State of Water Resources in Connecticut from a Human Dimensions Perspective – Baseline Data

Basic Information

Title:	State of Water Resources in Connecticut from a Human Dimensions Perspective – Baseline Data
Project Number:	2016CT296B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	CT-002
Research Category:	Social Sciences
Focus Category:	Water Use, Management and Planning, Water Quality
Descriptors:	None
Principal Investigators:	Anita Morzillo

Publication

1. Barclay, J.R., Z.B. Smiarowski, L.S. Keener-Eck, and A.T. Morzillo. A Landscape-Level Human Dimensions Analysis of Water Scarcity in a “Water-Rich” State. in preparation.

Proposal Title: State of Water Resources in Connecticut from a Human Dimensions Perspective – Baseline Data

Principle Investigator:
Anita Morzillo, Assistant Professor, Natural Resource & Environment, University of Connecticut, Storrs, CT 06269-4087. Telephone: 860-486-3660, Email: anita.morzillo@uconn.edu

Summary:
An ongoing challenge is the sustainability of water resources among competing biological and human uses. Compared to biophysical research, the human dimensions aspects of water resources and management are severely understudied. This is particularly true in regions perceived to be "water rich," where drought conditions occur less frequently and are therefore more unpredictable than in regions with cyclical wet and dry seasons. The objective of this research was to synthesize existing human dimensions information about water resources and water-related communications (i.e., use advisories, restrictions, and other outreach-related communications) across the state of Connecticut. A geographic information system framework was used to compile and assess information about water supply sources, water suppliers, sociodemographics, and recent water-related communications (since 2011) at the town (n = 169) level. Results of analysis focused on three themes: 1) source and distribution of water-related communications across Connecticut towns, 2) the roles of public versus private water systems and sociodemographic factors in the control of water resources and water-related communications, and 3) the influence of a dominant water supplier in state-wide water resource resiliency. Results will be applied to future work focusing on stakeholder perceptions of water resources and management and informing the state's comprehensive water plan currently in development.

Introduction/Research Objective
An ongoing challenge is the sustainability of water resources among competing biological and human uses. Compared to biophysical aspects of water resources and management, the human dimensions (the study of interactions between humans and the environment, and characteristics

of humans that influence those behaviors) of water resources and management is understudied. This is particularly true in regions perceived to be "water rich," yet experiencing relative drought conditions that can result in conflicts among water users or restrictions on public and private consumption-- including Connecticut. It is expected that uncertainty related to timing, frequency, and location of precipitation at the local and regional scales (NOAA 2013) will exacerbate stresses related to water resources on human communities (MEA 2005). To this researcher's knowledge, no studies have holistically evaluated linkages between human knowledge about water sources, regional water issues, household use behaviors, and concerns about future water resources and management-- particularly in regions that are perceived as "water rich." The proposed work is a first step toward addressing this critical knowledge gap.

Connecticut provides an excellent and timely location for pursuing such research, particularly as the state develops its first comprehensive water plan. Although perceived nationally as "water rich" in a relative sense, public and private concerns about water supply are expressed. Use restrictions are activated within the state on a regular basis as a result of combined shortfalls in and timing of expected precipitation, and distribution of urban development. Together, uncertainty in precipitation events and urban development are adding pressure to existing water resources, resulting in speculation about how to meet future water use expectations across the state. For example, the town of Mansfield recently acquired alternative water sources for ongoing expansion of the University of Connecticut campus, yet socio-political and infrastructural constraints existed in terms of rerouting surface or ground water to the campus. It is likely that similar issues will emerge within Connecticut in the future, potentially resulting in a need to set water allocation priorities and to develop strategies for adaptation to such changes within the water resources and management infrastructure. Statewide, little is known about human dimensions of water resources and management in Connecticut, including perceptions of both public and private stakeholders about issues such as water availability, water conservation, and water quality concerns, and potential community response to water management strategies.

At this time, a compilation of the baseline data that are needed to develop a rigorous geographic-based sampling strategy for assessment of human dimensions of water resources and management does not exist for Connecticut. This research addresses that knowledge gap, and

the research question: from a human dimensions perspective, what is the current state of information and knowledge about water resources and management across Connecticut? This study is developing the information base necessary for using social science as a tool for understanding social dynamics that influence state-level strategic planning for water resource management across Connecticut's diverse variety of stakeholders.

