SIERRA NEVADA ADAPTIVE MANAGEMENT PROJECT
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Notes from the SNAMP Water Team fieldtrip
Foresthill, CA – November 18th, 2010 10 am - 2 pm

In Attendance:

Roger Bales – UCST Water Team
Nate Bogie – UCST Water team
Pete Cafferata - CalFire
Mike Chapel – USFS Region 5
Walter Clevenger – US Bureau of Reclamation
Marie Davis - Placer County Water Agency
Steve Eubanks – Retired USFS
Steven Glaser – UC Berkelely
Tyler Harkness – Foresthill Fire Dept.
Kim Ingram - UCST Public Participation Team
Susie Kocher - UCST Public Participation Team
Lynn Lorenson - Nevada County Fire Safe
Victor Lyon – USFS Tahoe National Forest
Danny Marks – USDA – ARS, NW Watershed Res. Ctr.
Katie Moriarty – Oregon State University
Rita Moriarty – Unaffiliated
Jim Ricker – North Fork American River Alliance
Tony Rodarte - USFS Tahoe National Forest
Phil Saksa - UCST Water Team
David Saah – SIG/University of San Francisco
Bruce Springsteen – Placer Co. Air Pollution Control Board
Bob Suter – North Fork American River Alliance
Patrick Womble – UCST Water Team

Introduction: Participants on the field trip met at the US Forest Service office in Foresthill, California and introduced themselves. The goal of the field trip was to increase understanding of the water research being carried out by the Sierra Nevada Adaptive Management Project (SNAMP) water team, especially the new wireless sensor network recently installed for the Last Chance project. Kim Ingram gave some background on SNAMP and the goal to look at fuels treatments as a neutral third party. Tony Rodarte gave the group an update on the Last Chance Project. They are in the implementation phase and have completed 90 acres of underburning. They will continue burning this fall if forecasted snow does not end their season, at which case the remaining 130 acres will be burned in the spring.

Water research sensor network: Dr. Roger Bales, one of two Principal Investigators for the SNAMP water team (along with Dr. Martha Conklin), passed around a hand out with maps and diagrams and reviewed the snow and soil moisture measurement sites for the Moutain Hydrology Research group within the UC Merced Sierra Nevada Research Institute. SNAMP funded instruments in the Last Chance and Sugar Pine/Fish Camp project sites are part of a larger effort that includes sensors within Yosemite National Park (along Tioga Pass Road) and at the Critical Zone Observatory (CZO) within the King's River Experimental Watershed (KREW). Roger is also proposing a wider network within the American River basin, of which the SNAMP/Last Chance instrument clusters are a part (for a copy of this handout, please see the SNAMP website: http://snamp.cnr.berkeley.edu/).

SNAMP is funded by both the US Forest Service and the California Department of Water Resources (DWR). This work is compatible with DWR's goal of building a new water information system for California. The SNAMP team's goal is to develop better information to evaluate forest management and to develop better water forecasts for the state. There are currently four different instrument clusters in the American River basin, and Roger would like to install an additional 20 to extend the strategic sampling across the basin. Expanded instrument clusters using wireless technology will capture the spatial variability in the watershed. This year DWR came up with funding for two more and Roger is working with the Sacramento Municipal Utility District (SMUD) to co-locate them at existing SMUD snow pillow sites. Each wireless system node currently costs about $1,000, or about $30,000 per cluster. To install 20 clusters in the American River basin it would cost about $500,000 for the hardware. DWR funding for additional installations depends on the availability of funds from current bonds, and on passage of a future water bond. The SNAMP Water Team hopes to turn maintenance of the stations over to operating agencies (SMUD) when the SNAMP project is completed, though they have not developed formal agreements for this. One site has the UC data going to a SMUD data site and transmission system.

Last Chance project measurements: Last Chance has two metereological stations including one at Duncan Peak, which the field trip visited. There are five instrument nodes wired to the met station and an additional ten wireless nodes and long distance relays (called hoppers). The Duncan Peak site has all the project instrumentation except stream channel measurements, which are done elsewhere in the Last Chance project. The wired- in snow depth sensors have been in place since 2007 yielding two full years of data. Wired in sensors can be place up to 150 feet from the base metereological station, which transmits data by satellite. The new wireless sensors installed this week allow data collection from a broader area using radio signals, which can travel up to 300 feet between the sensor and met station or between the sensor and a relay to the next sensor. The team will try to extend the network up to a kilometer with relay stations this fall, but hope eventually to be able to extend the network up to a mile from a metereological system. This wireless technology was developed by Dr. Steve Glazer, a professor of civil engineering at UC Berkeley and his graduate student Branko Kerkez. This wireless sensor installation in Last Chance is their first on the SNAMP project, and was just completed this week.


Figure 1. Duncan Peak met station

Met Station Data Collection: Participants carpooled out to the Duncan Peak meteorological station to observe the new wireless instrument cluster installed by the UC water team. The cluster consists of the same data collection instruments, but connected to the met station by wireless technology rather than wires.

Snow depth sensors: Snow depth sensors or "snow pingers" are mounted on top of a ten foot metal pole and measure depth of snow under the sensor. Pingers take readings every three minutes and log them every 15 minutes. The sensors can be raised by extending the length of the pole if there is more snow. They don't work if they are covered in snow, but once the snow melts they continue to make measurements. They have one installation in

Figure 2. Snow depth sensor at Duncan Peak.

the south that includes a web camera so they can tell whether a precipitation event is rain or snow and hope to install more in other sites. The team has not had any trouble with vandalism yet. With the new nodes added in 2010, the Water Team is currently collecting less data on soil moisture to allow more collection of snow data.

