Summary of Western Regional CUAHSI Science Workshop
San Francisco, CA
February 3, 2002

The meeting convened in the Embassy Suites Hotel in Burlingame, CA at 8:30 PST. Participants were:

Shiva Achet	Boise State University
Michael Barber	Washington State University
David Brown	Cal State Univ., Chico
Stephen Burges	Univ. of Washington
Bill Dietricht	UC-Berkeley
David Freyberg	Stanford
Steven Gorelick	Stanford
Douglas Kane	Univ. of Alaska Fairbanks
M. Levent Kavvas	UC-Davis
James Kirchner	UC-Berkeley
Joe McConnell	Desert Research Institute
Thomas Meixner	UC-Riverside
Tim Scheibe	Battelle PNL
John Selker	Oregon State Univ.
David Stonestrom	USGS, Menlo Park
Scott Tyler	U of Nevada Reno
John Wilson	New Mexico Inst. Of Mining and Tech.
Yu-Shu Wu	Lawrence Berkeley Laboratory

John Wilson began the meeting with an overview of CUAHSI, its history, mission, committee structure and current progress. A significant portion of the discussion following the overview focused upon the rationale for CUAHSI's focus on infrastructure, successes in the past of infrastructure proposals (IRIS, EarthScope, etc.). It was pointed out that while CUAHSI is currently focused on the U.S., it will need to look forward towards international cooperation and research.

David Freyberg next presented a brief outline of the Western Regional CUAHSI Workshop goals. These were:

- **Information Transfer:** Learn more about CUAHSI, its mission and process, status, and the Science Plan. Learn more about each other.

- **CUAHSI Science Plan**: Contribute to the design of the science agenda and plan.

- **Strengthen the hydrologic sciences community**: Build a stronger sense of community among hydrology educators and researchers.

- **Stimulate participation in CUASHI**: Encourage involvement in CUAHSI committees; promote new faculty and institutions to participate in CUAHSI

- **Continued development of the workshop process:** Provide guidance to leaders of future, local CUAHSI information workshops

Scott Tyler presented the current 5-pointers that have been developed for the Science Plan and a review of breakout topics used at the Chicago CUAHSI meeting. Discussion quickly moved away from the need to discuss the details of the 5-Pointers and focused on the larger issues of CUAHSI vision and mission. The larger mission and science focus of CUAHSI was deemed by the group to be very important to both community acceptance and acceptance by society of the needs of the hydrologic community. The science focus was generally deemed by the group to be inadequately defined.

The consensus of the group was that the details of the 5-Pointers were less critical at this point in CUAHSI's growth than clearly stating the overarching scientific and societal questions that hydrology currently faces. This consensus was significantly different than that reached in the Chicago meeting and reflects a strong belief by the participants of the need to clearly state the mission and overarching scientific questions facing the hydrologic sciences for the future.

Group discussion focused on the following points:

- What is the theme or vision of CUAHSI; the hydrologic community may be data rich but we are often science-limited.

- Forecasting, restoration and the impacts of change are critical areas of our science; we generally do not have the tools to predict future changes

- How will CUAHSI's science be integrated with other interdisciplinary efforts such as NEON?

- We need to develop technology to measure at appropriate scales and develop spatially averaged parameters along with fundamental scalable transport equations.

- What are the boundaries, both physical and disciplinary, of our science; i.e. do we include the ocean and atmosphere in our hydrologic cycle?

Based upon the group's discussion, three breakout groups were formed, each with the following same charge:

- Develop the central theme/vision for CUAHSI condensed into a short phrase or title

- Develop 5 bullet points to elaborate this theme

- Define how Long Term Hydrologic Observatories (LTHOs) would support this theme and what would an LTHO's objectives be.
- Define how the development of CUAHSI's Instrumentation/Monitoring initiative would support this central theme.

The breakout groups returned from lunch and presented their results and discussion. Reports from each of the three breakout groups follow the meeting summary.

The breakout group presentations led to discussion of the attributes needed to develop successful LTHO's and whether they should be considered as "natural laboratories" or natural observatories. While the question of laboratory or observatory was not answered in consensus, the following suggested attributes were identified:

- LTHO's need to contain gradients in land use, landform and climate

- LTHO's should contain multiple scales of processes and include nested scales

- LTHO's should be capable of controlled manipulation rather than left in a natural setting or relying upon uncontrolled land use practices to provide experimental conditions.

