Summary of CUAHSI Science Workshop
Atlanta, GA
2 February 2002

The meeting convened in the Crowne Plaza, Atlanta at 8:30 am EST. Participants were:

Martial Taillefert	GA Tech	mtaillef@eas.gatech.edu
Miguel Medina	Duke	miguel.medina@duke.edu
Fred Molz	Clemson	fredi@clemson.edu
Chris Romanek	Sav.R.Ecol.Lab	romanek@srel.edu
Venkat Lakshmi	South Carolina	venkat-lakshmi@sc.edu
David Furbish	Florida State	furbish@fsu.edu
Carolyn Ruppel	GA Tech	cdr@piedmont.eas.gatech.edu
Paul Schroeder	Georgia	Schroe@gly.uga.edu
Wendy Graham	Florida	wgraham@ufl.edu
Tom Burbey	VA Tech	tjburbey@vt.edu
Larry Murdoch	Clemson	lmurdoch@clemson.edu
Kevin Johannesson	Old Dominion	kjohanne@odu.edu
Robert Dickinson	GA Tech	robted@eas.gatech.edu
Robyn Hannigan	Arkansas State	hannigan@astate.edu
Gregg Davidson	Mississippi	davidson@olemiss.edu
Marshall Moss	CUAHSI	memoss@worldnet.att.net

Marshall Moss, David Furbish and Robyn Hannigan gave a brief review of the status of the consortium, its current situation with respect to planning its science programs, and the 5-point approach that is being used to gather grassroots input to the science plan. The eight 5-point statements that have been posted on the CUAHSI web site were discussed, as were the charges of the six standing committees. Also discussed were the needs and resources unique to the southern region.

The remainder of the morning was filled with a group discussion that addressed the following points:

Additions/changes/clarification:

- List of 6 points from Eagleson report…wording for (A) should include <u>subsurface</u> – land surface – atmospheric interactions
  - Wording for (A) should also include ecological interactions
  - Wording for (B) should include water/mass flux
  - Science questions should involve advanced computations/visualization
    - Problem-solving environment
- Observatories
    - Government agency involvement (eg., USGS) to provide *inertia:* “ideal”?
    - LTER as model?
    - Science MUST drive philosophy then expand to infrastructure including connections with USGS, NWS, USDA, USFS etc.

        - Key: defining missing elements to focus on needs for observatory structure
    - Observatories must be linked at onset, not afterthought (over-arching themes key)

    - Needs
      - National "clearinghouse" for data and data protocol (eg., model of ODP, ODPI)
      - Science must contribute to DEFINING type/scale of data collection
      - Connect with "geoinformatics"

- Measurement technology
  - IRIS model as guide
  - Synergy with academic labs (eg., instrumentation, tech support)
    - model – Purdue cosmogenic lab
  - Smart databases
  - Science/models – guide data collection/mining

- CUAHSI as a mechanism for developing collaborative interactions with related sciences (eg., biology, ecology etc.)

- Needs/resources of the southern region
  - Accurate prediction of water resources (quantity and quality) eg., drought driven
  - Sun-belt growth (population etc.) driven
  - Connection to climate change
  - Subtropical-tropical climate
    - High chemical reaction rates (southern region as end member)
    - Distinct subsurface matrix/material
      (eg., saprolite/fracture systems/carbonates)
  - Absence(?) of tradition of data resources
  - Connections to education and outreach
    - Summer institutes
    - Math/science schools
    - Graduate support/seed/fellowships(?)

- CUAHSI as national lobbying/advocate
  - NSF, congress groups etc.
  - Designated laboratory model (for access by science community)
  - International role (global issues/questions)

- Southern region unique resources/questions
  - Coastal population- long coastline
  - Groundwater-surface water interactions
  - NSF "critical zone" (coastlines)
  - Connect ecology, water quality (carbon sequestration) with tropical storms, flooding
  - Sea level changes
  - Karst…groundwater-surface water
  - Measurement/modeling
  - Saprolite/fracture systems – resources and quality
  - Sun-belt growth driven demands on resources

- Public service role
  - Documentaries

- Third generation science approach (basic and applied research go hand-in-hand)
    - Everglades
    - SERFC mission

- Key hydrological/ecosystems in southern region
  - Everglades
  - Piedmont
  - Saltmarshes/wetlands
  - Gulf coastline
  - Delta region
  - Karst

- ecology connections
- land-use changes
- hydrology crossing discipline boundaries by its nature
- Models
  - Constitutive equations/rules
  - Sparse data
  - Predictability
  - Benchmark data
  - Calibration/validation
  - "Community" model approach
  - "new" expectations of our models – data requirements needed to do this

Before breaking for lunch the group was divided into three sub-groups. The topics were: (a) land-atmosphere-subsurface interactions (include systems, disciplines, boundaries), (b) data across scales – scaling, subgrid parameterization, (c) the vision for CUAHSI – priorities (science focus), short & long term, education and outreach. The reports of these three sub-groups are provided as appendices to this summary.

