Connecticut Institute of Water Resources
Annual Technical Report
FY 2016

Introduction

The Connecticut Institute of Water Resources (CTIWR) is located at the University of Connecticut (UConn) and reports to the head of the Department of Natural Resources and the Environment, in the College of Agriculture, Health and Natural Resources. The current Director is Dr. Glenn Warner and Associate Director is Mr. James Hurd.

Although located at UConn, the Institute serves the water resource community throughout the state as it solicits proposals from all Connecticut universities and colleges. The Institute works with all of Connecticut's water resource professionals, managers and academics to identify and resolve state and regional water related problems and to provide a strong connection between water resource managers and the academic community.

The foundation for this connection is our Advisory Board, whose composition reflects the main water resource constituency groups in the state. Currently the Advisory Board is composed of 10 members. CTIWR staff also participate on statewide water-related committees whenever possible, enabling the CTIWR to establish good working relationships with agencies, environmental groups, the water industry and academics.

The USGS 104B program is the financial core of the CTIWR. The Institute does not receive discretionary funding from the state or the university, although the CTIWR does receive funds to cover two thirds of the Associate Director's salary per year from the Dean of the College of Agriculture, Health and Natural Resources as match for our program administration and other activities.

Research Program Introduction

The majority of our 104B funds are given out as grants initiated in response to our annual RFP that is released in September of each year. The majority of these funds go to research projects. To solicit research proposals, the Institute sends an announcement to Connecticut institutions of higher learning requesting the submission of pre-proposals. These are reviewed by the CTIWR Director and Associate Director. When selecting potential projects for funding, the Institute considers three main areas: 1. technical merit, 2. state needs and 3. CTIWR priorities (use of students, new faculty, seed money for innovative ideas). Investigators submitting pre-proposals meeting the initial requirements are invited to submit a full proposal. Each full proposal received is reviewed by two to four outside individuals with expertise in the field described in the proposal. Proposals and reviewer comments are presented to the CTIWR Advisory Board, composed of 10 individuals that reflect the main water resource constituency groups in the state, and a determination is made on which projects are to be funded. This past reporting year we funded two research projects.

We also encourage submission of proposals to the 104G Competitive Grants Program by distributing the 104G RFP to various institutions and individuals and working with interested investigators to develop ideas. This reporting year we had three separate investigators submit proposals to the 104G Program from two different universities, the University of Connecticut and Sacred Heart University.

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.

Names and Degree Level of Students Working on Project

1) Janet Barclay, Ph.D., UConn Department of Natural Resources & the Environment

2) Lindsay Keener-Eck, M.S., UConn Department of Natural Resources & the Environment

3) Zoë Smiarowski, undergraduate, UConn Department of Natural Resources & the Environment

Presentations at Conferences or Workshops Related to Research Project

1) Smiarowski, Z.B., Barclay, J.R., L.S. Keener-Eck, and A.T. Morzillo. 2017. Human dimensions of water availability in Connecticut. Connecticut Conference on Natural Resources, Storrs, CT.

2) Morzillo, A.T., Barclay, J.R., Z.B. Smiarowski, and L.S. Keener-Eck. 2017. A landscape-level

human dimensions analysis of water scarcity in a “water-rich” state. US Regional Association of the International Association for Landscape Ecology annual meeting, Baltimore, MD

Publications

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. Manuscript in preparation.

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

Microfluidic-based Biosensor Chip for Rapid and Calibration-free Detection of Viable E. coli and Total Coliforms for Water Quality Control

Basic Information

Title:	Microfluidic-based Biosensor Chip for Rapid and Calibration-free Detection of Viable E. coli and Total Coliforms for Water Quality Control
Project Number:	2016CT297B
Start Date:	3/1/2016
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	2nd district
Research Category:	Engineering
Focus Category:	Water Quality, None, None
Descriptors:	None
Principal Investigators:	Yu Lei, TaiHsi Fan

Publications

There are no publications.