- LTHO's with long-term hydrologic records or proxy records (dendrochronology, etc.) already available will be more valuable than those without such data.

The attendees were then asked what, if any, hydrologic characteristics were unique to the western region and should these be included in CUAHSI science planning. Numerous unique characteristics critical to the continued function of society and ecosystems were identified and are summarized below.

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- Competition between urban, agricultural and ecological demands for water is most intense in the western US.

- The western region is the most urbanized population in the US, with population densely settled in cities. Urban hydrology and watershed disturbance is significantly more important in the west than other regions.

- The west is dominated by the most highly-hydrologically disturbed systems in the US, including urbanization, water diversions for agriculture, largest dependence upon dams and impoundments. Such disturbed systems have resulted in large changes in flow regimes and timing of flow regimes.

- Riparian corridors are limited in extent in the west; yet contain the major centers of biodiversity.

- The west contains the most complexity of geology, topography, landforms and hydrometeorology.

- Arctic hydrology is an important climatic driver, and covers very large areas of Alaska.

- The west contains the largest areas of arid and semi-arid areas of the US

- Large portions of the western region are dominated by a Mediterranean climate, unlike much of the rest of the US.

- Snowmelt is a dominant water source in the west.

- The hydroclimatology of the west is dominated by the confluence and complex interactions of Pacific and western air masses, unlike other regions of the country. Strongly influenced by ENSO and PDO.

The group consensus was that these attributes represent serious challenges and questions for hydrologic science development in the western United States. These attributes apply to many regions of the world and in development of CUAHSI's Science Plan, should be included for study and analysis.

The meeting concluded at approximately 4:30 PM.

SUMMARY Breakout Group #1 Discussion of CUAHSI
San Francisco Regional Workshop, Feb 3, 2002
Summarized by: David Brown

Group Members: Bill Dietrich, Steve Gorelick, Levent Kavvas, Tim Scheibe, Dave Brown

Our breakout discussion groups were assigned the task of developing:

- An overall theme, or central vision for the CUAHSI effort
- A list of up to five specific work elements that help elaborate the vision

Also, we were asked to consider the need for and approach to developing: (1) hydrologic observatories; and (2) instrumentation facilities/programs.

Overall Theme/Vision for CUAHSI

A central difficulty in our discussion resulted from trying to reconcile a statement of scientific vision with the need for a simple phrase that could engage a wider audience (funding sources, politicians, the public). No single theme or vision statement emerged unscathed.

There was support for one suggestion, "The scientific basis for hydrologic forecasting". Improving our ability to understand and make predictions with regard to hydrologic systems is a critical need. However, concerns were raised over the use of the term "forecasting" in agency missions (NOAA, National Weather Service) and public perception or understanding. It may be that marketing and/or editorial assistance might overcome this difficulty.

An alternative theme centered on "Mechanisms of hydrologic change(s)". Here again, concerns were raised over connotations associated with use of the term "change". Possible confusion might arise this vision were tied to existing global change programs. Key attributes of an overall theme should include improving: our basic understanding of hydrologic system; forecast capabilities; and our knowledge of the effects of changing environmental conditions (water resource management, land use, climate change, etc.).

In thoughts after the meeting, the summarizer suggests the following overarching theme for CUAHSI:

"Understanding and forecasting hydrologic systems in a changing world"

Specific Work Elements to Support the Overall Theme

Lacking a final vision statement, we identified the following work elements or priorities with general agreement.

New technological opportunities (LIDAR, inexpensive rain gages, subsurface imaging, etc.) deployment

Critical science needs, including:

- Closing the hydrologic cycle/developing improved water balance estimation/measurement methods
- Inadequate forecasting methods
- Inability to utilize existing and new data sets
- Need for new science and scientific tools (governing equations describing fluxes across multiple spatial scales, for example); 5-point CUAHSI research targets proposed to date

Characterizing spatial and temporal variability remains a major research priority.

