Summary of CUAHSI Science Workshop
Harvard University, Cambridge, MA
9 March 2002

The workshop convened at Harvard University, in Room 119 of the Maxwell Dworkin Building at 9:00 am EST. The meeting was organized and led by Richard Vogel of Tufts University, Ana Barros of Harvard University, and Marshall Moss of CUAHSI. There were a total of 29 workshop participants at the workshop. The name, affiliation and email address for these participants is given in Table 1.

Marshall Moss gave a brief overview of the status and history of the consortium. The overall planning efforts associated with the creation of a science plan were reviewed along with the current committee activities. The job announcement for a new executive director of CUAHSI was distributed to all participants. The remainder of the morning consisted of an open group discussion.

Many questions were raised during the morning discussions. Many of the questions raised could be addressed by others in the room, hence those questions did not really lead to further discussion. However, a number of questions were raised during the morning discussions which were not answered including:

- What would the field of hydrology look like with an order-of-magnitude more funding?
- What resource requirements are required by universities to enable them to answer the science questions which have already been documented?
- What would it take for CUAHSI member universities to each have a department of hydrology at their institution?
- How can the individual investigator could be integrated in to CUAHSI community activities?
- What is a fundamental scientific question in the field of hydrology, analogous to the type of questions which initiated the formation of other community science programs such as IRIS, and NCAR?
- What if we create a sophisticated hydrologic infrastructure, such as a state-of-the-art field station, but only one or two people know enough to manage the equipment? This is true of LIDAR equipment, which is too expensive for an individual to maintain, but can only be used by a handful of investigators in the world.
- Marshall Moss mentioned several times that one CUAHSI committee charged with defining research applications has not yet been formed and is in need of leadership.
- How can the activities of federal agencies be integrated into CUAHSI activities.?

Before breaking for lunch, the group used the above discussion and questions to formulate sub-groups to address four separate topics. The topics were:

(1) ***Breakout Group I on a Proposed Major Scientific Focus of CUAHSI*** This group developed a proposal for a major "***interface scientific***" focus which offers opportunities to naturally integrate hydrology, biology and ecology while simultaneously revealing the variability and dynamics of fluxes at the interfaces within the water cycle. A summary of this group by Efi Foufoula-Georgiou is attached.

(2) ***Breakout Group II on a Proposed Major Scientific Focus of CUAHSI*** This group developed a proposal for CUAHSI to address scientific questions relating to quantification of all components of the hydrologic cycle at all temporal and spatial scales including biological, geochemical and human interactions. A summary of this group by Richard Vogel is attached.

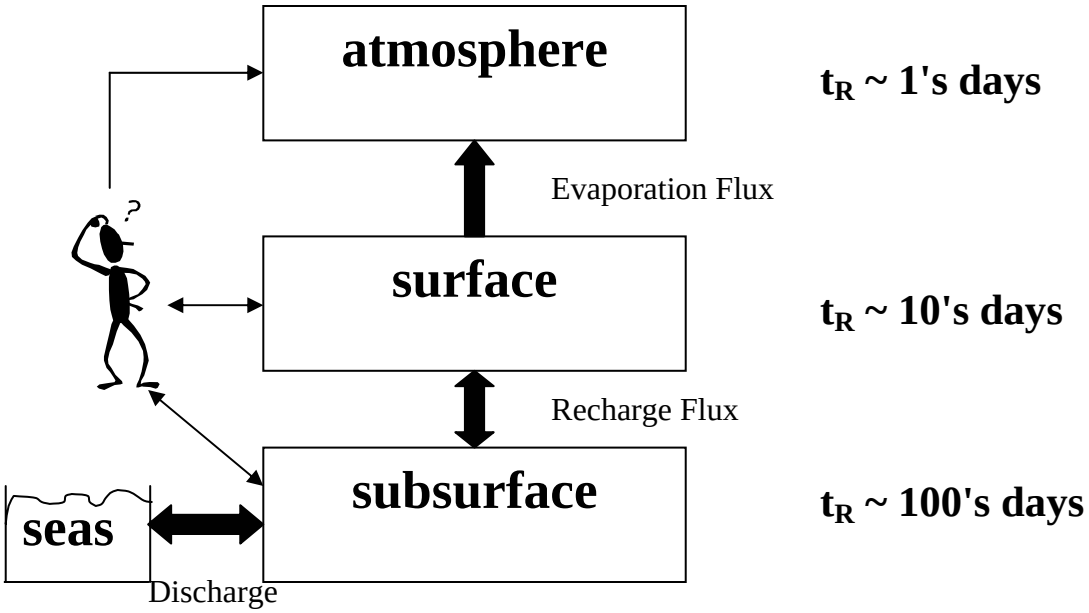
(3) ***Breakout Group III on Long Term Activities of CUAHSI***: This group considered the long term functions and activities of CUAHSI relative to the on-going definition of a hydrology science plan. How should CUAHSI be organizing itself beyond taking advantage of immediate funding opportunities? How do we want this organization to serve the hydrology community in 10, 20 or 50 years? A summary of this group by David Ahlfeld is attached.

