HydroView: An Integrated Platform for Research in Hydrologic Science

Richard P. Hooper,
Executive Director
Consortium of Universities for the Advancement of Hydrologic Sciences, Inc.

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universities allied for water research

The Challenge from National Science Foundation (NSF)

- What are the fundamental scientific challenges facing hydrology?
- Is a new mode of research necessary to face those challenges?
- What infrastructure investment will transform hydrology?

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The Community Response

- Define “hydrologic science” more broadly than hydrology
- Organize a consortium to represent the community
- Design infrastructure program to transform the science

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What is Hydrologic Science?

- Expands beyond traditional hydrology
- Focus on “why” the earth works as it does, like other earth sciences, moving beyond traditional problem-solving orientation
- Embraces parts of hydrology, geomorphology, hydrogeology, biogeochemistry, …
- **Hydrologic cycle is central organizing principle**

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Science Needs: Terrestrial Hydrologic Cycle

- Improving hydrologic “laws”
  - Heterogeneity
  - Discontinuity at interfaces
  - Understanding feedbacks
- Recognizing interdisciplinary controls
  - Biological influence
  - Geomorphic evolution
  - Human dimension
- Challenges
  - Scaling
  - Prediction and Limits-to-Prediction
  - Forcing, Feedbacks, and Coupling

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Approach

- Calibrated River Basins
- 10,000 km^2 ± 1 order of magnitude
- Extensive characterization for more rigorous hypothesis testing
- Supporting Facilities
  - Informatics
  - Instrumentation
  - Synthesis

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Opportunities

- New sensors
- New communication technologies
- Remote sensing
- GIS/Lidar/Geophysics
- Many others

Megabytes of data—
But does it help us improve understanding?

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HydroView

- Initial infrastructure program
- Mutually supportive elements
  - Observatories
  - Instrumentation
  - Informatics
  - Synthesis

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Hydrologic Observatory (HO) Design Concepts

- Large (~10,000 km^2) instrumented basins
  - Permits exploration of all interfaces, including land surface/atmosphere
  - Provide **coherent, multi-disciplinary, multi-scale** data
  - Characterize stores, flux, flowpaths, and residence-time distributions of water, sediment, nutrients, and contaminants.
  - Research platform for broad range of environmental scientists
- Community facilities
  - Core data available to everyone
  - Open access to site
  - On-site professional staff
- Budget Estimates
  - $3M annual operating cost and $10M 5-yr capital budget

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Typical Core Data

- Characterization
  - High resolution topography
  - Detailed geologic mapping
  - Vegetation surveys
  - Land use/ land cover
- Space-Time Grids
  - Precipitation fields
- Time Series
  - Discharge
  - Water Quality
  - Groundwater Levels
  - Chemistry
  - Towers
- Remote-sensing
  - Soil moisture
  - Vegetation greenness

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Strategic Collection of Data

- Hypothesis Driven
- Replication
- Balance
- Perspective: Understanding the terrestrial hydrologic and biogeochemical cycles and relation to climate