Coping with change in hydrologic systems, both temporally (seasonal, annual, climatic) and spatially (land-use and resource management)

In the reconvened large group discussion of these elements, it was suggested that the final element related to change could be an umbrella or framework for the first three elements. This idea should be explored in future discussions.

Hydrologic Observatories

The model of natural labs should be pursued rather than fixed observatories in the classic sense. By this we mean that watersheds or river basins should be identified where process/mechanism studies can drive the deployment of the monitoring network. Data gathering networks should be developed in these watersheds such that a complete hydrologic mass balance can be developed for both local (within the watershed) process studies and for theoretical research.

Instrumentation Development

Time ran out before we could discuss this topic in any detail.

SUMMARY Breakout Group #2 Discussion of CUAHSI
San Francisco Regional Workshop, Feb 3, 2002
Summarized by: James Kirchner

Our charge was to 1) try to come up with a concise, coherent, overarching theme, 2) describe what a long-term natural laboratory (LTNL) would look like, and 3) describe what an instrumentation infrastructure system would look like. We undertook to work backwards, from the specific to the general.

Natural laboratories

We described four possible models for LTNL's:

1. The first is "LTER plus satellites": a set of fixed, long-term study sites, modeled after (and probably co-located with) LTER sites, with surrounding "satellite" watersheds to provide a larger-scale context for what is observed.

2. The second model is "new technology": the notion here is to make spatially-distributed measurements at large scale via remote sensing, without selectively focusing intensive effort on a small set of subcatchments.

3. The third model is "pulsating intensive", in which high-intensity campaigns by university researchers rotate among several sites. In principle any individual site would receive focused, intensive effort for roughly three years, followed by roughly a decade of low-intensity routine observations, probably undertaken by one or another agency (while the intensive university efforts went to other sites). In theory, each site would be revisited every decade or so for several years of intensive effort.

4. The fourth model is "campaign-and-tail", in which several years of a high-intensity campaign effort then tails off to progressively lower-level effort, as the high-intensity campaign migrates to a new site (similar to 3, without revisiting old sites).

Regardless of which model is used, the focus of the LTNL's must necessarily be to provide observations at high temporal and spatial density to extend the spectral range of traditional hydrologic measurements. The timescales involved must extend at least to 10 years, in order to encompass sufficient year-to-year variability.

Instrumentation

On the subject of instrumentation, the working group found it useful to consider three classes of instruments: 1) conventional instruments (rain gauges, stream gauges, water level recorders, etc. etc.), 2) emerging instruments (e.g. LIDAR), and 3) future opportunities that could be created by concerted efforts to develop new capabilities. In

any case, the key function should be to facilitate things that we cannot do now, in particular a) to provide exotic high-cost equipment for use by the community, or b) to provide large arrays of conventional equipment for intensive short-term campaigns. The committee thought it wise to contract out as much as possible for relatively specialized capital-intensive services (such as laser altimetry surveys, or mass spec analyses of water samples). The committee also noted that a major push to enhance instrumentation infrastructure would hopefully lead to the design and fabrication of new instruments, that are not currently available off-the-shelf. An open question is how to facilitate those developments -- through the hiring of instrumentation staff, or through a competitive grants program?

Theme

We did not have much time to think about the overarching theme.

SUMMARY Breakout Group #3 Discussion of CUAHSI
San Francisco Regional Workshop, Feb 3, 2002
Summarized by: Thomas Meixner

Group discussed for a while the concept of the vision thing and what should the vision be for the CUAHSI proposal. While the group struggled we came to no conclusions as to what the ultimate mission should be. I think the ensuing discussion when we presented our results indicated that everyone agreed a vision was necessary but general agreement or even majority agreement evaded us.

For our particular group we discussed the following possible vision statements.

Water for life
Water for successful life
Water for continuation of life
Fate and Future of Water Resources
Water as change agent land and vegetation as substrate
Water as a possible acronym for the community's joint science project

Themes-

Understanding the movement storage and transformations of water and its influence on ecosystems and society.

Hydrology as the study of place. The implications of this were discussed in that they indicate the implausibility of the ungauged catchment problem.

Unfortunately we did not get further than this in fleshing out implications for Natural Hydrologic Laboratories or measurement technologies. Possibly future groups could use our and the results of the other workshops to flesh out the implications of different themes on the final proposed work of CUAHSI.