Proposal Title: Microfluidic-based Biosensor Chip for Rapid and Calibration-free Detection of Viable *E. coli* and Total Coliforms for Water Quality Control

Principle Investigators:

Yu Lei, Associate Professor, Chemical & Biomolecular Engineering, University of Connecticut, Storrs, CT 06269-3222. Telephone: 860-486- 4554, Email: ylei@engr.uconn.edu

TaiHsi Fan, Associate Professor, Mechanical Engineering, University of Connecticut, Storrs, CT 06269-3222. Telephone: 860-486- 0553, Email: thfan @engr.uconn.edu

Introduction/Research Objective:

Waterborne microbiological contaminations remain one of the major threats to public health. The Centers for Disease Control and Prevention has reported that each year, 4 billion episodes of diarrhea result in an estimated 2 million deaths, mostly among children. Waterborne bacterial infections may account for as many as half of these episodes and deaths.

In the past decades, a variety of technologies have been developed to detect the total coliforms and *E. coli* in drinking water. However, they usually take 18-24 h to complete. From a public health standpoint, it is too time-consuming to announce a boil water notification if the sample is positive for total coliforms or *E. coli*. Therefore, an innovative, calibration-free, easy-operation, robust, and ultrasensitive method for fast-screening skeptical drinking water samples is highly demanded. Preferably, it can also discriminate the viability of total coliforms and *E. coli* as conventional EPA-approved methods.

The research objective of this multidisciplinary proposal aims to develop a novel, cost-effective and user-friendly microfluidic-based digital biosensor chip (in conjunction with a commercial available large-volume water sample concentrator) for rapid, ultra-sensitive, and calibration-free detection of viable *E. coli* and total coliforms in drinking water, based on the activity of β-glucuronidase for *E. coli* and β-galactosidase for total coliforms, respectively. A number of novel features are introduced to the proposed system to make the MEMS biosensor faster and more sensitive toward the targets. This project will also positively impact education of graduate, undergraduate and high school students by integrating advanced water quality monitoring into their educational and laboratory training.

Methods/Procedures/Progress:

1. Completing the training needed for the fabrication of the proposed microfluidic devices at Center for Nanoscale Systems (CNF) in Harvard University

The student received extensive training for the total of 18 training sessions required for our device fabrication at Harvard CNF over 6 months, including safety training, Nexx PECVD, Suss MJB4 Mask Aligner, Cleanroom Headway Spinner Training, Technics Plasma Stripper/Cleaner, Anatech Barrel Plasma System, Tystar Bank2 Wet/Dry Oxidation, Tystar Bank2 TEOS Silicon Dioxide, Tystar Bank2 Metal Anneal, Tystar Bank1 Silicon Nitride, Tystar Bank1 Polysilicon, Tystar Bank1 Non-Metal Anneal, STS PECVD, Denton E-Beam Evaporator, South Bay RIE, Veeco Dektak Profilometer, Scanning Ellipsometer, and Nexx RIE.

2. ***Fabrication of microfluidic device***

Microchannels with the narrowest cross-section feature of 10 µm in width and 15-25 µm in height were fabricated in PDMS by the standard soft-lithography technology, developed in our previous research. Figure 1 shows the as-prepared microfluidic device with patterned electrochemical sensing electrodes and microfluidic channel and fluidic connectors developed in PI laboratory. In principle, arbitrary topology, depth, width, and feature size ranging from several microns to hundred microns can be fabricated. In brief, SU-8 2025 and 2015 negative resists (Microchem) were spin-coated on 4” silicon wafers. Exposure with the mask and development with propylene glycol methyl ether acetate (PGMEA) produced channels with the pre-designed feature size. Polydimethylsiloxane (PDMS, Sylgard 184, Dow Corning) was mixed at a 10:1 ratio and poured over the SU-8 mold which was then baked at 80 °C for 1.5 hr to create the final channel. On the

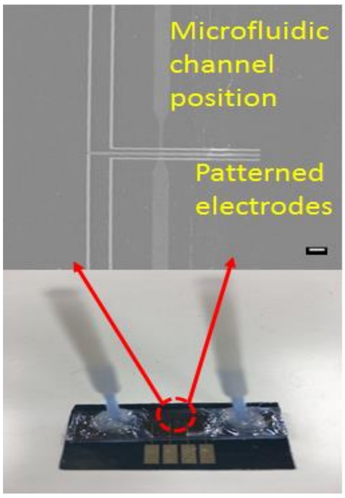

Figure 1. The as-prepared microfluidic device with patterned electrochemical sensing electrodes. Scale bar = 100 µm.

other hand, the electrochemical sensing electrode patterns on Si wafer are fabricated in photoresists with photolithography and then Au/Ti metal layers were sequentially deposited on silicon wafer using thermal evaporation technique. After lift-off process in the photoresist developer, the electrodes with pre-designed shapes and dimensions were formed on the substrate surface. To complete the device fabrication, the PDMS channel was plasma bonded to the Si substrate containing the pre-patterned electrodes and then assembled with appropriate connectors to form a microfluidic system. By regulating the perfusion rate of the carrying electrolyte, the targeted bacteria can be deployed to the channel for the proposed detection.