The objectives of this study are to:

1. Compile a compendium of information needed for detailed study of human dimensions of water resources for Connecticut ("state of water resources in Connecticut from a human dimensions perspective"). Some information is publicly available but scattered at the town, municipal, regional, and state levels. Other sources include town, regional, and state officials and other stakeholders involved with development of the water resources and management plan. Aggregation and synthesis of these data will allow for state-wide assessment of water resources information.

2. Through data synthesis, develop a framework for broader future statewide sampling and detailed data collection. Organizing and synthesizing aggregate water source, water user, and socio-demographic data into a geographic information systems (GIS) framework will allow for geographic assessment and visual interpretation of social science data. Such information will allow researchers to identify patterns in existing information and data needs, and will inform future strategic geographically based sampling and analysis.

Methods/Procedures/Progress

Data were collected at the town level (n = 169), which allowed for geopolitical consistency and the ability to assess data patterns across the state. Additional information about municipalities and regions is included, as appropriate. We hypothesized that water resource information vary by town and region. Three main categories of data were collected included in this analysis:

1. Water Sources and Distribution

There are three categories of public water systems in Connecticut: 1) community (residential consumers), 2) non-transient/non-community (consistent, non-residential consumers, e.g., schools and office buildings), and 3) transient/non-community systems (e.g., restaurants and parks) (CSS 2015). For this project, we focused on community and private systems (category #1 above), which we defined as all non-public systems, including individual residences with private wells. The term "parent company" refers to entities that control one or more community systems.

Three sources of water systems data were integrated: 1) Community Water Systems from the CT DPH (CT DPH 2014); 2) water system services areas (Eric McPhee, CT DPH, personal communication); and 3) municipality-level Water Quality Monitoring Schedules (CT DPH 2016a). Together these data provided spatial data on existing water systems, population served by water systems, and ability to reconcile discrepancies among the data. Also included were water sources for each water system (CT DPH 2016b), aquifer protection areas (CT DEEP 2012) and drinking water watersheds (Eric McPhee, CT DPH, personal communication).

2. Estimating Community versus Private Water Supplies

Water company service maps and population served data were integrated with town maps (CT DEEP 2005) and town population estimates (CT DPH 2012) to estimate the proportion of residents dependent upon community versus private water supplies. Because of data inconsistencies, several assumptions had to be incorporated to enable comparisons across towns (details included in "manuscript in prep"). Assumptions were applied to estimate the population served by community and private water sources in each town. The population within each town served by water systems serving only that town (i.e., single-town systems) was first identified using information from data category #1 (above). Two methods were used to distribute among towns the population served by systems serving multiple towns (i.e., multi-town systems; details included in "manuscript in prep"). For each town, method used to estimate the population served was determined based on which approach of the two resulted in a larger calculated population size. Further adjustments were made to the town-level estimates of population served by each water company until the estimates were constrained by the total population of the town (no more

than 5% exceedance), and by the population served by the water system (within 5% of the population served). Finally, the population served by private water systems (i.e., wells) was estimated as the difference between the town population and the population estimated to be served by community water systems (both single town and multi-town systems combined).

3. Media Communications about Water Availability

We used multiple sources to compile water-related public media communications from the past five years (January 2012- November 2016): Lexus Nexus and Proquest Newspapers database search engines, websites of 13 water companies, and websites of all 169 towns/municipalities. For each communication, we recorded communication type (e.g., restriction, outreach, restriction type (e.g., mandatory, voluntary), issuer, date, geographic scope, topic, keywords, and source.

Other Data Sources

Additional data gathered included Connecticut socioeconomic and geographic data obtained from the American Community Survey 5-year Estimate (2010-2014) and the 2010 US Census Bureau decadal census. Connecticut land cover data were obtained from the UConn Center for Land Use Education and Research.

Data Analysis

ArcGIS was used to create a linkage of town maps, water communication, water system, sociodemographic, and land cover data. Media communications were organized and sorted using Microsoft Access. Relationships among water and socioeconomic variables were evaluated using R-version 3.2.2.