Soil moisture: Soil moisture probes are installed in the soil below the snow pingers. They reach about 3 feet below the soil surface, though at one site visited they extend down only one foot because of the shallow soil. Because soil moisture decreases in the top three feet of soil even while trees continue to grow, colleagues recently did an excavation of a whole tree and its roots to verify how deep the roots typically go. A UC Davis group that collaborates with UC Merced at the Southern Sierra Critical Zone Observatory (CZO) in the Sierra National Forest, excavated the soil from a white fir using digging and air blasting. They found that most roots were in the top three feet of soil. Note that the CZO is co-located with the USFS Kings River Experimental Watersheds (KREW).

Sensor boosters (“hoppers”): These look like the snow pingers, consisting of wireless electronic relay stations mounted on poles with an antenna. They relay the signal from a pinger to the next pinger or hopper within the network (and actually to several to create redundancy in the system and minimize the chance that the system will go down). The wireless network uses a computer with processing, memory and transmittal that use such low power that one battery should last each system for two years. Transmission is at the same frequency as home based wi-fi networks. Technology was supplied by Dust Networks. The system was developed for industrial applications since it costs less to install the electronics of each relay (about $100) than to string wire long distances in manufacturing facilities. So far the SNAMP team is getting great wireless reception, but it’s possible that will get worse when humidity is high. There is also a reduction in transmission capability under dense canopy. The team is studying the performance of the system.

Snow water content: The SNAMP water team physically measures the weight of the snow at the meteorological stations several times a year. This allows them to measure the snow water content. There is a snow pillow at Greek store on the American River district and it measures weight of snow continuously.

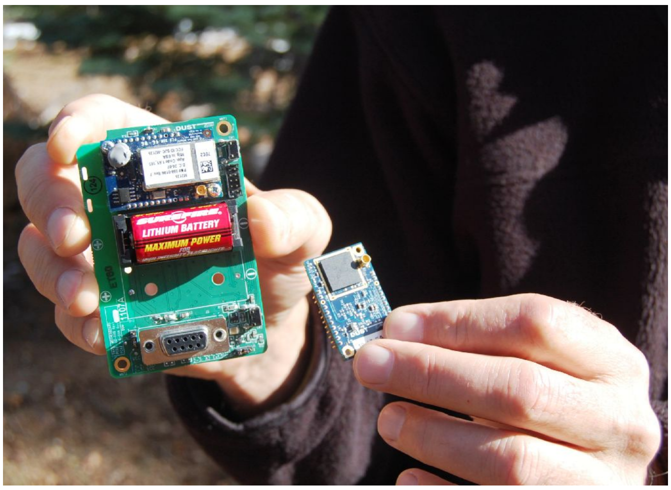

Figure 3. Low power computer compenents used in the sensor wireless system.

Flow: Streamflow is being monitored using stage and discharge measurements but the SNAMP Water Team is currently working on installing wiers to improve accuracy of summer low flow measurements. These are being installed at the end of culverts and will be removed during winter high flow periods. The team is not specifically targetting measurement of flow after wildfire. Two bed load pans have been installed at the southern SNAMP site but another three arrived with holes in them and were returned. The team hopes to receive five more for the northern site.

Study design: Sensors have been installed using a stratefied random method. They are trying to represent the conditions in about a square kilometer. Conditions considered include aspect and canopy cover. One met station and nodes are located at 5,000 feet and the other is at 7,000 feet to capture both rain and snow dominant elevations.

The instrument clusters are measuring the water cycle to inform modeling, which will integrate the data and extend the results to areas where no measurements are being made. The KREW/CZO site will be used to inform modeling done for SNAMP as well because it has more intense data. This will be important for conducting meta-analysis, a SNAMP goal.

They are finding that soil moisture declines in the spring and summer after snowmelt, as does evapotranspiration (ET) of vegetation. Soil moisture as a variable is less expensive to measure than ET. Satellite data can show the amount of snow covered area in large watersheds on a daily basis as long as there are no clouds. All together, they will be able to measure preciptation, snow on the ground, soil moisture, snow melt and stream flow and they can estimate/ model evapotranspiration. This daily water balance will be used to constrain the models.

Figure 4. UC Berkeley graduate student Branko Kerkez shows a schematic of the wireless sensor network to Pete Caferratta, CalFire hydrologist.

Roger said that the SNAMP and water research on affiliated project promises a substantial improvement on the current method of water forecasting because it measures physical parameters and uses process based modeling, rather than the current system which uses statistical analysis of past water yields based on limited physical measurements. The current system is reasonably accurate for total seasonal runoff in average years, but has high uncertainty in wet and dry years. It is also based on historical snow data, which may not predict water yield well for a changing climated. The increased water sensor network should be able to reduce that uncertainty. Participants at the field trip said the water team's research was very promising because it tied together data from the other teams (spatial and forest) to make predictions about effects of treatments. They also said that the potential for the system to improve water forecasting for the state was critical.

Next Steps:
Next steps for the Water Team are to secure funding for additional instruments and to continue to build on collaborative efforts in support of the project. A southern site field trip is being planned for Spring/Summer 2011, as well as a UCST Water Team Integration Team meeting.