve Taylor]

Title
LiDAR-Based Slope Models as a Guide for Geomorphic Mapping: A Case Study in the Upper Nehalem Watershed, Oregon

Abstract
Morphological changes on Earth's surface can be observed using digital elevation models (DEM's) produced by airborne laser altimetry (LiDAR) techniques. Bare earth LiDAR data at high spatial resolutions provides a tool for analysis of geomorphic surface features such as channel patterns and landslide terrain. Surface expressions of topographic data yield insight into understanding the range of surface processes operating in mountainous watersheds.
This study employs ArcGIS10 spatial analyst extension to examine and calculate slope variance in Lidar-based elevation models of the Upper Nehalem Watershed. Empirical classification of slope values into three classes, (0-20, 20-70 and 70-90 degrees) assists with geomorphic mapping of active channels, valley bottoms, hillslopes and landslide topography. Landslides are of particular importance because they have potential to be hazardous, impact riparian habitat, and affect water quality. High degrees of slope variability and hummocky topography are indicators of either current or past landslide activity. GIS-based analysis of Lidar elevation models is a useful tool for geomorphic mapping in the Upper Nehalem Watershed.

Presenter
Brandon Snook, Dept. of Earth and Physical Sciences, Western Oregon University, Monmouth, Oregon
[Faculty Mentor: Steve Taylor]

Title
Geology, Geomorphology, and Salmonid Distribution in the Upper Nehalem Watershed, Oregon

Abstract
Mountainous watersheds are fundamental landscape elements that form an important setting for local ecological interactions, human occupation, and water resource development. The western Oregon landscape is associated with active mountain building and extreme precipitation patterns that result in a dynamic geomorphic system characterized by seasonal flooding, slope failure, and debris flow activity (Benda, 1990). Taylor (2002) conducted GIS-based analyses of Coast Range watersheds to elucidate associations between bedrock composition and slope gradients. The study revealed that certain bedrock types are associated with significantly steeper slopes, wider valley bottoms, and higher occurrence of slope failure compared to others. Understanding the controls for routing and storage of sediments in this region are a critical component of habitat management plans. The working hypothesis for this study is that stream gradients, channel network and valley morphologies will statistically vary as a function of bedrock composition and climatically driven erosion patterns. The model implies that spatial variation of bedrock lithology is a primary factor controlling slope, hillslope delivery rates, and the resulting sediment-transport efficiency of the channel system. This work forms part of a collaborative partnership between Western Oregon University, the Upper Nehalem Watershed Council and a rapid bio-assessment program funded by the Oregon Watershed Enhancement Board (OWEB).