Results/Significance

To the researcher's knowledge, this is the first attempt to integrate the data described here. Key findings are summarized as follows. Findings are considered preliminary until peer-review of results are completed (manuscript in preparation; see below).

Water Systems

Sixty-five towns acquire >95% of their water from ground water sources. Twenty-three acquire >95% of their water from surface water sources. Thirteen towns acquire approximately 50% of water from surface and ground water each. Eight towns purchase >50% of their water from other water systems.

The largest public community systems in Connecticut (by population served) are the Aquarion Water Company of Connecticut, Regional Water Authority, Metropolitan District Commission, and Connecticut Water Company. Collectively, these four largest water systems serve people in 73 towns. The proportion of each town population served by at least one of these companies ranges from 5-100%. Five towns are served by two of these companies. One town is served by three of these companies.

The large public water systems are not representative of all Connecticut water systems. There are 355 unique parent company public water systems in Connecticut that serve ≥25 people; most serve <200 people (*n.b.* schools and correctional institutions are included in these summary numbers but not included in analysis). The majority of water systems serving <200 people were apartment complex, mobile home communities, parks, or senior citizen communities. Most Connecticut water systems (n = 301) serve only one town, and typically between 1,000-100,000 people. Towns associated with a larger proportion of private water systems were often considered to be rural, many of which are in eastern Connecticut. There are 17 towns for which >95% of water systems are categorized as private water systems.

Water-Related Communications

A propensity of water-related communications took place in the western part of the state, as well as the New London area. The western part of state is largely served by Aquarion water company. Also prominent were the towns of Mansfield and Lebanon. Mansfield is in the process of installing a diversion pipeline form the Shenipsit Reservoir to meet the needs of the growing

University of Connecticut campus. Lebanon is a concentrated agricultural area with several large livestock and poultry farms.

Statewide alerts were categorized as either: 1) concerns about issues relating to water quantity, and 2) restrictions related water usage issues by the town, water company, or statewide. The majority of alerts (87%) were issued by the water companies and relevant to the west side of the state. Fewer communications existed among towns in eastern and south-central Connecticut (n = 24). Towns with fewer water-related communications were generally those containing a larger area of open water, and a greater number of residents on private systems (i.e., groundwater).

Implications of results in the manuscript in preparation include:

- Areas of the state with the fewest number of communications may be attributed to ruralness and prevalence of private versus public water systems;
- There appear to be inconsistencies in the data related to large urban areas that have an unexpectedly low number of residents on community water systems, and residents in smaller towns on public systems (these inconsistencies are being verified and corrected);
- The role of dominant water systems in water communications and statewide water resource resiliency.
- System size versus degree of protection for local-level water shortages.

References

Connecticut Department of Public Health (2016a). Public Water Quality Monitoring Schedules and Compliance Information. http://www.ct.gov/dph/cwp/view.asp?a=3139&q=387350

Connecticut Department of Public Health (2016b). High Quality Source List. http://www.ct.gov/dph/lib/dph/drinking_water/pdf/2015_High_Quality_Source_List.pdf

Connecticut Department of Public Health (2014). Community Water Systems worksheet. http://www.ct.gov/dph/cwp/view.asp?a=3139&q=387346

Connecticut Department of Energy and Environmental Protection (CT DEEP) (2012) Aquifer Protection Areas Shapefile. ftp://ftp.state.ct.us/pub/dep/gis/shapefile_format_zip/Aquifer_Protection_Area_shp.zip

Connecticut Department of Public Health (CT DPH) (2012) Annual Population Estimates. http://www.ct.gov/dph/lib/dph/hisr/hcqsar/population/excel/pop_towns2012.xlsx

Connecticut Department of Energy and Environmental Protection (CT DEEP) (2005) Connecticut Town Polygon. http://www.cteco.uconn.edu/metadata/dep/document/CONNECTICUT_TOWN_POLY_FGDC_Plus.htm

State of Connecticut General Statutes (CSS). 2015. Standards for quality of public drinking water. Sec. 19-13-B102. https://eregulations.ct.gov/eRegsPortal/Browse/RCSA/%7B5552BDFF-788C-4516-8BD1-91B8C5479127%7D