

Earth Science

Session Chair: Steve Taylor

Session Title: Earth Science in Context: Land Use and Watershed Function in the Willamette Basin

Location: Werner University Center (WC)

Posters

2:00 – 4:00 p.m., WC Pacific Room

Faculty Presenter: Steve Taylor

Title: Earth Science in Context: Land Use and Watershed Function in the Willamette Basin

Abstract: This theme session involves presentation by 20 WOU Earth Science students enrolled in ES473 Environmental Geology and ES407 Senior Seminar, spring term 2008. The focus of the session is on the geologic framework, land-use history, and environmental setting of the Willamette Basin in western Oregon. Over 70% of the state's population lives in the watershed and it represents one of the most dynamic urban-mosaic landscapes in the United States. Expanding population and economic growth requires development of sustainable management practices balanced by maintenance of essential watershed functions. This compilation of work provides a sampling of the critical natural resource issues associated with the Willamette Valley. Topics include: geologic framework, regional climate history, geomorphic hazards, disturbance and riparian vegetation, geomorphic response to forest practice, river restoration, and water resource evaluation.

2:00 – 4:00 p.m., WC Pacific Room

Josh Troyer

Faculty Sponsor: Steve Taylor

Title: Tectonic Framework of the Willamette Valley, Oregon

Abstract: The Cascade Volcanic Arc is the result of millions of years of tectonic activity along the Cascadia Subduction Zone. The Cascadia Subduction Zone is an oceanic-continental convergent plate margin where the Juan de Fuca plate is being obliquely subducted beneath North America. Subduction and related andesitic volcanism are roughly subdivided into five major episodes, beginning about 35 Ma and continuing to the present. The evolution of the Cascade Volcanic Arc has shaped the varied physiography of the present-day Pacific Northwest. The Willamette Valley is situated between the Cascade Range to the east and the Coast Range to the west. The lowland is broadly interpreted as a forearc basin associated with arc volcanism and accretionary uplift. Bedrock of the Willamette Valley consists of oceanic basalts largely overlain by terrestrial and marine sediments, related to episodic deltaic deposition. Volcanic rocks are interspersed throughout the basin and the entire valley is overlain by Quaternary surficial deposits. Angular unconformities are common in the Willamette Valley owing to regional tilting and localized faulting throughout the basin. Clockwise rotation of fault blocks has resulted from a long history of oblique convergence and accretionary tectonics.

2:00 – 4:00 p.m., WC Pacific Room

Ben Shivers

Faculty Sponsor: Steve Taylor

Title: Physiographic Framework of the Willamette Lowland Aquifer System

Abstract: This paper focuses on the physiographic framework of the Pacific Northwest, specifically the geology of the Willamette lowland aquifer system and its natural vegetation. The Willamette Lowland is a 5,680 sq. mi. area positioned between the Oregon Coast Range to the west, and the Cascade Range to the east. The Willamette aquifer system is separated into the five hydrogeologic units, these include: (1) the basement confining unit, (2) the Columbia River basalt aquifer, (3) the Willamette confining unit, (4) the Willamette aquifer, and (5) the Willamette silt unit. These units have variable porosity and permeability, and establish the groundwater resource base for a large percentage of Oregonians. Large Pleistocene glacial-outburst floods, coupled with volcanic activity, have covered the Willamette Valley with unconsolidated surficial deposits as thick as 250 feet. Fertile soils at the surface have given birth to approximately 11,764,000 hectares of forested area in Oregon and Washington, and the agricultural zones we see today.

