Quantifying Historical Legacies: Challenges of Synthesis Research

Charles Vörösmarty, Mark Green and The Northeast Regional Consortium for Hydrologic Synthesis

CUAHSI Cyber-Seminar
23 October 2009
The 500-Year Challenge:
To quantify the widespread transformation of hydrosystems from natural to human-dominated systems over local-to-regional domains in the North East corridor from 1600 to 2100
NE Corridor: A Broad Spectrum of Changing Environments
Freshwater-mediated Links to Economic Development, Ecosystem Health, Land-Coastal Linkages, National-Regional-State-Local Governance

Total Nitrogen Yield
New England Sparrow Model (USGS)

Dams & reservoirs

WATER FOLLIES
Groundwater Pumping and the Fate of America's Fresh Waters
ROBERT JEROME GLENNON
NSF-CUAHSI Pilot Synthesis Center Activities (2007-2010)

Executed through

- *The Northeast Regional Consortium for Hydrologic Synthesis*

  Lawrence Band, Beth Boyer, Rafael Bras, Ellen Douglas, Balazs Fekete, Steve Frolking, Mark Green, Paul Houser, Jennifer Jacobs, Upmanu Lall, Dennis Lettenmaier, Marc Levy, Pete Loucks, Michael Mann, William McDowell, Robert Naiman, Craig Nicolson, Roger Pielke, Sr., Steven Running, Guido Salvucci, Adam Schlosser, Sybil Seitzinger, Paula Sturdevant-Rees, James Syvitski, Richard Vogel, Charles Vörösmarty, Thorsten Wagener, Peter Weiskel, Wil Wollheim, Eric Wood

  …..with their students

  …..with Summer Synthesis Institute participants

  …..with CUAHSI Early Career Fellows (J. Arrigo, D. Bain, B. Pellerin)

  …..with U.S. and international partners incl. UIUC

*Cross-cutting the community... cross-cutting career stages*
CUAHSI Summer Synthesis Institutes

• 6 Weeks in residence (Boston Metro Area (M.I.T.) in 2008; City College of NY in 2009)
• Team-oriented work driven by graduate students (synthesis scholars) & several mentors
• Century-scale blocks: 2008 & 2009 & 2010….

The Colonial Period (1600-1800)

The Industrial Revolution (1800-1920)
Summer Institutes: *Creating a Framework for Interdisciplinary Dialogue*

**Conceptual Model:**
Expressly designed to
-- Create common framework and nomenclature to unite disciplines
-- Rank sources of change

Focus on chief agents of change and how these factors vary over time

**Climate ∆ and variability**

**Land Use & Cover Change**

**Water Engineering**

The Northeast Regional Consortium for Hydrologic Synthesis
Residence time: an integrated measure of regional stocks and fluxes

\[ \tau = \frac{\sum S}{ET + Q + DP} \]
Land Cover

1. % Forest over time
2. Convert to water stored in biomass
3. Rely on contemporary experiments and simple modeling for soil moisture

David Foster et al., Wildlands and Woodlands: A Vision for the Forests of Massachusetts
Mill Dams

1. Number in 1810 at the county scale
2. Date of first in each state
3. Assume linear growth
4. Estimate average mill pond geometry using remnants

Map from Walter and Merritts (2008) Science
Beavers

1. Develop rule set based on existing literature:
   a) Beaver ponds per stream length
   b) Watershed position of beaver ponds
   c) Average beaver pond geometry

2. Place these rules on the national stream network (contemporary)

3. Compare beaver population estimate from rule set to fur export numbers
Residence Time Results

1600 Baseline

Change by 1800 Preliminary Estimate

Legend
Residence Time (days)
- 0 – 30
- 30 – 40
- 40 – 50
- 50 – 60
- 60 – 95

Legend
Residence Time Change (days)
- 35 – 25
- 24.99 – 15
- 14.99 – 5
- 4.99 – 0
- 0.001 – 6
Defining Hydrologic Change:

Water Availability = P - ET - WQ - Legal

Precipitation = Total Amount Available
Unavailable due to ET and LULC
Unavailable due to Water Quality
Unavailable due to Social or Legal Constraints
River Basin Fight Pits Atlanta Against Neighbors

By SHAILA DEWAN
Published: August 15, 2009

ATLANTA — The residents of the economic engine of the South, as they like to call this comparatively gleaming and rapidly expanding state capital, have always suspected that they are the objects of resentment from their more rural neighbors.

Now they are certain of it.

A recent court defeat has left Atlanta howling that its enemies, including Alabama and Florida, are trying to choke off the city’s prosperity, if not out of sheer spite then at least the misguided notion that jobs and money would flow to them instead. The conflict is the timeworn rural-versus-urban enmity writ large, a battle over water that has pitted Atlanta against its neighbors in and out of Georgia.

“The only motivation is political,” Charles Krautler, the director of the Atlanta Regional Commission, said of the fight. “We don’t have as good of spin doctors as they do. It’s easy to point the finger at big bad Atlanta.”

Ostensibly, the war among the three states is about a river basin that supplies the taps of 3.5 million people in metropolitan Atlanta before it flows down the Alabama-Georgia state line and into the Florida Panhandle. Each state says the others are demanding too much water. But
Hydrology

Reaching Different Disciplines

- Outreach meetings
- Synthesis scholars

In 2010/11:
Public Health, Evolutionary Biology, Hydraulic Engineering, Public Policy, Game Theory

Bollen et al. (2009), Clickstream Data Yields High-Resolution Maps of Science, PLoS one
Synthetic Ideas/Findings to Emerge from Our Effort

- Metrics of human water “footprints” are feasible to construct, are informative, create important focal points for synthesis
- Researching the evolution of this human-water system requires links outside hydrology...to biological & social sciences
- **Clear need** for Digital Historical Archive and Inter-disciplinary Water Systems Model ...common currency for multiple disciplines... fuel transformation in social and historical fields
Additional 2009-2010 Synthesis Activities

• Synthesis Multi-versity: Student-Led Science Networking Collaboratory, Cyber-seminar series, Expertise “Clearinghouse” / Mentor-Student matchmaking

• Sessions at AGU, AWRA\textsubscript{(water resources)}, AHA\textsubscript{(history)}, ESA\textsubscript{(ecology)}, AAG\textsubscript{(geography)}, ASEH\textsubscript{(environmental history)}

• Papers to appear in a variety of outlets (4 from 2008 / 8 planned from 2009)
NEXT CYBER-SEMINAR: 20 November, 2009...detailing major upcoming events on the horizon

For more information see: http://hydrosynthesis.ccny.cuny.edu