July 8th, 2011 SNAMP Water Research Team Fieldtrip Notes

10:00 to 2:30, Glen Meadows Work Center, Dinkey Creek, CA

In Attendance:

Roger Bales - UC Science Team
Jim Bridges – Westlake RCD
Steve Brink – California Forestry Assoc.
Michelle Dooley – CA Depart. Water Resources
Sheri Eng – Public Relations office for Pacific Southwest Research Station
Peter Hopkinson - UC Science Team
Carolyn Hunsaker – USFS Pacific Southwest Research Station
Julie Gott – US Forest Service
Steve Haze – Yosemite & Sequoia RC&D
Lacy Kirakou – Univ. of California Merced
Ethan Kirk – Rep. Denham office
Susie Kocher - UC Science Team
Ian Lemay – Rep. Costa's office
Anne Lombardo – UC Science Team
Sarah Martin – UC Science Team
Matt Meadows - UC Science Team
Maxwell Norton – University of California Cooperative Extension
Shay Overton – Provost & Pritchard Eng.
Ram Ray - UC Science Team
Samantha Ray - daughter
Bob Rucker – Congressmen Denham office
Cole Rojewski – Congressmen Nunes office
Charles Sikora – Forest Consultant
Allyson Smith - UC Science Team
Jason Smith - UC Science Team
Phil Strand – US Forest Service
Ernie Taylor – CA Dept of Water Resources
Crawford Tuttle – Cal Fire
Tom Wheeler – Madera County Board of Supervisors

Figure 1. Meeting up at the USFS Glen Meadows work station. Photo by Sharon Eng, USFS PSW.

Handouts and photos from the field trip are posted at: http://snamp.cnr.berkeley.edu/teams/water

I. Welcome and Overview: The fieldtrip took place at the Kings River Experimental Watershed near Shaver Lake, off of Dinkey Creek Road, 30 miles south of the SNAMP southern site near Oakhurst, CA. The purpose of the trip was to share the latest

instrumentation installed in the Sierra to help better understand large scale water balance issues. Members of the group introduced themselves and Susie Kocher gave a brief over view of Sierra Nevada Adaptive Management Project (SNAMP).

II. Introduction to the Kings River Experimental Watershed Project: Dr. Carolyn Hunsaker, US Forest Service, Pacific Southwest Research Station, gave an overview of the goals and projects of the King's River Experimental Watershed, the first long term water study in the Sierra Nevada. KREW is a paired watershed study with a before-after-control-impact design with two replicate sites, eight watersheds and ten streams.

Figure 2. Dr. Carolyn Hunsaker describes the KREW project. Photo by Sharon Eng, USFS PSW.

The KREW project is designed to study effects of fuels treatments including thinning and burning. However, the focus is not just on water quality and quantity, as in SNAMP, but rather a broader ecosystem study including biological measurements for invertebrates, algae, vegetation and Yosemite toads. Funding has come from the Forest Service. KREW was initiated in 2000 and began collecting data in 2002. They currently have 8 years of pre-project data, 4 more than intended because litigation has slowed the implementation of the studied projects.

III. Intro to the SNAMP Water Studies: Dr. Roger Bales explained that this SNAMP sponsored field trip was being held at KREW because it is the premiere research site for water in the Sierra Nevada. The SNAMP water team is using information from a number of different water studies because that intensity is needed to accurately parameterize the water models used in SNAMP. KREW data is important to the SNAMP project because it is so intensive.

Roger is the lead scientist for a University of California five campus research collaborative that has received about a million dollars a year from the National Science Foundation to better understand the hydrological cycle. The Southern Sierra Critical Zone Observatory (CZO) has been in place at KREW since 2003. The critical zone is defined as the zone of life on earth, stretching from the bedrock up through the atmosphere. The KREW CZO site was the first of

Figure 3. Dr. Roger Bales of UC Merced gives an overview of the SNAMP water study and relationship to KREW. Photo by Sharon Eng, USFS PSW.

three, now six in the nation. They have invested about $600,000 in instrumentation here. Funds are also coming from the Department of Water Resources.

The new technology in place here is transforming the amount of data that can be collected. It has great potential Sierra wide to lower the uncertainty of water prediction and to inform forest management. One finding from the KREW CZO site is that the higher elevation catchments produce two to three times more runoff than lower elevation catchments. This is because the higher elevation catchment has a higher fraction of snow precipitation, less vegetation and coarser soils. Outstanding questions include the amount of water tapped by trees from unconsolidated material below the soil horizon when water is no longer available in the top soil.

IV. Instrumentation at the top of catchment P301: The group traveled by car to observe the CZO eddy-covariance tower and instrumentation on trees and in meadows.