2:00 – 4:00 p.m., WC Pacific Room

Ian Macnab

Faculty Sponsor: Steve Taylor

Title: Quaternary Geology and Geomorphology of the Willamette Basin, Western Oregon

Abstract: The Willamette Valley of northwestern Oregon is associated with widespread Quaternary-age sedimentary deposits. Understanding the nature of the deposits not only provides a history of Quaternary depositional environments in the valley, but also information on surficial materials that form important regional aquifer systems. The oldest of the five major Quaternary-age sedimentary units are deeply weathered, 2.5-0.5 Ma fluvial sands and gravels flanking the valley margins. Tectonic deformation isolated these terraces from further deposition. Subsequent lowering of the valley resulted in up to 500 m of fill. The upper 10 - 50 m is comprised of braided channel alluvium that interfingers with 40 - 100 m thick fans emanating from the mouths of Western Cascade drainage basins. Dividing these gravels are dozens of 15 – 12.7 ka Glacial Lake Missoula flood deposits. These strata are up to 35 m thick and are composed of gravel, sand, silt, and clay. During the past 12,000 years, the braided channel system that dominated the depositional environment of the Late Pleistocene evolved into the anastomosing and meandering system present today.

2:00 – 4:00 p.m., WC Pacific Room

Tanja Aas

Faculty Sponsor: Steve Taylor

Title: Environmental Setting and Land Use in the Willamette Basin

Abstract: The Willamette Valley of western Oregon is characterized by agricultural and urban land use, with multiple pathways for environmental degradation. The southern part of the basin is associated mainly with grass crops, while the central and northern portions support various types of crops including grains, field crops, tree fruits and nuts, small fruits and berries and vegetables. The primary threat to rural degradation of water and soil quality is via the widespread application of herbicides and insecticides. These pesticides find their way through the channel network, ultimately discharging into the lower Columbia. This paper provides an overview of the environmental setting of the Willamette Basin and an expose on the threat of pesticide use to regional water quality.

2:00 – 4:00 p.m., WC Pacific Room

Laura Stallard

Faculty Sponsor: Steve Taylor

Title: Present-Day Climate and Vegetation of the Willamette Valley

Abstract: This paper examines the present-day climate and vegetation patterns in the Willamette Valley, and forms part of a larger theme session entitled “Earth Science in Context: Land use and Watershed Function in the Willamette Basin”. The Willamette Valley climate zone encompasses a 200-km-long lowland that lies between the Coast and Cascade ranges. This region is characterized by generally cool, wet winters and warm, dry summers. The Mediterranean climate pattern results in a unique assemblage of vegetation, including the dominance of coniferous forests. The focus of this poster is on elevation-controlled changes in vegetation throughout parts of the Willamette Valley, as a function of local climate variation.

2:00 – 4:00 p.m., WC Pacific Room

Bobby Kelso

Faculty Sponsor: Steve Taylor

Title: Quaternary Climate and Vegetation History of Western Oregon

Abstract: This paper presents a summary of paleoclimate and vegetation studies in western Oregon during the late Quaternary. The Willamette Valley climate is dominated by mild winters with massive accumulation of precipitation. In the summer months rains begin to disappear and we are dominated by warm, dry high pressure systems. In the Cascades and Coast Range we see a similar pattern, but there is a slight variation. The winter variation brings snowfall to higher elevations and short lived, intense thunderstorms in the summer. The vegetation, in association with the law of uniformitarianism, helps us unravel the past climate. Different plant assemblages occurred in the Willamette Valley and surrounding mountain regions during the past 100,000 years. Since plants are extremely sensitive to even minimal climate changes, we can determine relatively precise climate variations over time, based on the sedimentary record.

2:00 – 4:00 p.m., WC Pacific Room

Brittnie Andrew

Faculty Sponsor: Steve Taylor

Title: Groundwater Hydrology of the Willamette Basin, Oregon

Abstract: 70% of the population in Oregon lives above the seven major aquifer systems in the Willamette Valley. The seven primary hydrostratigraphic units include the High Cascade, Upper Sedimentary, Willamette Silt, Middle Sedimentary, Lower Sedimentary, Columbia River Basalt, and the Basement Confining. Precipitation recharges these units at an average rate of 22 in/yr between the high and lowland areas. The period of greatest rainfall occurs from November to April and allows for more water to infiltrate than is withdrawn from the regional aquifer systems. Summer months with evaporation and irrigation account for the most water use. Regional groundwater levels fluctuate by about 65 ft each year and are projected to decline with time as population in the valley increases and recharge varies with changing climate dynamics.

