Using NOAA Hydrometorological Testbed Soil Moisture Observations in Flood Forecasting

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Goal: Improving Flood Forecasting Using Soil Moisture Observations

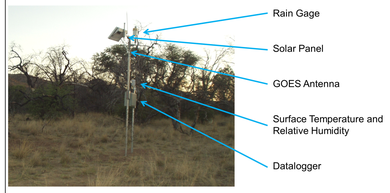
The Hydrometeorology Testbed (HMT) soil moisture observing networks have been conceived and deployed to provide soil moisture observations for NWS operations, hydrological model development, climate research, state governments, and water resource management communities.

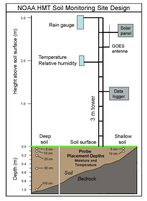
- Hydrometeorology Testbed - West (22 observing stations)
- Hydrometeorology Testbed - Southeast (7 observing stations)
- Hydrometeorology Testbed - Arizona (6 observing stations)
- Hydrometeorology Testbed - Colorado (2 observing stations)

Question: Can the HMT Soil Moisture Observations be used operationally to forecast saturation excess flood events?

Soil Moisture Observing Platform

A Typical Soil Moisture Observing Station

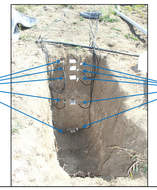




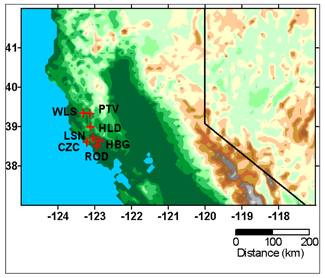
Two minute averages of each variable are computed and transmitted hourly to Boulder.

Custom calibrations are derived for each station using gravimetric sampling.

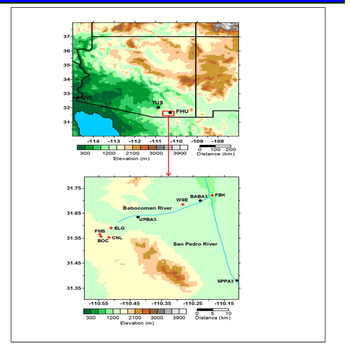
The high temporal sampling rate used makes it possible to study the response of the soil on time scales ranging from sub-hourly to decades.



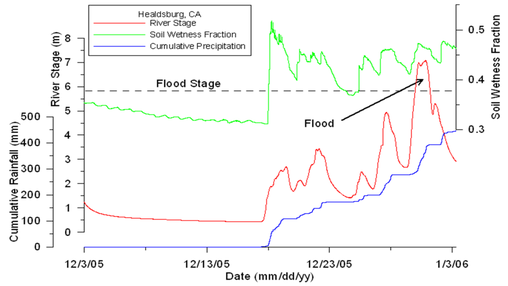
California Russian River Basin



Arizona Babocomari River Basin

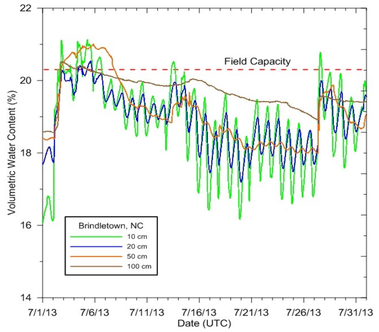


California Russian River, Flood 31 December 2005 – 3 January 2006



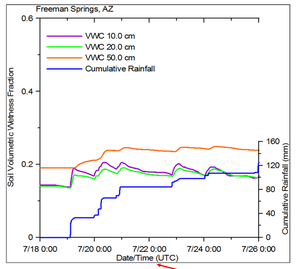
- Precipitation associated with a series of winter storms fell on nearly saturated soil and brought the soil well above field capacity (0.35)
- Once the soil reached field capacity, river flow responded rapidly to each successive storm event
- Flooding coincided with an Atmospheric River event that produced 110 mm of precipitation in the basin

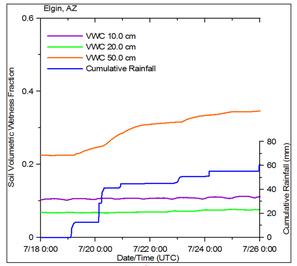
North Carolina Catawba River, Flash Flood 26 – 27 July 2013

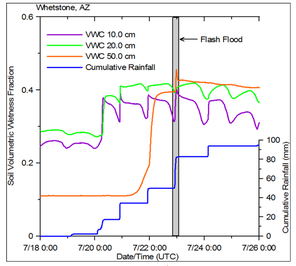


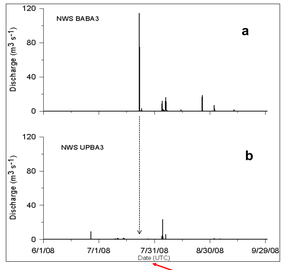
- Soil drying down after precipitation 12 –13 July
- Basin soils are well drained sandy/silt loam
- Field Capacity ~ 20% VWC
- Timing of soil column saturation and heavy precipitation occurred within a six hour period.
- Analysis suggests an infiltration excess flood event
- Soil moisture observations less useful in flood forecasting when the precipitation rate exceeds the infiltration rate of the soil

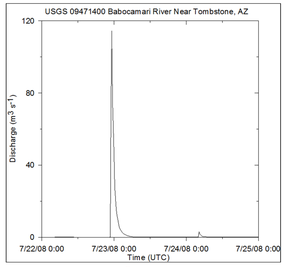
Soil Moisture Distribution and Streamflow Observations in the Arizona Babocomari River Basin 23 July 2008 Flood











- More precipitation fell at Freeman Spring than the lower basin stations at Elgin and Whetstone
- Deeper soil column absorbed the excess precipitation

- Shallower soil column at Whetstone reached field capacity sooner and the additional precipitation that fell on the afternoon of 23 July could not be absorbed

- When discharge peaked in the lower Babocomari Basin the flow in the upper basin was nearly zero.

Summary

The case studies shown here indicate that antecedent soil moisture conditions played a crucial role in controlling the hydrological response of the Russian and Babocomari River basins during flooding events. They suggest that forecasts of saturation excess flooding can be improved when the observed soil volumetric water content is near or at field capacity.

Soil moisture observations may not be as useful in forecasting infiltrations excess flood events. The Catawba River floods indicate that soil texture and infiltration rates play a strong role in determining the hydrological response of a river basin.

References:

Zamora, R. J., F. M. Ralph, E. Clark, and T. Schneider, 2011: The NOAA hydrometeorology testbed soil moisture observing networks: Design instrumentation, and preliminary results. J. Atmos. Ocean. Technol., 28, 1129-1140.

Zamora, R. J., E. Clark, E. Rogers, M. B. Ek, and T. A. Lahmers, 2014: An examination of meteorological and soil moisture conditions in the Babocomari River Basin before the flood event of 23 July 2008. J. Hydrometeor., 15, 1, 243-260.

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