Results/Significance:

***1. E. coli* culturing**

As *E. coli* possesses both activity of β-glucuronidase (unique for *E. coli*) and β-galactosidase (ubiquitous for total coliforms), *E. coli* will be used in this study to represent both *E.coli* and total coliform. First, a safe *E. coli* lab strain (DH5α), obtained from the strain collection of our laboratory, was used as a model bacterium for the training purpose. *E. coli* was inoculated into Luria broth (LB) medium and incubated overnight on a gyratory incubator shaker at 37 °C and 200 rpm, which allowed the growing stationary phase to be reached. Then, bacterial cultures were serially diluted (10-fold steps), and 10 μL aliquots of samples were applied to LB agar plates and incubated for 24 h at 37 °C, for enumeration of colonies. At the same time, the stationary-phase cultures were diluted to different concentration ranging from 1 cfu/mL to 10^6 cfu/mL in buffer.

***2. Direct detection of E. coli* in microfluidic-device.**

As a preliminary test, the amperometric counting was conducted using the developed device. A constant voltage (+0.6 V) is supplied through the modified working electrode (deposition of Ag on the patterned electrodes to shrink the cross-section area channel at the position of electrodes) and the current vs time response was reordered for the flow of carrying buffer solution in the absence and presence of *E. coli.* The solution was driven by syringe pump

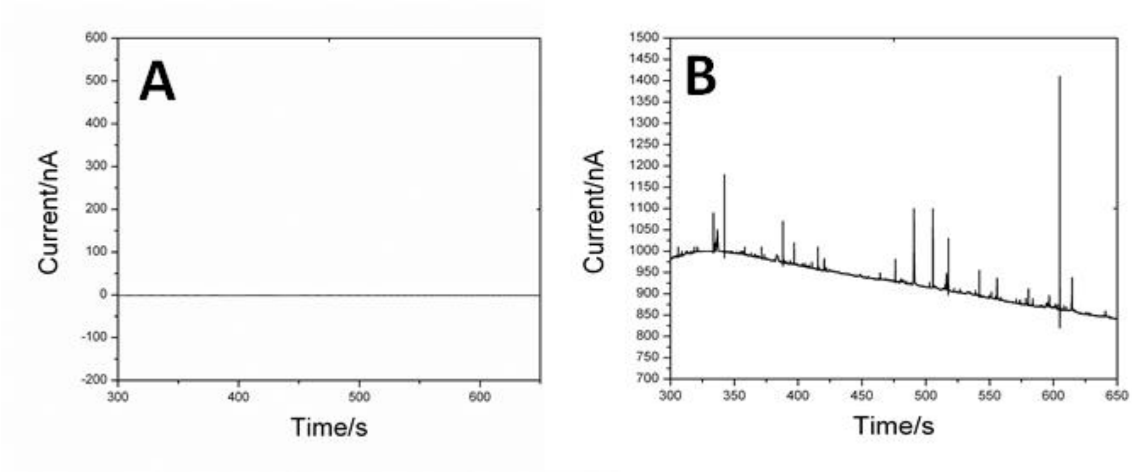

Figure 2. The preliminary study of amepromettric detection for PBS buffer sample in the absence (A) and presence (B) of E. coli.

to flow through the microfluidic device. Figure 2 shows the corresponding results. One can see that a lot of pulses are recorded in the presence of *E. coli*, while only background noise was observed for the buffer in the absence of *E. coli*. It is hypothesized that each pulse may be resulted from the pass of one *E. coli*. This result indicates that it is highly possible for direct counting of *E. coli* without using any calibration curve, which will be further investigated in the 2nd year.

