Sierra Nevada Hydrologic Observatory (SNHO)

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Introduction

Specific aim: Develop integrated measurement and modeling strategies that combine remote sensing and ground-based data with state-of-the-art models to achieve accurate estimates of snowpack, snowmelt and the partitioning of snowmelt into runoff, infiltration and evapotranspiration. Four broad science questions motivate this research:

- How do hydrologic systems that are subjected to multiple perturbations respond?
- How do pulses and changes propagate through the hydrologic system?
- What are the time lags and delays of stresses in different systems?
- How can the predictive ability for these responses be improved?

Location: Wolverton (36.5956^{o}N, 118.7333^{o}W) is a non-wilderness area at about 2170 m elevation, located in the Marble Fork of the Kaweah River basin, in Sequoia-Kings Canyon National Park (figures 1 and 3). It is road accessible year round and in an area with complimentary long-term research measurements and investigations. The largely forested (mixed conifer), 8 km^2 Wolverton basin is nested within the 135 km^2 Marble Fork.

Primary objectives:

- Develop accurate, basin-scale measurement strategies for water balance in mountain basins.
- Integrate ground-based instruments with remotely sensed data and advanced hydrologic modeling to develop a process-level understanding of water cycle responses to perturbations in a representative mountain basin.

Figure 1. Wolverton in summer, showing meadows in lower part of basin, and forested slopes above (left) and Wolverton meadow and basin in spring during snowmelt (right).

Basic premise: Strategically placed instrument clusters, designed to complement satellite remote sensing information, together with models of surface and subsurface hydrology, provide the basis for more accurately and efficiently measuring and scaling the water balance, and thence basin-scale fluxes, than does an approach that relies on sparsely distributed measurements of the type now available.

Geophysical survey design

The main focus of the planned geophysical surveys is to produce an improvement in the hydrological models of the Long Meadow study area. In this case this will be achieved through the imaging of the spatial variation in depth to bedrock over the Long Meadow site. This will produced a 3D image of the thickness of the sediments beneath the Meadow, thus allowing for an improved constraint on the boundaries for subsequent hydrogeological modeling. As a consequence of this imaging we will also gain a better understanding of the subsurface architecture, thus potential hydrogeological controls. Since topography within the original bedrock can produce preferential flow patterns in the overlying sediments.