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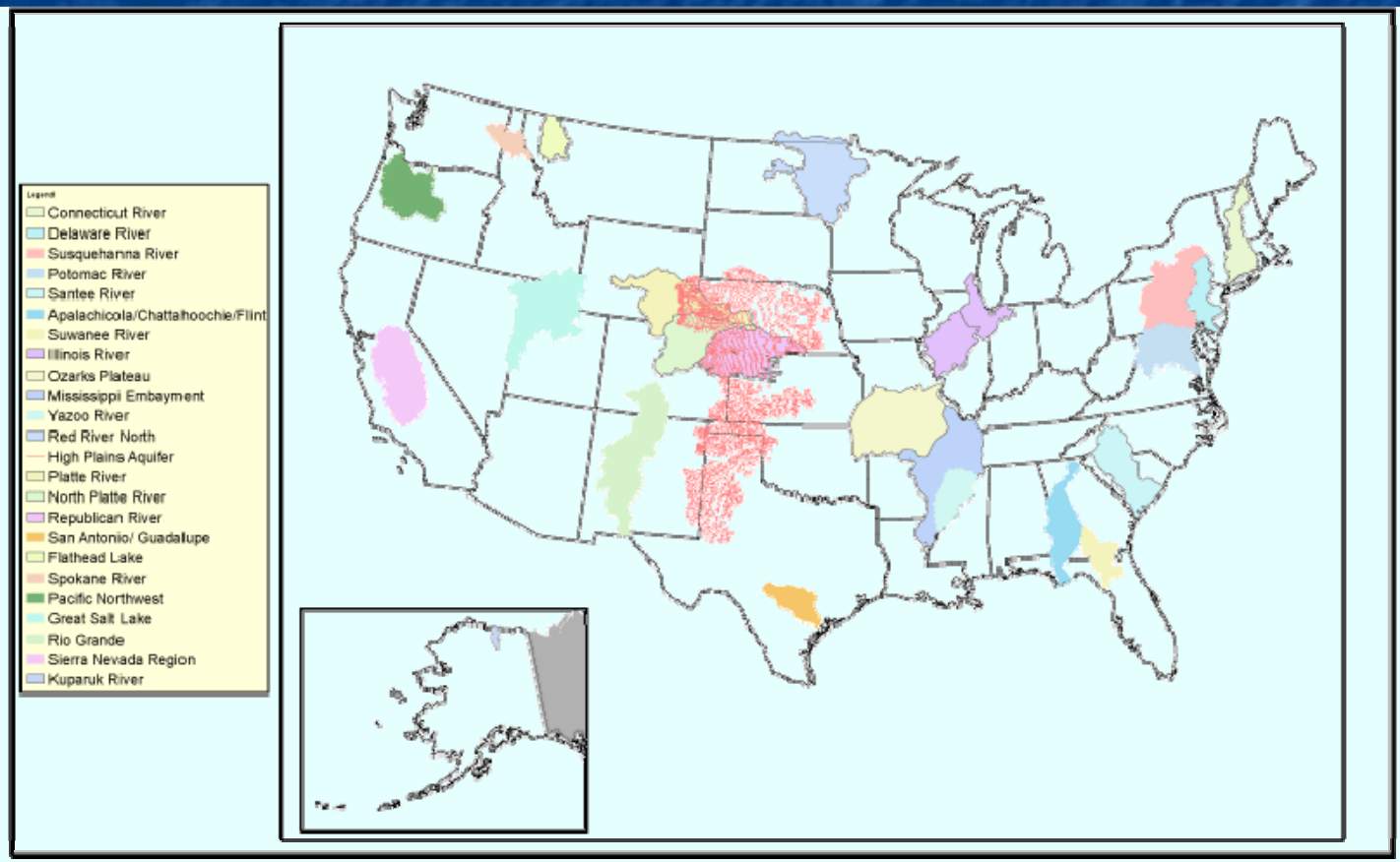
HO Status

- Neuse Paper Prototype Study—just published
- National Workshop—August, 2004 Logan, UT
- NSF Program Announcement: Summer, 2005
- Selection of 2 HOs: March, 2006
- Further build-out dependent on funding strategy and success of test-beds.
- Vision: ~15 HOs for conterminous US

HOs Under Design



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Collaboration Opportunities

- Modeling
  - Identifying dominant hydrologic processes across scale
  - HO's approach scales of interest to GCM community
- Ground referencing
  - Comprehensive water cycle data
  - Infrastructure to support campaigns

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Summary

- Major hydrologic science research initiative funded by US National Science Foundation
- Objective: improved predictive understanding of terrestrial hydrologic cycle
- Driver: Linkage with climate science, biogeochemistry

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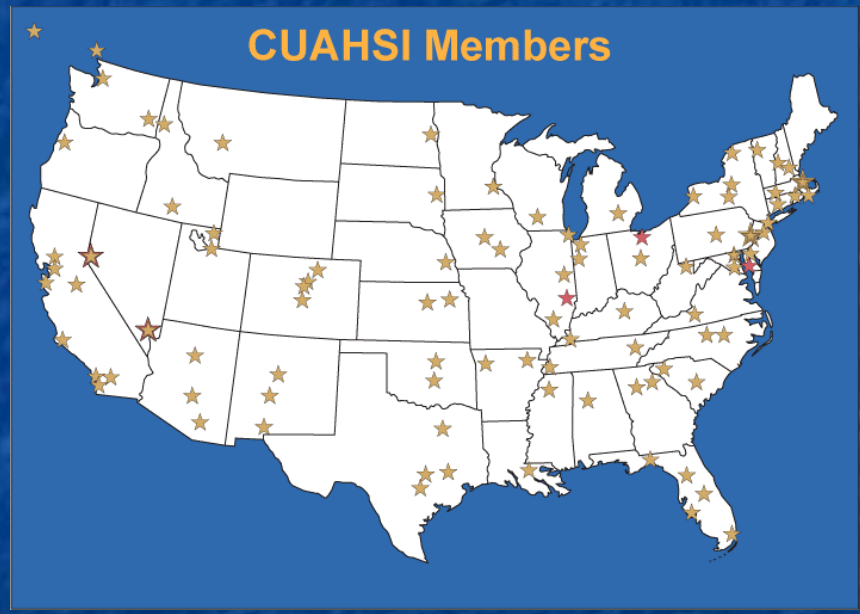
Who is CUAHSI?