3. *Design of microfluidic device with two electrochemical sensors*

To directly amperometric counting of both *E. coli* and total coliforms, microfluidic device with two patterned electrochemical sensors was designed. Figure 3 show the design of two patterned electrochemical sensors after photoresist development. Briefly, P-type Boron doped, <1 0 0> orientation silicon wafer are used. Silicon wafer was dry-oxidized through CVD-10 with an oxide layer of 106 nm in thickness (measured by ES-2 Scanning Ellipsometer). Positive photoresist Shipley 1805 was spun at 4500 rpm to create a 5 micron thickness of photoresist onto LOR3A which was first spun at 3500 rpm to create roughly 320 nm thickness of LOR3A on the wafer, followed by UV light exposure at wavelength of 405nm for optimized intensity at 52 mJ/cm^2 with a focus at -2 plane (Defocus) by using Maskless Aligner MLA 150. The treated substrate was developed in CD-26 developer for 1 minute and dried by nitrogen gun. The detailed feature of electrodes pattern can be referred to Figure 3. We will continue to do the metal deposition, followed by lift-off to generate the two sensors on the Si wafer, thus realizing simultaneously detection and differentiation of *E. coli* and total coliforms. The new device will be employed in the 2nd year research.

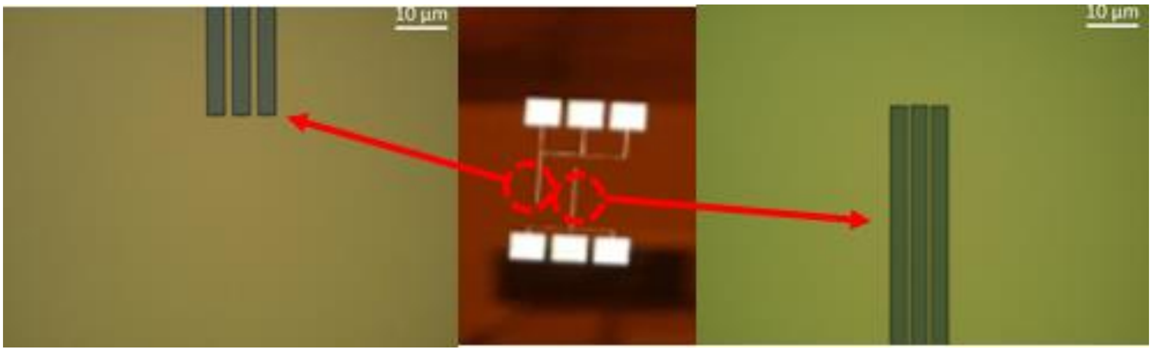

Figure 3. Featured pattern of pre-designed microelectrode devices (scale bar: 10 □m) after UV light exposure at 405 nm by Maskless aligner (MLA) 150.

Names and Degree Level of Students Working on Project

Qiuchen Dong, Ph.D. degree in Biomedical Engineering

Fei Cao, Visiting Professor from China Pharmaceutical University

Presentations at Conferences or Workshops Related to Research Project

None

Publications

None

Information Transfer Program Introduction

None.

CT IWR Technology Transfer

Basic Information

Title:	CT IWR Technology Transfer
Project Number:	2016CT298B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	2
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	None
Principal Investigators:	Glenn Warner, James D Hurd

Publications

There are no publications.

Connecticut Institute of Water Resources

INFORMATION TRANSFER PROGRAM

Seminar Series:

The CTIWR helps support a weekly seminar series held during the Fall semester by the Department of Natural Resources and the Environment. This series includes the CTIWR sponsored "William C. Kennard Water Resources Lecture" during which a respected water resources professional, normally from outside the state, is invited to speak on an issue of interest to researchers, students, and other interested individuals in our state. This past fall CTIWR hosted Dr. Robert Max Holmes, Deputy Director and Senior Scientist at the Woods Hole Research Center in Woods Hole, MA. Dr. Holmes provided an hour long presentation titled, “Permafrost, Arctic Rivers, and Global Climate Change,” to approximately 65 attendees where he discussed the dramatic changes underway in the Artic, and how trends in river discharge and chemistry can be used to diagnose large-scale regional climate change. In addition to the presentation, Dr. Holmes met with Department Graduate Students for an informal discussion to share research ideas and experiences, and met with select Department faculty.

Figure 1. Presentation by Dr. Robert Max Holmes during the Department of Natural Resources and the Environment's Seminar Series.

