Physiographic Drivers of Snow Water Storage – Modeling the Spatial Distribution of Our Water & the Suitability of Our Monitoring Network

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GEO 580 – June 1, 2011
Measured SWE at Santiam Junction on April 1 (Elevation 1143 m)

Less snow – more uncertainty?

Decline = 8 mm / year ***
Water Volume Loss in a 500-m Elevation Band = 0.5 km³
NRCS SNOTEL sites miss the high elevation snow.
Average SWE and Snow Covered Area in April 1, 2009

Created by Kelly Gleason - May 2011
Data Source – SNOTEL (NRCS) & SWE (SnowModel – Courtesy of Eric Sproles)
Average SWE and Snow Covered Area in April,

Created by Kelly Gleason - May 2011
Data Source – SNOTEL (NRCS)
& SWE (SnowModel – Courtesy of Eric Sproles)
Questions

• What are important physiographic drivers of snow accumulation processes in the Western Oregon Cascades?

• Can a landscape-based Binary Regression Tree model be used to predict snow distribution, depth, and variability in the McKenzie River Basin (3,000 km²)? N. Santiam River Basin? Willamette River Basin (30,000 km²)?

• Can this characterization be used to distribute a representative monitoring network to capture the future spatial variability in snowpack?
Objectives

• Use physiographic variables to develop a landscape-based model to characterize SWE within the McKenzie River Basin.
• Use that model to classify SWE in nearby watersheds.
• Randomly select objective and representative monitoring network.
ArcGIS Methods

• Import physiographic and modeled SWE data
• Zonal statistics with elevation
• Extract physiographics and SWE in Mckenzie River
• Develop BRT snow classification model based on landscape characteristics
• Use this BRT to develop GIS analysis model to predict SWE using landscape physiographics
• Select representative sampling locations
• Test on N.Santiam River and extrapolate to Willamette River
## Binary Regression Tree

R = 0.95 **  
RMSE = 0.11  

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<th>Elevation</th>
<th>Veg Class</th>
<th>Other</th>
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Molotch and Bales, 2006
Observed SNOTEL SWE (m) & BRT Expected SWE (m) at Sampling Points & Total SWE Volume across Willmette River Basin, Oregon
Not all areas land available – used criteria selection model

• In Raster Calculator:

\[(\text{binary public}) \times (\text{buff 500 - buff100}) = \text{available land for sampling sites}\]

• Used output to extract by mask BRT Classes area
• Created random raster w/in extracted BRT area to determine random location that meets criteria
Binary Selection Model to Select Public Land & 200-500 m of Road

Federal Lands in the McKenzie River Basin

500 meter Buffer of Roads in the McKenzie River Basin

100 meter Buffer of Roads in the McKenzie River Basin

×

−

Public Land within 200-500m of Road in the McKenzie River Basin

Legend

- SNOTEL
- Hwy
- Yes
- No
- Meets Criteria
- McKenzie

Created by: Kelly Gleason - May 2011
Data Source: Willamette National Forest
DEM - SRTM, SNOTEL - NRCS
BRT Snow Classes within Available Land
(Public Land within 200-500m of Road)
in the McKenzie River Basin

Legend
- SNOTEL
- Hwy
- BRT Classes

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
mckenzie

Created by: Kelly Gleason - May 2011
Data Source: Willamette National Forest
DEM - SRTM, SNOTEL - NRCS
Randomly Selected Sampling Locations within Each BRT Snow Class

Legend
- BRT Points
- SNOTEL
- Hwy
- BRT Classes
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15

Created by: Kelly Gleason - May 2011
Data Source: Willamette National Forest
DEM - SRTM, SNOTEL - NRCS
Conclusions

• BRT landscape classification shows promise for characterizing snow zones – but difficult to validate using point based SNOTEL information.
• Current underestimation of SWE by model to be further calibrated & validated using fractional snow covered area remote sensing model.
• Present-day snow monitoring sites will not be in representative locations in the future – need an objective approach to monitor climate impacts.
Questions?