(4) ***Breakout Group IV on Defining Research Applications***: This group developed recommendations to meet the stated CUAHSI objective to, "Assure the applicability of the advances through a program of technology transfer." A summary of this group by Tom Ballestero is attached.

In late afternoon, each of the sub-groups made a presentation of its deliberations that were discussed by the group as a whole. These discussions are captured in the attached reports for each of the above groups.

The workshop concluded at approximately 4:45 pm EST.

Breakout Group I on a Proposed Major Scientific Focus of CUAHSI



Summary

This working group, after lengthy discussions, concurred that it is important for CUAHSI science to start in a focused way (which does not explicitly address every single unsolved problem in hydrology) and branch out as the program evolves. In that spirit, it was discussed that pressing issues for hydrologic research should not be presented starting in the usual approach of deficiencies in our understanding of the whole hydrologic cycle and our inability to close the hydrologic budget at almost all scales. Also, the need for investment in the hydrologic sciences should not be presented as a necessity for incremental improvements on everything hydrologists have achieved so far. Rather, a way of presenting the need for this new initiative could start with a focus on two major fluxes of the hydrologic cycle that we understand the least and we have the least amount of observations to work with. These fluxes are: evaporation and recharge.

The three major reservoirs of water (excluding lakes and seas) are the atmosphere, the surface and the subsurface. The residence times of water in each of these reservoirs differ by an order of magnitude. Water and energy exchanges between these three reservoirs take place over a broad range of scales. From all the fluxes between these reservoirs evaporation and recharge are the only ones not directly measured. Specifically, these fluxes are:

- totally unobserved (treated as residuals of budgets)

- greatly influenced by biology
- greatly affected by human activities
- central to determination of
    - water quality (recharge and evaporation)
    - weather forecasting (evaporation)
    - water resources (recharge and evaporation)
    - riparian zones (ecological health)

Precipitation is the external flux that drives the whole system and has a tremendous variability over space and time. This variability makes precipitation a difficult variable to predict and there are several issues still unresolved as to the accuracy by which this variable can be observed from raingauges, radars and satellites. Yet, it is a flux that comparatively to evaporation and recharge, hydrologists have many more observations to work with. It is obviously tightly related to all other fluxes and it is a critical component of hydrologic cycle as a whole. It directly affects evaporation and recharge (each at different time and length scales) and is therefore, interwoven into the proposed focus presented above.

A few issues that add strength to the above focus:

(1) The above framework offers opportunity to naturally integrate hydrology, biology and ecology since they all happen at the **interface** of the atmospheric and surface reservoirs and directly affect the evaporation activity. The same applies for the recharge fluxes. Thus, this initiative can be seen as one that focuses on "**Interface science**".
(2) The major goal of the proposed program could be "**to reveal the variability and dynamics of fluxes at the interfaces within the water cycle".**

The facilities necessary for this science are:

- Direct measurement technology and techniques
- Designed to incorporate physiochemical soil hydrodynamics from nano to macroscales
- Build from biology out (-xylem hydraulics; biogeochemical flux constraints; molecular biology and physical chemistry)
- Intense experiments (use synergy with existing ones)
- Long-term monitoring