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

The workshop concluded at 2:30 pm.

Group 1:

Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)
Atlanta Workshop, February 3, 2002

Land-Atmosphere-Subsurface Interactions

Biosphere, Ecology, Boundaries

A Summary Report by

Miguel Medina, Duke University, miguel.medina@duke.edu
Robert Dickinson, Georgia Tech, robert.dickinson@eas.gatech.edu
Carolyn Ruppel, Georgia Tech, cdr@piedmont.eas.gatech.edu
Gregg Davidson, University of Mississippi, Davidson@olemiss.edu
David Furbish, Florida State, furbish@fsu.edu

The most salient point the group wanted to highlight is that:

- Water is the receiving and transporting medium for all substances (e.g., nutrients, sediment, mobile ions) in the surface and subsurface environments, as well as in the atmosphere in addition to air.

A most important task is the **quantification of fluxes** across phases of the hydrologic cycle and across national and international political boundaries. There is a lack of agreement on the fluxes to **model and measure**, and their impact on ecology and society.
Among the most important elements to define, develop, and/or characterize are:

- Vertical and horizontal boundaries: e.g., of hydrologic cycle sub-systems such as land-ocean, land-atmosphere, surface-subsurface, and wetlands
- Temporal and spatial scales and their variability
- The sensor and measurement technology required to quantify these fluxes

A fundamental question to pose is:

- How is the environment going to change as a result of climatic excitations and human inputs?

In some of these environments it is difficult to identify whether systems are sources or sinks (e.g., carbon, water) and the extent of coupling that occurs. Is modeling of these fluxes a function of the scales (space/time), associated with heterogeneity (e.g., soil/atmosphere subsystem, surface water-ground water mixing zone) incorporated into both numerical and field experiments)? How can CUAHSI facilitate the research infrastructure required to answer these questions scientifically? Should this research infrastructure consist of nationally-designated analytical and lab facilities, observatories, and a new infrastructure for flux measurements at multiple scales?

CUAHSI should provide a united front for espousing these hydrologic science research initiatives to funding agencies, but it should not duplicate the role of existing university and government facilities for storing and managing data. The organization could play the role of a clearinghouse, providing quality benchmarks and facilitating the distribution of unique data sets that would foster the development of techniques in mathematical modeling or visualization to better understand complex phenomena across phases of the hydrologic cycle.

An example of a complex interaction is the *interchange between surface water and ground water bodies,* often idealized as a simple unidirectional transport process. For example, stream reaches have been characterized as either "gaining" or "losing." On a relatively large scale, this characterization may be adequate. However, more detailed examination has shown that the flow system in the near-stream subsurface can be complicated and is probably best thought of as a superposition of flows that occur at a number of different spatial scales. Ground water flow paths can show that stream-aquifer connections are more complicated than usually envisioned due to a wide range of variables, including geologic setting, oscillation in hydraulic conditions, as well as the morphology of the banks, surface water body bed, and variations in the hydraulic conductivity of the porous media and streambed materials.

Ground water and surface water interactions and mixing can be divided into the following three different zones: the surface water column, the upper sediment section near the sediment bed, and a zone of transition from ground water to surface water below the sediment-water interface. The latter zone has also been identified as the hyporheic zone. Ground water interacts with surface water through streambeds and banks: the process of water and solute exchange in both directions across a streambed is usually termed the hyporheic exchange. The direction of seepage through the streambed is commonly related to abrupt changes in bed slope or to meanders in the stream channel. The dimensions of the hyporheic zone depend on the type of sediment in the streambed and banks, streambed slope and variability, and hydraulic gradients. The hyporheic zone is a potentially significant zone of biological activity in aquatic systems; the ecological and health risk factors are reviewed in more detail later in this chapter. Due to ground water and surface water mixing within the hyporheic zone, the chemical and biological characteristics of water within the zone may differ considerably from those of adjacent surface water and ground water systems.

Group 2: “CUAHSI Vision”
Members: Larry Murdoch, Clemson; Fred Molz, Clemson; Chris Ramenack UGA-Savannah River Ecology Lab; Wendy Graham UF; Robyn Hannigan Ark State; Kevin Johannesson Old Dominion

The group reviewed the CUAHSI Mission statement and discussed possible revisions/additions/deletions from the proposed mission. Many in the group did not have a lot of history with CUAHSI or a lot invested in the development so far.