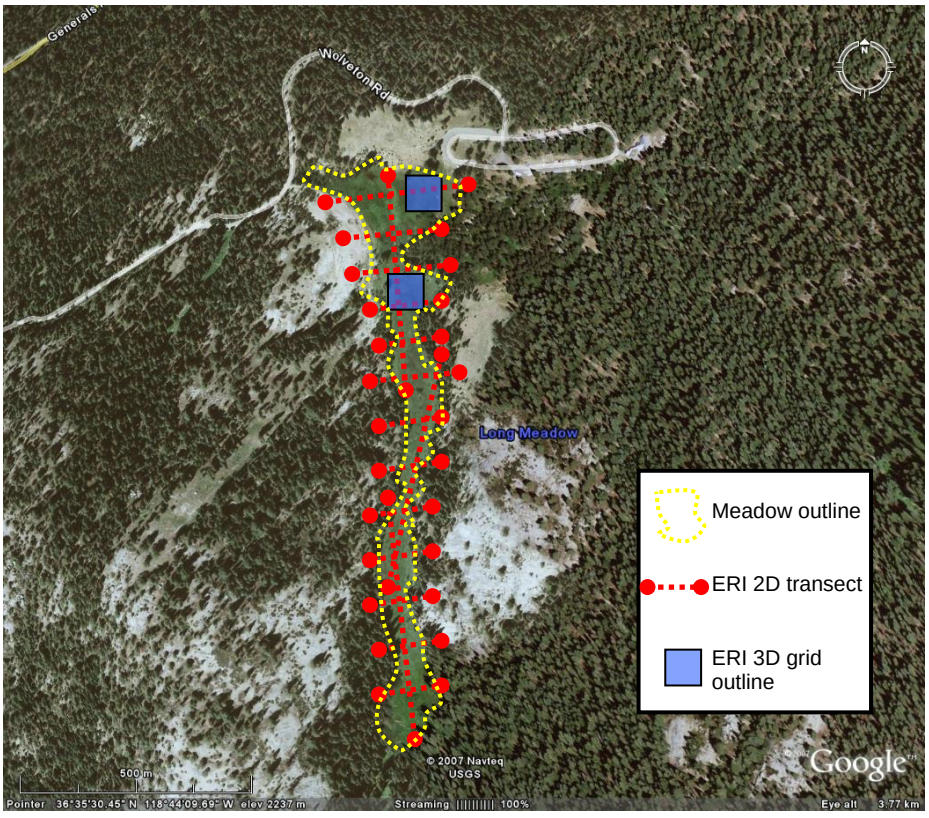

Figure 2. Depiction of the plan for data collection of the ERI data in the Long Meadow site. This is only for reference, the actual design may vary significantly from this representation depending on the results from the preliminary surveys and on site conditions.

The underlying geology of the area is granitic in nature, with a thin layer of soil of varying thickness (typically between 1-4m) overlying this, composed of weathered bedrock. With this contrast in material, it is felt that the electrical resistivity imaging

(ERI) technique would be most suitable for imaging the boundary between the two layers. The solid bedrock should display relatively high resistivity values, whilst the infilling sediments, containing clay minerals, water, etc., will be more conductive. In addition the automated data acquisition and relatively portable nature of the technique allows for quick collection of high resolution transects over the large spatial area of the meadow.

Proposed dates for this survey are in the Fall, at present between 16th September 2007 and 3rd October 2007. This will ensure that the meadow area has dried out, since during the snow melt season and summer months the meadow essentially becomes a wetland area with standing water in the topographic lows.

Our plan is to collect a number of 2D transects both parallel and perpendicular to the long axis of the Long Meadow site (figure 2). This will allow a well constrained 3D image of the subsurface to be created from the 2D transects, in a quick and efficient manner. The exact number of transect will be dependent on both the sediment thickness and its extent towards the edges of the meadow, which will dictate the transect length and electrode spacing. In addition the variability in the subsurface topography throughout the meadow will dictate the number of transects need to capture these spatial variations. In addition a number of small 3D grids of ERI data, located around the installed infrastructure, will be collected. The grids, of the order of 20 x 20 m, will allow a higher resolution characterization of the subsurface structure in areas which are well constrained by ground-truthing. These grids can also aid the interpretation of the 2D transects in areas where the ground-truthing is minimal.

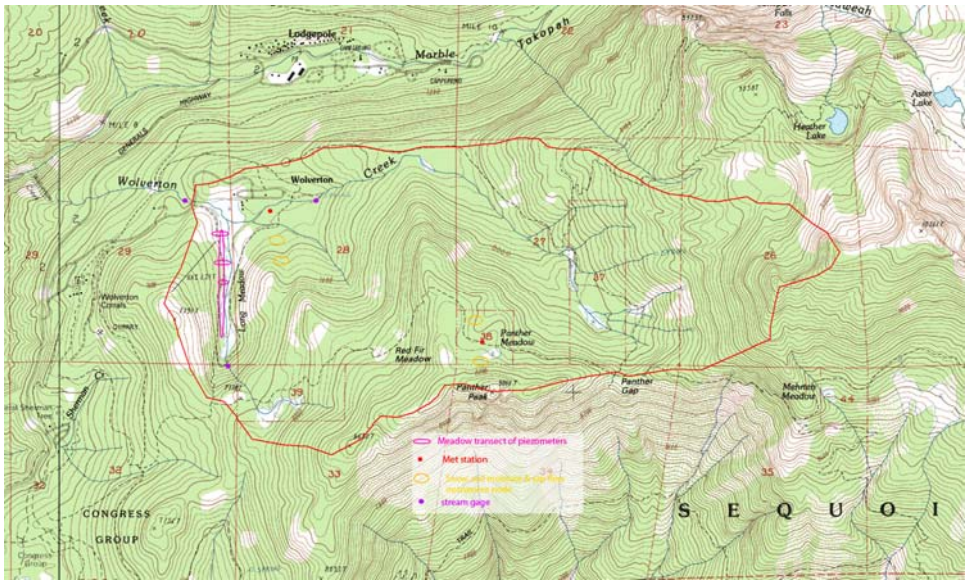

Figure 3. Completed infrastructure installations within the Wolverton basin (outlined in red), the Long Meadow site is located at the western end of the watershed.