Critical Zone Observatory tower: The eddy-covariance tower, established in 2007, is a platform for research on critical zone processes including carbon dioxide and water vapor flux. The tower stands 160 feet tall and hosts the newest instrumentation technology including measurements of humidity, solar radiation, temperature (at the top and bottom), wind speed, precipitation, evapotranspiration, and forest respiration. It quantifies the exchange of water vapor and carbon dioxide between the atmosphere and the forest to measure the forest's evapotranspiration rate within about half a square mile. The tower supports radio equipment and a solar powered cell relay to transmit data. It is part of a wireless configuration allowing for observations over a greater distribution of the landscape. Data is collected every quarter of a second, summaries are only sent every half hour by satellite. One of the instruments

Figure 4. Dr. Roger Bales and the 160 foot flux tower. Photo by Sharon Eng, USFS PSW.

alone generates a gigabyte of data every three months.

The tower located at KREW is at about 6500 feet in elevation and is the first of four currently in place. The others are at the San Joaquin Experimental Range at about 1200 feet, Soaproot Saddle at 4000 feet and Shorthair Creek at 8900 feet. There are three more in the planning as paart of the National Ecological Observatory Network (NEON). The eddy-covariance tower at KREW is in a productive zone for tree growth, and so, water use. Results so far show that trees use more water than previously thought. They have measured use of 25 to 35 inches of water a year, while most ecological papers stated it was only in the range of 20 inches a year.

The CZO site is a result of a partnership between the US Forest Service Pacific Southwest Research Station and the University of California. It is funded by the National Science Foundation's Earth Science Division.

Figure 5. UC Merced hydrologist Matt Meadows shows off the sap flow meters in a white fir on site. Photo by Sharon Eng, USFS PSW.

Single Tree Instrumentation: This white fir may be the most instrumented in the world. Sap flow and water content probed are oriented around the tree, while the soil is instrumented heavily in a a 12 spoke pattern. Instruments measure sap flow, temperature, humidity, radiation, soil moisture, snow depth, soil matric potential, diameter using dendrometer bands, and a time-lapse camera. They have just installed instrumentation to do deep soil moisture monitoring, having augured 10-13 ft before hitting bedrock. Adjacent to this tree was another tree whose root structure had largely been exposed to study its structure and extent. Wireless radio boosters assist in transmission of data. The general area around the tree will be thinned and burned when the fuels treatment project is implemented. Six other trees within KREW have similar, but less, instrumentation. A total of 26 trees have sap flow meters to help measure night and day fluxes.

Meadow instrumentation: Twenty-three monitoring locations are in place accross the forest and meadow in sets arranged on a north to south transect, under the tree canopy and out in the open. Over 600 sensors are attached. They are measuring soil moisture, soil matric potential, snow depth, air temperature and relative humidity, and solar radiation. The wireless sensors have been in place for two years. Sixty radio relays transmit data to a cell hub. They use only a small battery which will run each one for a year. The radios use mesh technology and are self organizing – if one goes out the network reorganizes itself so the network can continue transmitting data.

The instruments here are similar to those installed at the SNAMP research sites and across the American River basin. They are deployed to capture spatial variability to quantify the water content of the snow pack. Blended with other data, this should improve water forecasting and management.

Figure 6. Wireless monitoring stations in meado. Photo by Sharon Eng, USFS PSW.

Cattle are not excluded from the meadow so that realistic current conditions are being studied. Meadow restoration treatments will include removing encroaching conifers by endlining them out within 50 feet from the meadow. This is an aggressive treatment for the Sierra National Forest which has not done much removal of lodgepole encroachment so close to a meadow before.

V. P301 outlet Stream Instrumentation: The group then traveled to the bottom of catchment P301 to look at KREW stream instruments including a small and large weir for water flow measurements, a large sediment basin, and automated samplers. Carolyn Hunsaker explained that the weir uses a pressure transducer to measure the depth of the water above it in a channel reach of known and unchanging size. This allows calculation of stream flow. They are also measuring sediment including suspended sediment and bedload and chemistry including pH and conductivity. Chemistry is measured using samples collected by an automated sampler.

Figure 7. Carolyn Hunsaker explains how the monitoring flume below works. Photo by Sharong Eng, USFS PSW.

Sarah Martin explained that the SNAMP sites have similar instrumentation except that they do not have flumes or sediment basins installed. The team is working on getting flumes installed at the outflow of several culverts since there are no stream sites that are appropriate in the study watersheds. Instead of installing sediment basins, the SNAMP sites will use bedload samplers. The bedload sampler they are working with is a fluid filled cell installed within the stream bed that measures the pressure of sediment over it. The problem is that most of the cells have leaked. The water team is working with the manufacturer to resolve these issues.

