ES476 Hydrology Class Field Trip Feb. 8, 2016
Corvallis Science Pub, Gordon Grant, U.S. Forest Service, Pacific Northwest Research Station
"Water in the West" Summary Notes

Introduction

Trivia Quiz Questions on Willamette Valley Hydrology

> December = the wettest month of year on average; over 20 significant dams in Willamette Valley, Municipal Water Supply is not a common use of dams in WV (flood control, recreation, hydro power), Clear Lake is in the McKenzie River basin, cutting trees in forest results in increased Q in rivers over time, Coast Range Watersheds and Cascade Watersheds are different (different geology, age of rocks, rock types), High Cascade volcanic rocks store enough groundwater to equal that of Lake Meade NV,

Climate Change and Future of Water Use in the West (with focus on Willamette Valley)

Water Resources: quantity + quality + purpose of use = who decides on management policy?

Humans and the Hydrologic Cycle: drought------ "Panic" --------rain----------floods ----------apathy

Rainfall patterns in western U.S.: PNW northern CA, OR, WA = high rainfall in western regions of states; 100 deg. West longitude and western Interior = semi-arid to arid (10-20 in / yr)

Willamette Valley Landuse: 5% urban, 20% agriculture, 70% forestry

Mediterranean Climate; peak rainfall in December; highest rates

"Water year" = Oct 1 to Sept 30 of each year, the year in which it ends in Sept; so for example, we are currently, as of 2/24/16, we are in Water year 2016, which will end Sept. 30, 2016.

Willamette 2100 project – climate predictions using climate models for the next 100 years, project based at Oregon state University

> Climate models indicate warming average monthly and annual temperatures, receding snow pack to higher elevation peaks in Cascades, the same to increased rainfall each year, average annual temp. increase from 46 F to 54 F, more precipitation as rain, less precipitation as snow, decreased snow pack, flashy seasonal runoff in rivers, minimal modulation by snowmelt in summers; moral of story more precip. as rain, less snow pack ===== groundwater will become important to seasonally modulate river flows during the dry months.

Cascadia Geologic Framework

Controlling Factors in Western Oregon: bedrock geology (age of rocks, petrogenesis), tectonic setting, location, elevation and infiltration rates…

> Moral of Story: Western Cascades and Coast Range = old, lower permeability rocks; High Cascades = younger, higher permeability volcanic rocks

Rain Shadow / Orographic effect with westerly airflow from Pacific; lifting and rain over coast range, lifting and precipitation over High Cascades; High Cascades on average receive ~100 inches of precip. per year (rainfall equivalent); infiltration rate is high in young volcanic rocks, recharge of high cascades bedrock aquifers, feeds upper reaches of rivers in Deschutes and Willamette Basins. McKenzie River = poster child of groundwater fed springs, big spring discharge

The young "High Cascade Aquifer system" extends from Mt. Lassen in northern California through Oregon, to north of Mt. Adams in Washington.

Age of Groundwater in High Cascades Aquifer: ~10 years from meteorologic precipitation to infiltration to discharge in rivers (based on isotope analysis as tracer). Winter season – river flow charged with young water; Summer season – groundwater dominated by older water

Groundwater dominated basins include Clackamas, Mckenzie, Santiam; 30% of summer flow in Willamette River / Portland comes from McKenzie river (~12 big spring discharges); moral of story: High Cascade Groundwater modulates summer dry season / flow in rivers, very important resource

Western Cascades and Coast Range basins are more flashy and seasonal in discharge, less groundwater modulation (older, less permeable rocks, scrappy aquifers). Rivers in these areas more seasonal, with winter flooding the norm (dams and flood control notwithstanding).

