Application of A Land Surface Model For Drought Monitoring And Prediction In Washington State

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Outline

- Introduction
- Issues
- Methodology
- UW Hydrologic Monitoring System
- Performance Evaluation
- Summary and Future work
Drought: The Creeping Disaster

- 20 major drought events since 1900
- $400 million lost in 2001 and $300 million lost in 2005, mostly in the agricultural sector

**Motivation:**

Provide objective measures of climate and hydrology to help characterize and predict drought in Washington State.
ISSUES
Current WA State policy defines drought as occurring when "water supply falls below 75% of normal" (CHAPTER 173–166 WAC)
Drought: The 75% Rule

Spatial variability

Snow Water Equivalent

Seasonal variability

Runoff (5-day average)
Current Drought Assessment: Coarse Spatial Scales

10 Climate Divisions vs 62 Water Resources Inventory Areas (WRIAs)
Current Drought Assessment: Large Weight to Traditional Drought Indices

Objective *Long-Term* Drought Indicator Blend Percentiles

January 12, 2008

**Western Formulation Inputs (as percentiles):**
- 30% Palmer Hydrologic Index
- 30% 60-Month Average Z-Index
- 10% 60-Month Precipitation
- 10% 24-Month Precipitation
- 10% 12-Month Precipitation
- 10% CPC Soil Moisture Model
Drought Severity depends on

- Precipitation
- Temperature
- Hydrological condition
- Socio-Economic Condition

Hydrologic Model-Based Indices

- Complex Water Balance Model
- Simplified Water Balance Model
- Cold Season Process
Methodology
Variable Infiltration Capacity (VIC) Model

Precipitation, Temperature

Soil moisture and runoff percentiles

Soil moisture and runoff
(Standardized Runoff Index)
(Shukla and Wood, 2008)

Current compared with the historical climatology (1915-2005)
Drought Indices

The plots below show current percentiles for soil moisture and SWE relative to a recent climatological period. These will update daily with a lag of ~2 day.

<table>
<thead>
<tr>
<th>Current Plots</th>
<th>SM</th>
<th>SWE</th>
<th>Basin Averages Plots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Plots</td>
<td>1 day</td>
<td>1 week</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Runoff</td>
<td>Not Available Yet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Real-time Water balance plots

http://www.hydro.washington.edu/forecast/sarp/
Soil Moisture & SWE Percentile Plots

Soil moisture percentile

Snow Water Equivalent*

percentile

* Amount of water contained in the snowpack
Water Balance Plots

Current Water Year
Long term median

Current conditions and minimum, maximum, and quartiles from 1971-2000

Precip (cumulative)
Temperature
Soil Moisture
Snow Water Equivalent
Runoff (cumulative)
Runoff (5-day average)
Drought Indices

The plots below show the values of Drought Indices (e.g. PDSI, PMPDI, CMI, ZIN). These plots are being updated at the lag of 1 week.

NOTE: This site is under development.
Performance Evaluation

Statewide 2005 Drought

Warning signs point to a wilting summer
By Hal Bernton
Seattle Times staff reporter

ZILLAH, Yakima County — Ric Valicoff and his Yakima Valley neighbors live on the drought frontline, reliant on Cascade snowmelt to grow apples, cherries, grapes and other fruit.

This year, the snowpack is a bust, and the bare mountain slopes may offer an unsettling peek into the future.

Today, Washington Gov. Christine Gregoire declared a statewide drought emergency, directing her Emergency Drought Committee to gear up an emergency command center, track and coordinate responses by state agencies and make sure state resources reach where they are needed, according to the Associated Press.
2005 Drought: Water Balance analysis

- Snow pack was 26% of average as of April 1st
- Precipitation was between 51 and 76% of average
- Streamflows were between 22 and 90% of average

(Source: WSDA, http://agr.wa.gov/Environment/Drought/)
USDM vs. Soil Moisture-Based Drought Analysis

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**Intensity:**
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

**SM percentiles**
- 11-20%  \(D1\)
- 6-10%  \(D2\)
- 3-5%  \(D3\)
- <2%  \(D4\)

Drought Monitor  Jan-2005  Soil moisture Percentile

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Drought Map

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Soil Moisture Map
USDM vs. Soil Moisture-Based Drought Analysis

March-2005

Sep-2005
A snow-depth gauge that would normally measure several feet of snow this time of year has no snow to measure at the USBR data collection site.
Future Directions: Model-based Outlooks

Soil moisture forecasts

![Graph showing soil moisture forecasts from February 2005 to September 2005. The graph includes Actual SM Percentile and Ensembles lines, with a vertical dashed line indicating March and a horizontal line showing a percentile value of 0.20.](image-url)
Future Directions: Model-based Outlooks

Soil moisture forecasts

![Graph showing soil moisture forecasts from June 2005 to September 2005. The graph includes lines representing Actual SM Percentile and Ensembles. A dashed line indicates the month of September, with a horizontal line at 0.20 representing the percentile value.]
Summary

- The hydrologic model provides useful information for monitoring drought
- It is a potentially viable tool for state-level drought management

Future Work

- Addition of ensemble hydrologic predictions
- Focus on communication of model-based drought information
Acknowledgements

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Thank you!

ON THE BRIGHT SIDE, THE DROUGHT HAS MADE RESERVOIR SECURITY MUCH EASIER.

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http://www.hydro.washington.edu/forecast/sarp/index.shtml
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