Consensus was that CUAHSI should become a united voice for hydrology, playing an advocacy role with funding agencies, cultivating potential future students, and captivating the interest of the general public. The idea of appointing a CUAHSI representative to AAAS was brought up and supported by the group. It was agreed that CUAHSI should facilitate the networking of interdisciplinary research groups to identify critical hydrologic issues, lobby agencies to fund research programs to solve these critical issues, and facilitate the bringing together of groups to write large inter-disciplinary long-term proposals which are significantly different from single-investigator or small group 3-year proposals currently funded by NSF. There seemed to be a general feeling that CUAHSI should not issue RFPs or distribute money itself, but should use existing avenues in NSF for that purpose.

Concern was expressed over tying up long-term funds in nuts and bolts, i.e. instrument warehouses, instrumented LTHOs or a fulltime staff maintaining large diverse databases. There was a consensus that CUAHSI should focus on leveraging what universities do best, and not duplicate what other Federal Agencies are currently charged to do. Some voiced a preference for CUAHSI having no permanent facilities thus leaving the university hydrologic community with the flexibility to re-invent itself, and re-focus on new emerging scientific issues. The idea of CUAHSI helping to obtain funding for longer-term (5-10 year), larger-scale, multi-university interdisciplinary research programs was appealing. However whether this idea was accurately captured in the current LTHO philosophy was debated. The idea seemed better captured by how the Oceanographic community apparently got the Coral Reef Initiative started and funded. There was discussion that CUAHSI , particularly at first, should function as a think-tank to identify the hydrologic equivalent of the “Manhattan Project”, or “putting a man on the moon”, and then put energy into helping the university community get this project funded and implemented. Perhaps the science-plan currently being developed will lead the way to the identification/refining a few large critical issues with mass appeal. There was a consensus that the science plan should receive wide circulation and review before the other committees (LTHO, Measurement Systems, Information Systems, etc.) were formed and began working on their white papers.

Group 3
Data across scales of temporal and spatial variability
(Martial Taillefert, Georgia Tech; Paul A. Schroeder, U. Georgia; Tom Burbey, Va. Tech; Venkat Lakshmi, U. South Carolina)

The SE-CUASHI workshop participants recognized that there already exists a large body of hydrologic data that has been collected (and will continue to be collected) by numerous agencies and groups (e.g., NSF-LTER sites, USGS-WEBB sites). It was also recognized that the definition of hydrologic data needs to be broader in scope; not only to include traditional data sets (e.g., rainfall, soil moisture, stream gauge and potentiometric surfaces measurements) but also allied science data sets (e.g., geochemistry, ecological, soil mineral, microbiological, genetic, and geological measurements) that are correlated.

This subcommittee was assigned the task of evaluating the need to assemble hydrologic data into a format that would allow the advancement of the state of hydrological knowledge. The search for general patterns and principles in other scientific fields by integration of data is proving to be fruitful. A good example is the National Center of Ecological Analysis and Synthesis (NCEAS). The assembly of hydrologic data into a CUAHSI managed data base would foster new techniques in mathematical modeling, dynamic simulation, visualization of hydrologic systems, and digital mapping of complex hydrologic phenomena.

Hydrologic data reflect processes that occur over a range of spatial and temporal scales. In the spatial regime, scales range from nanometers (e.g., exchange of ions from mineral surfaces to solutions) to 100 km (e.g., large basin scale process such as the size of regional air masses). In the temporal regime, scales range from milliseconds (e.g., photo-chemical reactions) to 100,000 years (e.g., paleoclimatic record in soil minerals).

After recognizing the inherent diversity among physical, chemical and biological variables through scales, the observation process (i.e., data collection) should (as best as possible) accurately span these time and space scales. Integrated hydrologic data collection is important because it:

(a) Provides a means for characterizing the natural (and perturbed) systems.
(b) Provides a means of identification of un-accounted processes between scales in models.
(c) Provides a means for producing forecasts of hydrological conditions (physical/chemical/biological) from models.

Salient features to be consider in developing a data system.

(1) All observations must be tagged with the appropriate spatial and temporal scales so as to avoid misrepresentation when used alone or with modeling.
(2) Explore data analysis, structure and schemes used in other disciplines in order to enhance/establish the relational structure (e.g., NCEAS)

(3) Field-based data collection should be given priority over laboratory simulations (i.e., measurement of “dirty” systems). The intent is to make linkages between modeling and observations. Scaling up laboratory observations to the natural world is an arduous task.

(4) The establishment of new LTHOs should be given lower priority for the following reasons.

    a. Existing facilities or sites (e.g., NSF-LTER, USGS, USDA, NWS/NOAA, US-Army Corp. of Engineers, EPA) cover a wide range of hydrologic regimes.
    b. Cost and efficiency issues would allow existing sites to be augmented to rise to the level to answer science questions.
    c. Some flexibility needs to be retained to create new LT sites should retain some that would address new (and pertinent) issues pertinent to new science problems.