2:00 – 4:00 p.m., WC Pacific Room

Heather Hintz

Faculty Sponsor: Steve Taylor

Title: Land-Use History and Hydrologic Alteration in the Upper Willamette Basin

Abstract: The upper Willamette basin from Eugene to Albany was settled by Euro-Americans in the 1840's. Since then, the Willamette River had been a vital part of the economy and way of life. The river was historically the fastest and safest way to transport goods and people. Over time, this river section has been altered from multiple channels to a simplified and often single channel system (Benner and Sedell 1997). Settlers simplified channels by constructing 'cut-off dams', draining wetlands, and diverting secondary channels. With a simpler channel, the river travels at a higher velocity, inducing bank erosion and channel bed degradation. Additional alteration of channel hydraulics resulted in greater floodplain recurrence intervals in the mid-valley, and provided a measure of flood control. Even though similar processes may occur naturally, they span a greater time frame compared to the effects of human alteration. River restoration in the upper basin is currently underway. Local dam removal and wetland enhancements are helping to bring the river back into harmony.

2:00 – 4:00 p.m., WC Pacific Room

Kristin Mooney

Faculty Sponsor: Steve Taylor

Title: Earth Kills! – Geomorphic Hazards in the Willamette Basin, Western Oregon

Abstract: Every year, lives are lost, and many people lose a great deal of money in property damage due to naturally-occurring surface processes. Decreasing the risk posed by these hazards costs money, but can save lives. Geomorphic hazards in the Willamette Basin include flooding, debris flows, landslides, and stream bank erosion. Risk increases with population growth and expansion into hazard-prone areas; for example floodplains, hillslopes, riparian areas, or any combination of these. Increased mitigation and risk reduction is increasingly more important to the safety and welfare of Oregonians. Strategies for reducing these hazards often fail, mainly due to lack of scientific information and unawareness by policy makers. Many

times local governments, which are not well informed, are put in charge of handling the hazard. Such strategies often do not take into account the actual risk posed by the hazard, the underlying geomorphic processes, or the appropriate mitigation technique. We live in Oregon and it is important for us to be aware of the geologic hazards that we may encounter. It is also important for us to have knowledge on how these hazards can be properly mitigated, so that we can make informed decisions. This paper provides examples of case studies related to geomorphic hazards in the Willamette Basin.

2:00 – 4:00 p.m., WC Pacific Room

Matt Buche

Faculty Sponsor: Steve Taylor

Title: Landslide Processes in the Oregon Coast Range: Willamette Valley's Western Margin

Abstract: The Oregon Coast Range (OCR) forms the western highlands of the Willamette River basin. Rates and mechanisms of mass wasting are influenced by lithology, bedrock structure, climate, and tectonics. OCR mass wasting processes are complex because of a complicated geologic history and dynamic climo-tectonic setting. Significant landslide terrains are associated with the Eocene deltaic fan deposits of the Tyee formation, which experienced uplift during the late Miocene. South-to-north facies progradation of deltaic-submarine ramp deposits is responsible for the two dominant slide types of the area: deep-seated landslides ($>0.1 \text{ km}^2$) and shallow, rapidly moving debris flows. Research on deep-seated landslides suggests that their impacts on hillslope and river morphology are underestimated. Debris flows have been extensively researched because of their sensitivity to climatic drivers. The inclement weather of the February and November, 1996, storms caused numerous debris flows and spawned political debates concerning forest harvesting practices and their effects on slope stability. Continued research on mass wasting processes is critical for developing environmental policies that conserve natural resources, salmonid populations, and human life.