- A consortium of 98 research universities, 4 affiliate members, and 2 int'l affiliates
- Incorporated June, 2001 as a non-profit corporation in Washington, DC



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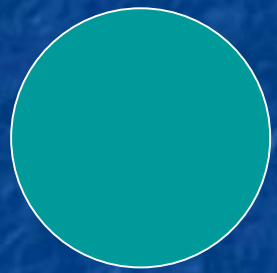

Premise

- Need *field observations* to advance theory
- Critical attributes
  - Coherent and commensurate
  - Multi-disciplinary
  - Multi-scale
  - Describe interfaces
    - Land surface-atmosphere
    - Region groundwater/river exchange

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Purpose

- Science Objective: To further predictive understanding of the terrestrial hydrologic cycle and its linkages with climate and biogeochemical cycles
- Societal Need: Will there be enough water for the next century?
  - ...of appropriate quality
  - ...to meet society's needs
  - ...to maintain the integrity of our ecosystems

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River Basin as Unit of Study

- Forcing
  - How does the basin respond to low-frequency precipitation forcings? How is the predictability of floods and droughts altered?
- Processing
  - How does the basin process precipitation and chemical inputs ?
- Evolution
  - How do changes to the land surface alter the hydrologic cycle?

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Need for CUAHSI

- Larger-scale, longer-term data and facilities to support researchers
- Enable research at disciplinary boundaries
- Support of larger research teams
- Improve efficiency and effectiveness of data collection and dissemination of research data

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Today's Briefing

- Brief definition of Synthesis, Informatics, and Instrumentation
- Focus on HO's
  - Design Concepts
  - Status of Prototyping Efforts
  - Near-term Plans
- Collaboration opportunities

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Design Concepts: National Center for Hydrologic Synthesis

- "Think tank" for hydrologic science
  - Neutral ground for scholarship
  - Includes academic, government and private sector scientists
- Emphasis on interdisciplinary, cutting edge ideas
- Modes:
  - Working groups (5-15 people, 1-2 yr duration)
  - Post-docs
  - Sabbatical visitors
- Products: journal articles

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NCHS: Status

- Host Institution: Berkeley
- Interim Director: Yoram Rubin
- Submission of NSF proposal: March, 2005
- Operation: Fall, 2005
- Initial NSF Budget: ~$500K/yr, ramping to $2M over 4 years
- Substantial external partnering w/ industry, gov't agencies, int'l research org.
- Watch for call for proposals (Eos)

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Hydrologic Information Systems Design Concept

- Provide common, convenient interface for users to retrieve HO data
- Federated digital library with DataViewer
- Metadata standards
- Advanced data systems technologies
- Automatic population with Federal Science Agency data (USGS, NWS, and others)

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Informatics Approach

- Pilot design phase (through March, 2006) for initial product
- PIs: David Maidment (UT), John Helly (SDSC), Mike Piasecki (Drexel), Praveen Kumar (Ill)
- Operational Center to deliver data products
- Thematic Centers for software development

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Instrumentation: Design Concepts

- Get instruments into scientists' hands with appropriate training
- Diffuse knowledge about state-of-the-art across disciplines
  - Handbook of Field Techniques
- Increase efficiency of instrument utilization
  - Leasing and sharing arrangements internally and with Federal science agencies (e.g., USGS HIF)

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Evaluation Criteria

- Science
  - Hypotheses Posed
  - Utility of Core Data for Characterization
- Leveraging of Existing Data
  - Identify “gaps” preventing science
- Partnerships
- HOs must attract “outsiders” to do research

