Hydrologic Response to Timber Harvest and Forest Management Practices in Western Oregon

Palmer Baldwin
Earth and Physical Science Department
Western Oregon University
Monmouth, Oregon
Email: pbaldwin15@wou.edu

Outline

- Introduction to the Hydrologic Cycle
- Methods/Locations
- Effects of Forestry Treatments
  - Streamflow/peak discharge response
  - Soil moisture response
  - Stream Temperature response
- Summary

INTRODUCTION

The Water Cycle

Water Storage

- Forest Canopy
- Snowpack
- Soil and Regolith

Movement

- Precipitation
- Evaporation
- Transpiration
- Snowmelt
- Throughfall

DISCUSS your PARAGRAPHS DATA

5/22/2019

[Diagrams and notes on the page]
Large increases in peak discharge after forest canopy removal
Decreasing effect over time
Proportional to canopy removal percentages
Consistent in all 3 locations

Soil moisture response

- Varies seasonally
- Plant cover decreases moisture content
- Wilting-point: no coming back
- Clearcut, broadcast burned forest examined

Soil moisture initially increases after treatment
Decreases after reclamation
Persistent deficit for remainder of study
Stream Temperature
- Stream temperatures legally mandated
- Temperature affects ecosystem service providers
- Currently measured on a scale that ignores local heterogeneity

Suspended Sediment Concentrations
- Outblocks accumulated more snow
- Increased snow = increased peak flow & increased mean daily discharge

- Spatial variability is higher in smaller order streams
- Land management models don't work on this spatial scale

Revegetation rapidly decreases soil moisture
- Persistent moisture decreases decreased forest regeneration
- Burning reduces wetability, infiltration
Suspended Solids

- Riparian treatments:
  - increase TSS, discharge in freshet events
  - increase daily peak discharge
  - increase snowpack accumulation
  - protect streambanks BUT alter balance

SUMMARY

- Increased canopy removal = increased runoff
- Increased roads = increased runoff
- Roads reroute surface and subsurface water flow
- Riparian treatments:
  - increase TSS, discharge in freshet events
  - increase daily peak discharge
  - increase snowpack accumulation
  - protect streambanks BUT alter balance
Sediment Dynamics and Erosion Response to Forest Management Practice in Western Oregon

Timothy B. Hagen
Earth and Physical Science Department
Western Oregon University
Monmouth, Oregon
Email: thagen15@mail.wou.edu

Outline

- Introduction
- Timber Harvest and Forest Management Practices
  - Locations: Western Cascades, Coast Range, PNW
  - Methods: Treated Vs. Untreated (Control)
- Effects / Response on Erosion Rates and Sediment Transport in Streams
  - Erosion Rates
- Summary / Conclusion

Outline and Overview

INTRODUCTION
Introduction
Sediment in the PNW
- Man made
- Natural
- Problems from sediment
- Fish
- Water quality
- Many experiments with data
- Sources type

Sediment erosion can happen in many different ways

Timber Harvest and Forest Management Practices

Locations
- PNW
- Western Cascades
- Controlled water sheds
  - H.J. Andrews
  - Alsea

Use Results / Adjust Consistency
Methods

Sediment monitoring equipment:
- Weirs
- Flumes
- Controlled experiments
- Logging methods
  - Clear cut
  - Patch cut

Clear cut from Watershed 1 H.J Andrews

Effects / Response on Erosion Rates and Sediment Transport in Streams

Erosion Rates

- Rates depend on method / location
- Weather
  - Storms
- Rates are highest after logging
- General trend
- Other reasons
- Fire
**SUMMARY & Conclusion**

The way we manage our forests greatly impacts sediment run-off. Rates are much higher after logging with weather. Black flies when ADP moves dirts with wind. Next year is worse.
Conclusion
Sediment erosion in the PNW is a problem for fish and water quality

The methods we used change rates of sediment run off

Sediment erosion is always highest after logging with wet months

The PNW is a prime location for sediment erosion
Forest Road Construction and Sediment Production in Western Oregon

Austin Wegner
Earth Science Department
Western Oregon University
Monmouth, Oregon
Email: awegner16@mail.wou.edu

Outline
- Introduction
- Areas of Study
- Treatment Methods
- Common Effects
- Corroborating Studies
- Results and Data
- Conclusion

Introduction
- Logging and logging roads have increased exponentially
- Roads are necessary for efficient harvesting and transport
- Mitigation of damage is the goal

Study Areas
- Western Cascades of Oregon
- Lookout Creek, Blue River Basin
- HJ Andrews Experimental Forest
- Alsea Watershed
**Treatment Methods**

- Road Grading
  - Helps to level the road
  - Ensures proper drainage
- Ditch Blading
  - Allows for more consistent sediment flow

**Treatment Methods**

- Vegetation removal
  - Decreases stability
  - Increases sediment transport
- Culverts
  - Helps direct flow
- Aggregate Distribution
  - Fines removal

**Common Side Effects**

- Debris Flow
  - Oversteepened slope
- Plugged culverts
  - Creates gullies
- Hillslope Side
  - Oversaturation and slope failure
- Increased turbidity

**Alsea Watershed Study**

**Fall 1998-1999**

3 Watersheds were involved

- Needle Branch Watershed (75 ha)
- Deer Creek (304 ha)
- Flynn Creek (202 ha) – Experimental Control

Treatments

- Needle Branch Watershed 85% clear cut
- Deer Creek Watershed 25% clear cut
- Flynn Creek left untreated
Alsea Watershed Study