We have a preliminary visit of a couple of days planned for late Spring 2007, or once the snow has melted back, where we aim to collect a series of test transects. These tests will enable us to answer the questions posed above and firm up the design of the Fall 2007

surveys. In addition to the ERI surveys, we will collect numerous electromagnetic induction (EMI) transects to produce a spatial map of ground conductivity throughout the meadow. We can then repeat this during the Fall 2007 survey to look at changes in ground conductivity, using these to infer variations in soil moisture over time.

Infrastructure

There are 3 transects of wells within the Long Meadow site (figure 3), exact completions and details to follow, these will provide ground-truthing for the geophysical surveys from logs at the time of installation. A number of these wells contain pressure loggers, which will provide a continuous record for the water table level and fluctuations during the survey periods. In addition a number of instrument clusters have been installed, including; stream stage and temperature, 2 meteorological stations, 4 soil moisture, temperature and snow instrument nodes the location of which are marked in figure 3.

Budget

The preliminary visit would be for a total of 5 days, this includes 2 days travel, and 3 days on site to conduct the test surveys.

For the main summer visit, we would be out in the field for a total of 18 days, this includes 2 days travel, 1 day to set up and 1 day to pack away, and 14 days on site to carry out the surveys (10 days for the ERI and 2 days for the EMI, with 2 days spare for downtime, etc.).

The plan in both cases would be to use a rental car from Enterprises on-campus office, hence the additional insurance is covered by the University policy. Accommodation is being provided by UC Merced for the duration of the field work, this is in a cabin within Sequoia National Park. The cabin has cooking and sleeping facilities, along with ac power.

On-site support provided by UC Merced

We are receiving on-site support for this project in a number of ways, including;

- Personnel to assist with the acquisition of the geophysical data is being provided for the duration of the proposed field work.
- Accommodation in the form of space in a cabin has been provided free of charge for the duration of the proposed fieldwork. This is located in close proximity to the field site.
- UC Merced is providing a total station and instruction for the surveying needs during the survey.

Additional costs

PRELIMINARY TRIP		Unit price	Taxes & extras	Total price
TRANSPORTATION				
Rental Car	5 days rental (Enterprise on campus). Intermediate sized SUV. LDW and supplementary liability insurance provided by Stanford University.	$400.00	$40.00	$440.00
Fuel Charge	Roundtrip mileage of 700 miles and assuming 15 miles per day, vehicle running at 18 mpg, and a fuel price of $3.00 per gallon.	$130.00	included	$130.00
ACCOMMODATION				
Subsidence	5 days @ $38 per day	$190.00	included	$190.00
GRAND TOTAL				**$760.00**

MAIN SUMMER TRIP		Unit price	Taxes & extras	Total price
TRANSPORTATION				
Rental Car	18 days rental (Enterprise on campus). Intermediate sized SUV. LDW and supplementary liability insurance provided by Stanford University.	$1400.00	$154.00	$1540.00
Fuel Charge	Roundtrip mileage of 700 miles and assuming 15 miles per day, vehicle running at 18 mpg, and a fuel price of $3.00 per gallon.	$162.00	included	$162.00
ACCOMMODATION				
Subsidence	18 days @ $38 per day	$684.00	included	$684.00
CONSUMABLES				
	Includes: replacing batteries in each system, cover any minor breakages (cables and connectors for example, on site purchase of tools, etc.	$300.00	included	$300.00
Equipment purchases	Additional 48 stainless steel electrodes for the 3D ERI surveys.	$200.00	$50.00	$250.00
GRAND TOTAL				**$2936.00**