2:00 – 4:00 p.m., WC Pacific Room

Donnie Kasper

Faculty Sponsor: Steve Taylor

Title: Landslide and Debris Flow Occurrence in Headwaters of the Willamette Basin

Abstract: There are many mass movement processes that affect the terrain we live in. This is extremely evident here in the Willamette Basin. We are surrounded by mountain ranges; to the east are the Cascades, and the west, the Coast Range. Steep mountain slopes combined with intense precipitation patterns render this region particularly prone to landslides and debris flow. These processes are in some cases deadly, and result in millions of dollars in property damage annually. Mass movement processes in upland subbasins of the Willamette include creep, earthflow, landslide, slump, and debris flow. These processes have different magnitudes and frequencies, depending on terrain factors and landuse history. Climate, snowpack, road cuts, vegetation, timber harvesting, hillslope gradient, geology and soils are all factors controlling the occurrence of these mass movement processes. Understanding of these processes is critical for the development of regional watershed management and hazards mitigation plans.

2:00 – 4:00 p.m., WC Pacific Room

Emily Hardy

Faculty Sponsor: Steve Taylor

Title: Biogeomorphic Considerations in the Willamette Valley: Ecological Response
Geomorphic Disturbance Regime

Abstract: The Willamette Valley, nestled between the Coastal and Cascade mountain ranges, is home to more than just the college students of Western Oregon University. Different geomorphic conditions within the valley are ideal habitats for diverse plant communities. *Quercus* (oak) woodlands, *Pseudotsuga* (Douglas Fir)-dominated forests, and grassland ecosystems blanket the landscape, yielding a variety of native flora. This species-rich region is susceptible to environmental disturbance, both man-induced and natural. Fires, landslides, debris flows, and floods are some of the ecosystem-altering events that occur with relative frequency in both the headwaters and valley bottoms. An understanding of regional geomorphic processes yields insight into the patterns of vegetative succession. In particular, case studies of environmental gradients are considered with a focus on plant associations, disturbance patterns, and the processes by which systems recover over time.

2:00 – 4:00 p.m., WC Pacific Room

Shawn Coreson

Faculty Sponsor: Steve Taylor

Title: Vegetative Response to Landscape Disturbance: Is There a Correlation Between Debris-flow Type Disturbances and Invasive Species in the Oregon Coast Range?

Abstract: The Willamette Basin of western Oregon is associated with a wide variety of geomorphic and anthropogenic disturbances in riparian zones. These processes include timber harvest, cultivation, flooding, and mass wasting (landslides and debris flows). Riparian areas are particularly vulnerable to habitat disturbance. Because debris-flows transfer large amounts of soil, rock and organic material, extensive scour and deposit zones are formed. These disturbed stream channels and riparian areas are well suited for vegetative colonization from both native and invasive species. Investigation of invasive plants suggests that while plant communities vary in their susceptibility, invasion may be dependent on the type of soil disturbance, or at least increase the likelihood that an invasive plant might occupy an area. The migration and distribution of both native and invasive plant species have important ecological implications for river restoration and regional land management strategies.

2:00 – 4:00 p.m., WC Pacific Room

Kevin Friscia

Faculty Sponsor: Steve Taylor

Title: Geomorphology and Ecosystems: Riparian Plant Associations in Mountainous Landscapes of Western Oregon

2:00 – 4:00 p.m., WC Pacific Room

RC Mock

Faculty Sponsor: Steve Taylor

Title: Geomorphic Response to Forest Practice in the Willamette Basin

Abstract: Willamette Basin forests are suffering from a diminishing energy supply and a loss of ecosystem services. Forest practices are associated with increased soil erosion and landslides. With disturbed soils, watershed productivity has historically experienced declining trends. In order to maintain optimum levels of forest production, balanced by minimized geomorphic effects, alterations in forest practice is a necessity. This paper examines the relationship between timber harvesting methods and erosion processes in upland basins of the Western Cascades. The effects of road construction and clearcutting are examined.