- Focuses on long-term effects of sediment increase
- Some effects are immediate
- Changes in the environment can be seen years after treatment

Suspended Sediment by Year (Alsea)

- Deep Creek (25% clear cut)
- Needle Branch (82% clear cut)

Trask Watershed Study

- 5 Road crossings studied
- Sensors are placed above and below harvest site
- Measurements of turbidity, SSC, and discharge are taken
- Data is collected at 3 separate times in the forestry process
- Data is then analyzed and compared to determine statistical relationships
- 12 road segments split into 4 categories
  - No traffic, No ditch grading (NTNG)
  - Traffic and no ditch grading (TNG)
  - No traffic, Grading (NTG)
  - Traffic and Grading (TG)
- As similar environments as possible
- Trucks make 10 round trips per day from Nov. 15 to Dec. 14
- Sediment collected and measured in runoff tanks

- Sediment production during traffic period
- Sediment production post-traffic period (7 month span)

Summary and Conclusion

Acknowledgement Slide
Timber Harvest/Forest Management Practices

Methods
- Treated (harvested) vs. untreated forest areas
- Different "age classes" of trees
- Christine May study (2002) observes frequency of debris flows based on tree age
Styles of Mass Wasting/Controlling Factors

Slump
- Short mass movement
- Coherent mass
- Loose sediment
- Caused by:
  - Shaking
  - Excessive water
  - Loss of slope bed
  - Undercutting

Earthflow
- Downslope viscous flow
- Generally fine grained
- Flow of sediment
- Causes:
  - Gravity driven
  - Saturation of sediment load
  - In between creep and mudflow

A slump with an earthflow at the base
Landslide

- More broad category name
- Involves processes less associated with water
- Can be a part of complex terrains
- Contributes to other mass wasting events

Controlling Factors

- Three main contributing factors to mass wasting events
  - Vegetation: soil stability
  - Water Saturation
  - Underlying Geology/Sediment loads

Effects of Forest Management on Mass Wasting

[Diagram and text not clearly legible due to handwriting and annotations]
Deep Seated Landslides
- Much greater effect on river environment
- As well as surrounding topography
- Initiated by seismic activity, stream erosion, high groundwater levels
- https://www.youtube.com/watch?v=SK54A128g

Effects of Deforestation

We need some actual science/data in your milk

DSL data

Shallow Landslides/Debris Flow

Show Data Discuss Results??

Show Flow
SUMMARY

CONCLUSION

Acknowledgements
Perspectives on Climate Change and Forest Hydrology in the Oregon Cascades

Samantha Abel
Earth and Physical Science Department
Western Oregon University
Monmouth, Oregon
Email: sabel14@wou.edu

Outline

- Introduction
- Climate & Climate Change Models
  - Historic / Present Models
  - Predicted Future Models
  - Implications on Forest Management
  - Conclusion

Introduction

- Willamette Basin
- Climate change
  - Less snow/pack
  - Earlier melt
  - Drier summers
- Oregon Cascades
  - Western Cascades
    - Surface flows
  - High Cascades
    - Spring-fed

CLIMATE & CLIMATE CHANGE MODELS

Historic / Present Models
Graphs of elevation's impact on SWE-P, causing changes in precipitation modes over the year; (E. A. Sproles et al., 2017)

Snowpack
- + 2°C model
- WY 2014 above average
- WY 2015 well below
- April 1 storage
- 1300–1800 m
- WY 2015: snow free

Rain-on-Snow Events
- Largest floods were 1995
- 26 storms from 1992 to 2012
- Outflow positively related to precipitation
- < 4 mm hr⁻¹
- Precipitation pulses = pulses of net outflow
- 12–32 hrs

Rain-on-Snow Events
- Feb 2, 1996 event
- Wavelet coherence
  - 1 = high degree of precipitation-outflow
- Black contours = statistically significant coherence
- N = net snowpack outflow
CLIMATE & CLIMATE CHANGE MODELS
Predicted Future Models

Evapotranspiration
- Above: just mean ET
- 40% increase in evaporative demand
- Below: vegetation change, soil water, vapor pressure, CO₂
- General decrease
- Additional 11-18% reduction by CO₂

Leaf Cover
- Private vs. public ownership
- Effects forest rates
- Highest ET at mid-elevations, high LAI
- LAI decrease 12-30%

Implications on Forest Management
- Climate change
  - Drier summers
  - Greater reliance on Western Cascade flows
- Less fish habitat
- More flood risk in winter
  - Early melt
- Problems of water use in the dry season

5/22/2019
Vulnerability of human-natural system

**Sensitivity**

- Human conditions: types of actors and institutions, management characteristics
- Environmental conditions: geology, elevation, drainage characteristics, snow accumulation & melt patterns, climate

**Response capacity**

- Human systems: existing programs, policies, & regulations
- Natural systems: existing and altered watershed attributes

Adjustment & adaptation

Model used to assess a sector's vulnerability to climate change and streamflow alteration; (K.A. Farley et al., 2011)

---

**Conclusion**

- Climate change
  - Drier summers, wet winters
  - Early melt, r-o-s
  - Snowpack retreating
  - Rain-snow transition line already shifting up elevation

- Leaf cover expected to decrease
  - Fire
  - Timber harvest
  - Overall evapotranspiration decrease
  - Some sectors prepared, some not

---

**ACKNOWLEDGMENTS**