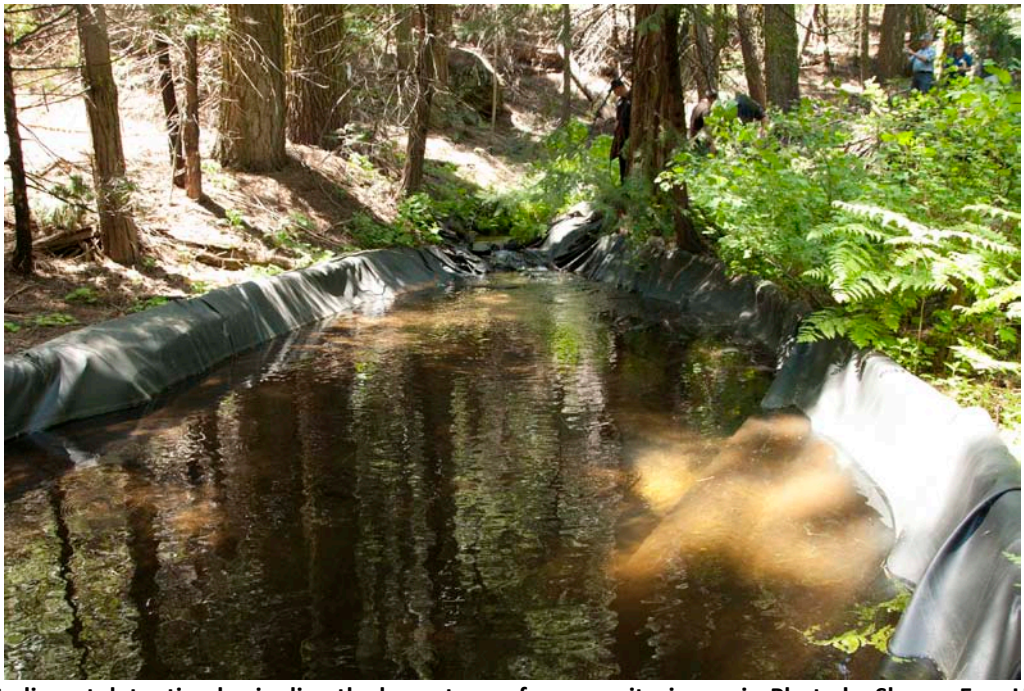

Figure 8. Sediment detention basin directly downstream from monitoring weir. Photo by Sharon Eng, USFS PSW.

The SNAMP team anticipates that the main water quality impact from the fuels treatments will be instream erosion occuring due to increased water flow in the channels as a result of decreased evapo-transpiration. They have installed channel bank erosion pins and are taking suspended sediment samples to measure this. They are doing bi-weekily to monthly water quality grab sampling for sediment, isotopes, and ions which can help to identify whether the water reached the stream from groundwater or snowmelt. The isotopic signal is different depending on elevation, where the fraction of precipitation falling as snow or rain differs. They are also measuring conductivity, dissolved oxygen, water temperature, turbidity, and water depth. There is a strong diurnal pattern in stream flow during the growing season, in part due to the rates of evapo-transpiration from the surrounding forests, which fluctuates during the day.

Carolyn added that given the use of water quality best management practices, they don't anticipate seeing much difference in erosion/sedimentation due to the treatments that will be done at KREW. They will be using the Index of Biological Integrity (IBI) to interpret the biological consequences from changes in stream sediment found. One result from data collection at KREW is that small streams seem to move more sediment than previously thought.

VI. Wrap Up/Next Steps: The CZO, KREW and SNAMP will continue to collect data and work together to develop more robust modeling efforts for landscape scale planning of water related issues. The SNAMP water team has just brought on a new modeller, Ram Ray, who will be starting to run the hydrological models. Some of this should be completed in time to present at the SNAMP annual meeting on October 27th in Sacramento. For more information, see the SNAMP website at http://snamp.cnr.berkeley.edu/teams/water.

Of the 28 participants on the field trip, 17 filled out evaluation forms after the meeting.
(1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree, NA)

They agreed that:

- I learned something new at this event. 4.9
- Constructive discussion was encouraged by facilitators. 4.8
- I felt my comments were heard by the UC scientists. 4.7 (34% said NA)
- The goals and objectives of the event were clearly stated. 4.7
- I felt my comments were heard by USFS attendees. 4.5 (38% said NA)
- There is a clear plan of action for the future on today's issues. 4.2