2:00 – 4:00 p.m., WC Pacific Room

Levi Hogan

Faculty Sponsor: Steve Taylor

Title: The Influence of Timber Harvest on Sediment Transport in Headwaters of the Willamette Basin

Abstract: Uplands of the Willamette Basin are home to a very productive temperate forest and associated timber industry. With this valuable economic resource comes the concern that logging activities may increase hillslope sediment erosion and consequently impact water quality, channel stability, and riparian ecosystems. In the 1950s, a series of watershed experiments were initiated at the H.J. Andrews Experimental Forest. This 30 year examination of hydrologic, geomorphic, and biological effects of timber harvest provided substantive data on sediment transfer in three separate forested watersheds. A separate study explored the 50-year record of sediment accumulated behind the reservoir at Dorena Lake elsewhere in the Western Cascades. Both studies, the focus of this presentation, provide insight into the effects of timber harvest on the discharge rates of water and sediment in headwater basins of the Willamette. Results indicate that logging does impact sediment transfer. However, the connection between the two is more complex than a simple associative relationship. Many other variables must be taken into account to fully understand the dynamic relationship between logging and water quality.

2:00 – 4:00 p.m., WC Pacific Room

Allison McGonagle

Faculty Sponsor: Steve Taylor

Title: Effects of Forest Roads on Hillslope Hydrology and Sediment Production in the Willamette Basin

Abstract: Upland areas of the Willamette Basin are associated with a long history of logging and related road construction. Sediment derived from forested areas can greatly impact the rates of geomorphic processes and water quality in downstream areas. Soil erosion on forest

roads can come from many different sources, with controlling variables that include slope angle and spatial position. A key event that has been subject to much research is that of the 1996 storm and flood in western Oregon. Intense rainfall caused widespread erosion in forested areas. Road erosion was dependent upon local geology, forest condition, and construction style. In addition, soil texture and degree of vegetative cover also played a role in controlling erosion rates. Forest roads in clear-cut areas were associated with significantly more sedimentation and higher erosion rates.

2:00 – 4:00 p.m., WC Pacific Room

Alicia Thompson

Faculty Sponsor: Steve Taylor

Title: Dams and Gravel Mining: Alteration of Riparian Ecosystems and Watershed Function in the Pacific Northwest

Abstract: Did you know that there are nearly 75,000 dams in the continental US and they are wreaking havoc on river hydrology and ecological services across the country? These dams were built with good intentions such as providing jobs, flood control, and energy production. However, dams have significantly impacted river hydrology and riparian habitats. Here in the Pacific Northwest, there are 2,048 dams and many are no longer in use. There is currently a trend by some river managers to remove dams and restore rivers to their unaltered state. Several of the related problems identified in the Northwest include the amount of sediment accumulated behind the dams, downstream erosion, and the practice of in-stream gravel mining. Gravel mining involves the removal of sediment from the channel for use in construction materials. Gravel mining adds to the effect of downstream erosion with significant alteration to the channel bed, armoring of gravel, and loss of spawning habitat for salmonids.

2:00 – 4:00 p.m., WC Pacific Room

Patrick Stephenson

Faculty Sponsor: Steve Taylor

Title: Landuse and River Restoration in the Willamette Basin: Linkage Between River Management, Geomorphic Process, and Salmonid Recovery

Abstract: The Willamette Valley is set in a dynamic landscape characterized by mountainous river systems, recreational water ways, a world renowned sport fishery, and prosperous agriculture. If these natural resources are not carefully restored and managed, they may be lost forever. River restoration projects are commonly used where waterways have been damaged by human impact. Current studies are focused on determining the natural variability of river systems and restoring natural processes to pre-settlement conditions. In order to reach this goal of natural river restoration, several criteria must be met: (1) understanding of river complexities and geomorphic process, (2) development of theoretical similarities between river systems,(3) formulation of new criteria and standards for monitoring techniques, (4) practical application of scientific modeling, and (5) development of effective models tempered by economic and social realities. With these methodologies, current river systems may be restored and future damage may be entirely avoided. This paper examines the river restoration process, with examples of work in the Willamette Basin.