

NS481/581 Introduction to Watershed Analysis and Luckiamute Watershed System

I. Introduction

A. Luckiamute Watershed = Focus of NSSI Interdisciplinary Science Course

1. Forms portion of the upper Willamette River system
2. Luckiamute river drains from central Coast Range east to Willamette
3. Why the Luckiamute?
 - a. close to WOU Campus, our home
 - b. easy access
 - c. serves as a natural boundary for study
 - d. forms part of world-class landscape in western Oregon

B. Watershed Concept

1. Collection of inter-related:
 - a. Topographic elements
 - (1) shape of landscape (flat, mountainous, etc.)
 - (2) slopes under the influence of gravity
 - (a) drainage of water and sediment
 - b. geologic elements
 - (1) bedrock composition (igneous, sedimentary, metamorphic)
 - (2) plate tectonics
 - (a) plate boundary vs. no plate boundary
 - (b) active tectonic setting
 - i) convergent
 - ii) divergent
 - iii) transform
 - (3) surficial deposits
 - (a) loose, unconsolidated materials at Earth's surface
 - (b) in general: soil and sediment at surface
 - c. climate / meteorological elements
 - (1) cold / warm
 - (2) dry / wet
 - d. hydrologic elements
 - (1) types and numbers of rivers
 - (2) flood-disturbance patterns
 - (3) groundwater use / spring discharge to surface
 - e. biotic elements
 - (1) flora
 - (2) fauna
 - f. cultural elements
 - (1) social framework
 - (2) land use patterns
 - g. Environmental Quality
 - (1) soil / water quality
 - (2) anthropogenic contamination
 - (3) human care and interaction with landscape

II. Fundamental Concepts of Natural Science and Earth Science

A. Fundamental Elements of Earth Science

1. Time
 - a. Time Frame
 - (1) Age of Earth ~ 4.6 billion years and counting!
 - b. Question: what is time and how is it measured?
2. Processes
 - a. e.g. volcanic eruption, river erosion
3. Processes + Time = Rates of Processes
 - a. how fast?
 - b. e.g. rate of lava production from a volcano
4. Material / Products
 - a. volcanic rocks
 - b. What is the volume of rock associated with Mt. Hood?

B. Spatial Scales

1. What is the scale at which we examine the Earth and it's components?
 - a. micrometers? mm? cm? m? km? 1000's of km?
2. microscopic to global

C. Temporal Scales

1. What is the time frame over which we examine the Earth and it's processes?
 - a. microseconds? seconds? minutes? hours? days? years? millions of years?
2. Scaling of Rates
 - a. how fast over how long?
 - b. slow processes over long periods = big change!

III. Morphology of Drainage Systems

A. Watershed - a network of stream and/or river tributaries that merge into one, common channel outlet.

1. Stream - channelized flow of water at the Earth's surface, under the influence of gravity
 - a. stream channel = "gutter of the continents"
2. Stream Tributaries - branches of channels that merge at confluences
 - a. Essentially valley systems in which topography results from fluvial erosion of landscape
3. Dynamic Equilibrium
 - a. Through Time: overall absolute elevation/relief diminishes through time via erosion and landscape degradation
 - (1) However, the overall relative relief or "graded profile" of the drainage basin will be maintained over time via dynamic equilibrium
 - b. I.e. The drainage basin systematically adjusts its morphology as landscape is denuded through time

- c. Landscape erosion / denudation is balanced by tectonic uplift / landscape construction
 - (1) e.g. volcanic eruptions build volcanoes, glacial erosion removes them
 - 4. Morphometry: systematic quantitative description of a drainage basin
 - a. Quantitatively describing and comparing geometric features of drainage basin
- B. Morphologic Features of Drainage Systems

- 1. Drainage Basin: spatially restricted network of branching surface streams/streams. aka a "watershed"- an area that contributes overland flow and groundwater to a specific stream network.
 - a. Drainage Divide: upland flow separation between runoff that descends in the direction of the drainage basin in question and that which goes toward and adjacent basin.
 - b. Drainage Net: the complex of streams within a drainage basin.
 - c. Nested drainage basins based on scale
- 2. Topographic Considerations
 - a. Valley- lowlying area that is totally or partially occupied by a stream channel

Includes: stream channel, adjacent floodplain, and valley sides. Valley bottoms may be narrow or extensively wide Valley sides may be gentle or very steep.

- b. Interfluvium- the high land above valley sides that separates adjacent valleys ("between rivers"). May be sharp and well defined or broad and diffuse upland drainage divides.
- 3. Stream Order Hierarchy: organization of drainage basin tributaries according to relative size (Horton, 1945; Strahler, 1952)
 - a. Stream Orders: hierarchical ranking of stream size within a drainage basin
 - (1) First order- smallest unit in system, represents a single tributary in a net.
 - (a) small scale tributaries in headland region of basin
 - (2) Second order- a stream formed by two first order streams coming together
 - (a) Medium scale tributary
 - (3) Third order- a stream formed by confluence of two second order streams
 - (4) Fourth Order: larger scale drainage basin

- b. Drainage Basin Classification: based on largest order trunk stream draining basin
 - (1) e.g. 5th order Basin = drained by 5th order trunk stream, etc.

IV. Fundamental Quantitative Parameters

- A. Slope or Gradient = rise / run
 - 1. $S = \text{change in elevation} / \text{change in horizontal distance}$
- B. Discharge (associated with flowing liquids)
 - 1. $Q = \text{volume of displacement} / \text{time}$
- C. Area = length * width
- D. Volume = length * width * height
 - 1. Volume = Area x Depth
- E. Elevation = height of point, vertically above or below sea level
 - 1. Relief = change in elevation between two points
- F. Angular Measurement
 - 1. degrees
 - 2. 1 circle = 360 degrees
- G. Map / Compass Bearings
 - 1. north, south, east, west
 - 2. North
 - a. True North = geographic north pole (rotational axis)
 - b. Magnetic North = magnetic north pole
 - 3. Azimuth Bearings (measured in clockwise angular direction from 0)
 - a. Due North = 0 degrees
 - b. East = 90
 - c. South = 180
 - d. West = 270
 - e. Northwest = 315... etc.
- H. Aspect = direction of landscape element relative to dominant orientation of incoming solar radiation
 - 1. e.g. south-facing slope vs. north-facing
 - 2. measured as an azimuth
 - a. e.g. if your house is built on a hillslope that has an aspect of 90 degrees, your house will face due east and you will have a great view of the Cascades.