Please join us for a seminar by the Institute of Water Resources Invited Speaker on Friday, September 30th from 2:30-3:30 pm in WB Young Building Room 100

Permafrost, Arctic Rivers, and Global Climate Change

Dr. R. Max Holmes
Senior Scientist
Woods Hole Research Center

This far-reaching presentation will discuss the dramatic changes underway in the Arctic, and how trends in river discharge and chemistry can be used to diagnose large-scale regional change. The potential implications of permafrost thaw for the trajectory of global climate change over the coming decades will be emphasized, as well as the efforts at the Woods Hole Research Center to "shorten the gap" between fundamental advances in our understanding of the Arctic and the application of the science for sound public policy – including through our participation in the White House Arctic Science Ministerial September 27-28, 2016. Research examples will be drawn from the work of the Arctic Great Rivers Observatory (arcticgreatrivers.org) and the Global Rivers Observatory (globalrivers.org), as well as projects focusing on the permafrost carbon feedback. Finally, a short video will introduce the Polaris Project (thepolarisproject.org), which has been taking undergraduate students to the Arctic each summer since 2008. Of potential interest to UConn undergrads, in 2017 the Polaris Project will select ~12 students to participate in a research expedition to Alaska's Yukon River Delta followed by a 2-week stint in Woods Hole.

Website:

Our Institute maintains the CTIWR web site (http://ctiwr.uconn.ed), which we update as needed. It includes information about the WRRI program, our Institute and its Advisory Board members, a listing of the current year's seminars, a list of sponsored projects, reports and publications, and access to electronic copies of our "Special Reports" series. We also use the web to announce special events and release of our 104B Program RFP, in addition to secure access to grant proposals. Technical reviews and information for the Advisory Board's review. We continue to cooperate with the University of Connecticut's digital archives department, which maintains our electronic reports as a part of its "Digital Commons @ University of Connecticut" project. This past year we have implemented a complete redesign of the website so all pages are consistent in look and design, and we are in the process of updating all the pages with current content. Particularly, we have scanned all of our existing hardcopy archived reports (dating from 1965 to current) from past projects funded through the CTIWR and are making them available through the Reports area of the CTIWR website. These are being provided in a searchable PDF format. Additionally we have added links to federal sites that provide information regarding water resources for Connecticut. We continue to explore ways to provide useful information through our website.

Digital Media Applications:

We continue to work on the development of digital media applications that will serve educational purposes to address water resource issues in Connecticut. Work has concentrated on the development of "storyboards" to describe runoff mechanisms and the changes in runoff under various land uses and land treatments, (*e.g.* disturbance during and following land development). The emphasis has specifically examined the role of impervious surfaces and disturbances of soils on the timing and rates of runoff as compared to undisturbed forest or grassland land uses. In particular, the change in infiltration processes and resulting runoff mechanisms (Hortonian versus Variably Saturated Area) are being illustrated and animated under various rainfall rates and land use applications. In addition, our intent is to convert the storyboards into short video clips that can be shared online through the CTIWR website. Future work will look at other water resource topics including stream-ground water connections, general water balances within

Figure 2. Home page of the Connecticut Institute of Water Recourses website.

watersheds throughout the seasons and short-term climate events, and stream flow-fish/aquatic life.

Conference Support:

The Institute is proud to be among the many sponsors that support the annual Connecticut Conference on Natural Resources (CCNR) held each March during spring break recess at the University of Connecticut. The CCNR attracts approximately 200 individuals from throughout Connecticut who are conducting environmental research, involved in developing policy, or otherwise interested in the natural resources of Connecticut. This conference serves as a venue for networking and sharing ideas regarding the varied environmental resources in Connecticut. CTIWR contributes $500 to support the conference.

Service and Liaison Work:

Currently, the Director actively serves on the following water related panels, committees or workgroups:

- Participant, CT Water Planning Council Advisory Group (WPCAG).
- Member, CT WPCAG, Drought Plan Working Group.
- Member, CT Water Planning Council (WPC), Other State's Water Plans Working Group.
- Member, Scientific and Technical Subcommittee of the Steering Committee, CT State Water Plan.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	1	0	0	0	1
Masters	2	0	0	0	2
Ph.D.	2	0	0	0	2
Post-Doc.	1	0	0	0	1
Total	6	0	0	0	6

Notable Awards and Achievements