Prepared by Efi Foufoula-Georgiou

Breakout Group II on a Proposed Major Scientific Focus of CUAHSI

Participants:

Richard Vogel, Rick Hooper, Glenn Warner, David Hyndman, Paula Rees, Guido Salvucci and Tom Ballestero

Summary

Our approach was initially to define the 'hydrologic sciences' and to use that definition to develop a scientific focus. We are aware that 'hydrologic science' has been defined by others, however, our group required a consensus. Our agreed upon definition is:

> "Hydrologic science involves our understanding and ability to quantify all components of the hydrologic cycle at all temporal and spatial scales including biological, geochemical and human interactions."

Unfortunately, there is a lack of adequate experimental measurements to fully quantify all components of the hydrologic cycle at any spatial or temporal scale. Our inability to close the hydrologic cycle also results in our inability to fully validate existing watershed models. Hence we are unable to verify our understanding or ability to quantify the hydrologic cycle. It follows that we are unable to perform rigorous hypothesis testing for trend assessment and a myriad of other applications of hydrologic science. Without a fundamental shift in the way in which hydrologic research progresses, our field cannot move forward. The importance of such a major shift in hydrologic research would have enormous implications because human interactions have introduced a host of new social problems relating to watershed and river restoration, environmental change, urbanization, etc. Advancement of the hydrologic sciences is a prerequisite to the solution of these social problems. It is only through a more comprehensive science plan that we will be able to understand and quantify hydrologic rate-limiting processes which in turn should enable us to address fundamental social problems.

Our group agreed that the following science question poses the greatest challenge to field of hydrology:

> What steps are necessary to improve our understanding of anthropogenic influences on a watershed?

This single fundamental question poses a myriad of scientific questions relating to our understanding of the hydrologic cycle and its impact on society.

Needs:

We envision the following needs to enable us to address this fundamental science question:

1. Adequate measurements to close the hydrologic cycle
2. Information systems for seamless access to a broad spectrum of datasets,
3. Efficient database management systems organized at nested scales with seamless GIS interface
4. Three classes of competitive proposals are envisioned:
    a. Proposals generated by single investigators as is currently common practice
    b. Proposals generated by teams of investigators which would arise from the CUAHSI community

Proposals relating to a hydrologic community center (HCC), which would act as a 'think-tank' to enable flexible interactions, workshops, fellowships, and other vehicles which encourage community advancement in the hydrologic science

Prepared by Richard Vogel

New England Regional CUAHSI Meeting – March 9, 2002

Breakout Group III on Long Term Activities of CUAHSI:

Participants:

Ana Barros, Dennis LeBlanc, Dennis McLaughlin, David Ahlfeld, John Hermance, Jim Wallis, Chris Eager

Summary:

This group considered the long term functions and activities of CUAHSI relative to the on-going definition of a hydrology science plan. How should CUAHSI be organizing itself beyond taking advantage of immediate funding opportunities? How do we want this organization to serve the hydrology community in 10, 20 or 50 years? Providing a venue for broad discussion and consensus building on a science plan for hydrology is seen as a key contribution of CUAHSI. Sharing the results of these deliberations with others, including a range of potential funding agencies, is also important.

The activities of CORE (Consortium for Oceanographic Research and Education - www.coreocean.org) are considered as a possible analogy. The group's understanding is that CORE facilitates the design of broad research programs, is a central clearinghouse organization and communicates the interests of the ocean research community to legislators and funding agencies. Among other activities, CORE has a formal relationship with relevant funding agencies to provide on-going advice on the specific science questions that the agencies are considering.

The following points were discussed and generally agreed upon by the group.

1) CUAHSI should institutionalize a process that engages the hydrologic research community in the task of devising and prioritizing a science plan for hydrology. This activity should be considered to be an on-going activity of CUAHSI (e.g. reports at regular intervals endorsed by all CUAHSI members).