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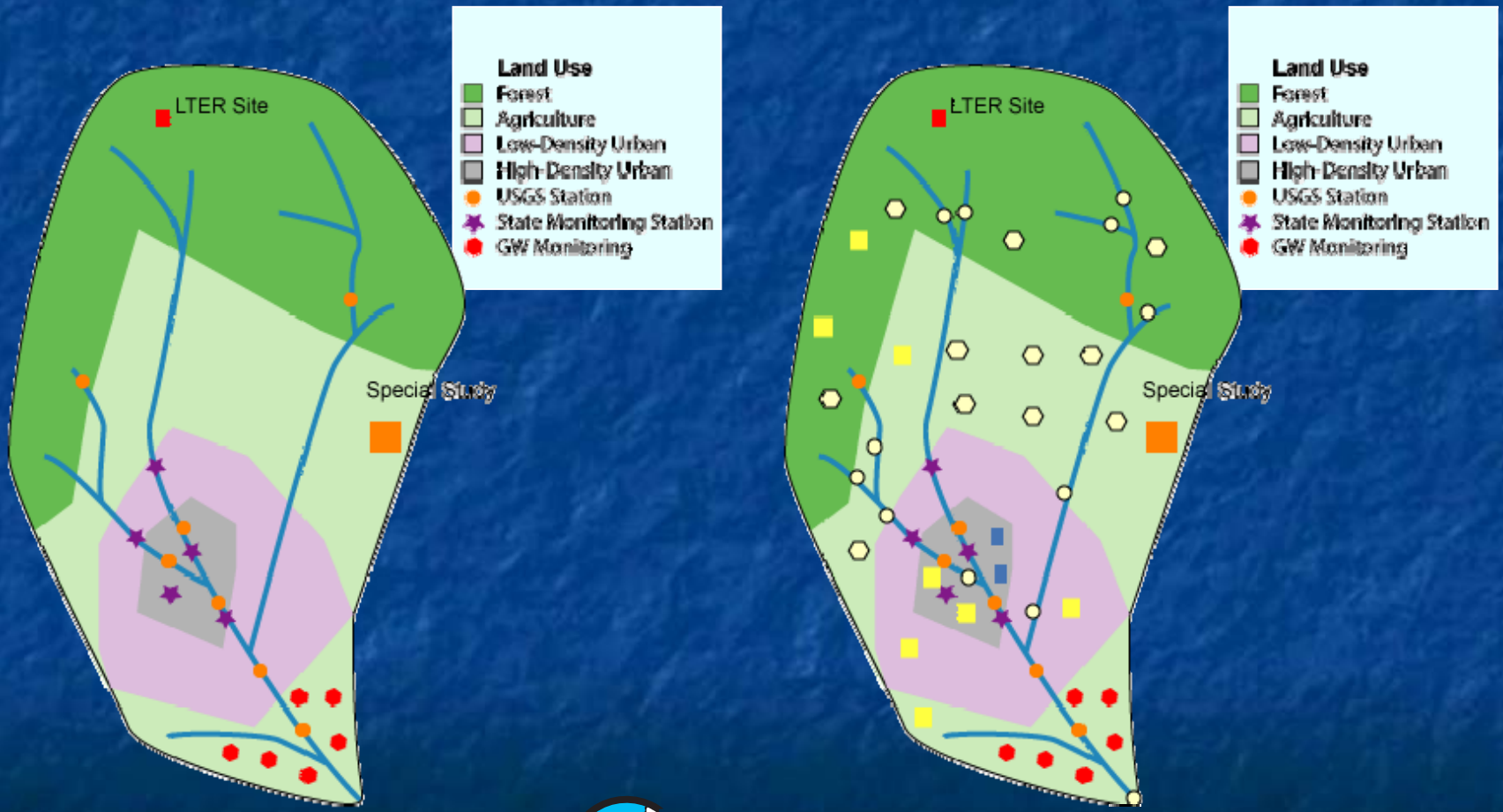
Leveraging Data



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Core Data

- Characterize
  - Stores
  - Fluxes
  - Flowpaths
  - Residence time distributions
- For
  - Water
  - Sediment
  - Nutrients
  - Contaminants

Across a range of spatial scales, including the whole basin

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Collaboration Opportunities-2

- HO
  - Participate in design (http://www.cuahsi.org)
  - Work at the site (in 1.5 – 2 years)
  - Contribute to committees on protocols
  - Network between Japanese and American sites
- Education
  - Proposing “CUAHSI Asian Doctoral Fellow” to U.S. Nat’l Science Foundation w/ Myron Mitchell (ILTER)

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Education and Outreach

- Each HydroView element has large potential E&O component
- Two additional initiatives:
  - Modular Hydrologic Field Camps
  - CUAHSI Cyberseminars

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CUAHSI Cyberseminars

- Begun Fall, 2003 (3 seminars)
- Continued Spring, 2004 (5 seminars)
- Free and open to all interested parties
- Typically between 20 and 30 sites with 150-200 people signed on
- Low-tech approach
- http://www.cuahsi.org

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Hydrology Field Camps

- Barriers to offering field camps
  - Traditionally not a part of CEE, but of Geology
  - Broad range of disciplines
  - Large amount of work for faculty
  - Expensive, need large student base to support

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Field Camp Approach

- Develop series of 1-week modules
  - Vadose zone
  - Aquifers
  - Surface water
  - Shallow geophysics
  - Aquatic Chemistry and microbiology
  - OSHA Training
- CUAHSI Review, approval, and distribution
- Cooperative Project between Clemson and N. Illinois
- Test site: Clemson

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