Water Policy, Management and Future Climate Change in the Willamette Valley

Four Main Actors (Controlling Variables):

(1) climate/seasonal temperature/precipitation rates: projected to increase average annual temp., increase rainfall, decrease amount of snow pack, increase seasonal/flashy river discharge (> pronounced wet and dry month conditions with decreased modulation by snow pack / time-release melt and runoff.
(2) Drainage Efficiency: ratio of runoff to infiltration (based on geology: Western Cascades + Coast Range = old, less permeable rocks, more runoff per unit area / less infiltration to groundwater; High Cascades = young, more permeable volcanic rocks / less runoff per unit area more infiltration to groundwater
(3) Vegetation / Forest Cover / Landuse = controlling amount of plant uptake and evapotranspiration; more trees and forest cover, hold more water in biological storage, reduce water available for runoff; less trees and forest cover, holds less water in biological storage, increase water available for runoff.
(4) Humans / Water Policy / Dam Management: how many dams, how much storage capacity, how will dam storage be managed seasonally; how is water used throughout the year==== urban vs. agricultural use vs. forest management

Climate variables: rain vs. snow, temperature / timing of precipitation, total amount of precipitation, vegetative growth cycles vs. seasonal precipitation patterns, snow/rain mix according to elevation

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Model predictions from Willamette 2100 project: avg. annual temperature will raise by 1.5 deg. C by 2025, wetter / rainy winter season, decreased snow pack, snow melt will happen quickly and early in spring, summer low flow season will happen earlier in year (more flashy conditions=== on / off, less modulation by snow melt). The prediction is for increased risk of “snow drought” = enough precip.; but falling as rain, not snow (will result in strong summer, dry rivers)

High Cascades: increased rainfall, decreased snow (say good bye to Hoodoo Ski Area), groundwater modulation of dry season river flows will become very important.

Model Sensitivity / Predictions: northern Cascades (northern WA and BC) – river adjustments will be highly sensitive to snow pack loss; Central Cascades of Oregon into Northern CA will be more modulated by High Cascade aquifer / groundwater discharge.

Case study on McKenzie river in summer 2015 drought conditions: groundwater modulated the situation, the 1 year drought condition of 2015 did not have a significant impact of river flow (low sensitivity)… but could change in future if aquifers are depleted.

Cascades and dam building: most the dams in Willamette were built in 1960's as part of flood control; store water in winter, release in summer, ~20 dams in Willamette Basin; dam management modulates flashy-ness of river discharge, dampens in winter, props it up in summer; problem in 2015 winter drought, the dams did not fill to capacity and were largely dry in summer 2015; altered river management by Corps of Engineers.

Willamette Valley Water Management Implications

Dams are used for seasonal flow regulation, dampen winter wet season flows, increase summer dry season flows.

27% of water use in Willamette consumed by forest and trees; forests are biggest user of water in Willamette Basin.

Forest Disturbance: drought, fire, logging… all reduce forest consumption, result in short term gains in river discharge and runoff (regrowth after disturbance re-consumes more soil moisture)

Forest Management impacts surface water hydrology; Fire suppression – growth – water consumption –river drought

Increase forest cover > storage, < water loss from watershed

Climate change and population growth in Willamette Valley in coming decades will require more water resources, particularly in summer time. Wet winters and dry summers, with reduced snow pack will result in more dry season drought and water shortages. Glacial retreat, reduced snow pack, increased stream temperatures, reduced discharge in summer rivers.

A change in management strategy will be required to balance forest ecosystem needs vs. human water needs; possible actions include: aquifer storage recovery systems, increasing dam / reservoir storage capacity, permaculture techniques for tree production.

Oregon problems will be compounded by drought and water issues in California: water refugees moving to state, agriculture buy outs of large land tracts (moving central Valley ag. Northward), diversions from Oregon ground/surface water to southern California ("pipeline")

Moral of Story: Oregon has High Cascade Aquifer and groundwater storage / surface water modulation; southern California has older Sierra Nevada, limited groundwater resources + combined with potential for drought of surface systems

Increase dams, interbasin transfers, forest management, economic/social shifts in population… all real possibilities that are happening more and more… water wars could be upon us…