2) CUAHSI should institutionalize relationships with all relevant agencies involved in hydrology. These agencies might include NSF, NASA, NOAA, USGS, DOE, USDA, DOD (Corps of Engineers), FEMA, EPA. An element of this relationship would be communicating to the agencies the high priority science questions developed by CUAHSI. It might work well if the agencies were connected to each other in a partnership arrangement with sharing of funding towards a common pool. CUAHSI would then serve an advisory role to this partnership.

3) A relationship with the agencies must be developed from both the CUAHSI and agency directions. CUAHSI should begin discussions with the agencies and get feedback on how this relationship should be structured.

4) The mission statement for CUAHSI should be revised to include a description of the role of CUAHSI in developing and disseminating research plans. (See attached proposed mission statement)

The group identified one possible structure. A Committee (perhaps the existing standing Hydrologic Science Committee?) is charged with arriving at a consensus on timely science questions for hydrology. The Committee membership would be large and would rotate frequently to provide ample opportunity for a wide range of opinions. The Committee would devise methods for soliciting input for the full hydrology research community including leading discussions and issuing white papers. The Committee would interact with agencies or agency partnerships on a regular basis under the auspices of a contract or memorandum of understanding.

In discussions with the full workshop group it was noted that the advisory role envisioned here might be perceived to overlap with existing entities such as the NRC – Water Science Tech Board and the Water Cycle Program. It was also noted that the role of CUAHSI could be longer term and reflect a broader consensus than may be possible with these other entities.

Prepared by David Ahlfeld

New England Regional CUAHSI Meeting – March 9, 2002

PROPOSED CUAHSI MISSION STATEMENT:

To facilitate advancements in the hydrologic sciences, in the broadest sense of that term.

CUAHSI will accomplish this by periodically identifying a broad-based research agenda for hydrology, setting priorities, and disseminating the results of this process to the hydrologic community and the public. As part of its mission CUAHSI will:

* promote an on-going discussion of timely science questions and societal needs in the hydrologic sciences;

* provide university scientists conducting research in the hydrologic sciences access to data and information at wide ranges of spatial and temporal scales, as well as access to the most appropriate instruments and technologies for the creation of hydrologic understanding to address a list of pressing national and international problems;

* nurture general understanding of hydrologic sciences through programs of education and outreach; and

* assure applicability of the advances through a program of technology transfer.

Prepared by Dennis McLaughlin

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Breakout Group IV on Defining Research Applications

Participants

Tom Ballestero – University of New Hampshire
Paul Barlow – USGS

Summary

The following are recommendations meant to meet the stated CUAHSI objective to, "Assure the applicability of the advances through a program of technology transfer." No costs have been contemplated for some of these recommendations, although a few a substantial in effort.

1. Assessment of Users Groups and their Needs
    a. Within the University Systems
    b. Professional Societies
    c. Government Agencies
    d. Community Groups
    e. Scientific Organizations
    f. Non-Governmental Organizations
    g. Resource Managers

2. Directed Workshops/Short courses/Conferences
    a. Synthesis of results by individuals researching a similar problem, or various investigators studying different aspects of a site
    b. Focused to target audiences
    c. Exposure forums for policy makers
    d. Fund efforts to make new research methods accepted/standard applications (for example runoff generation).

3. Database – The anticipated CUAHSI research efforts will generates a variety of data. Much of this is lost in journal publications and relatively inaccessible to researchers. A concerted effort is warranted to enable researchers to utilize data generated in CUASHI research.
    a. Documentation of data
    b. Standards for data
    c. Integration with federal/state databases

4. Web Site – A best first effort is to initiate a portal to introduce CUAHSI, inform membership of activities, and serve as a focus for all CUAHSI activities.

5. Co-Sponsorship of Technical Meetings

6. Enhance/Develop Educational Field Facilities for Each Campus

7. CUASHI Members Need to Ensure that Hydrologic Courses Are Included in a Set of Mandatory University General Education Electives

8. Build Partnerships with Existing Organizations

9. Publications and Publications Database

Prepared by Tom Ballestero

Table 1
Summary of Participants of New England Regional Workshop on March 9, 2002

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