

Preparing for Climate Change in Groton, Connecticut: A Model Process for Communities in the Northeast



**A Report to the Town of Groton and Communities throughout New England from
ICLEI-Local Governments for Sustainability and
Connecticut Department of Environmental Protection**

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Missy Stults and Jennifer Pagach

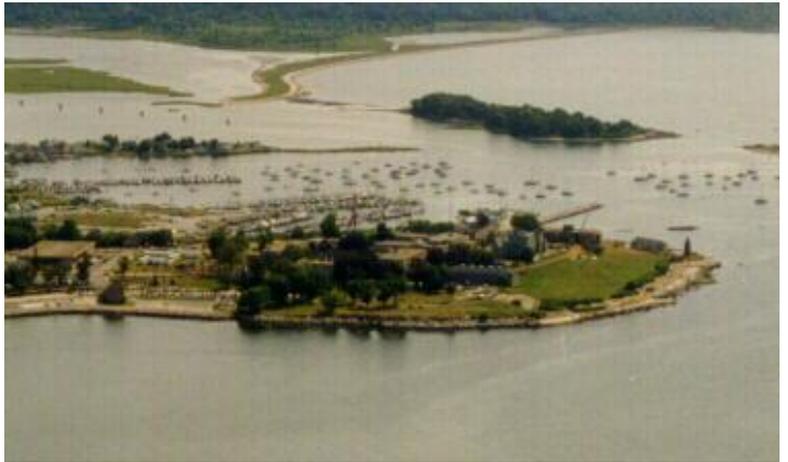
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Executive Summary

A series of coastal climate change adaptation workshops were held in Groton, Connecticut throughout 2010. The workshops were designed to convene federal, state, and local government, as well as academic, non-profit, and community partners to develop a model for coastal community adaptation planning in a “home rule” state. In addition to fostering vertical collaboration between levels of government, the process allowed horizontal coordination within each level that resulted in innovative collaborations. The key stakeholders involved, the commitment from supporting and sponsoring agencies, and the cutting-edge science and economic modeling presented all worked to make the process successful. While a 500-year storm event that occurred on March 30, 2010 almost cancelled the second workshop, the washed out and flooded roads and bridges illustrated that 1) climate impacts are already costing multiple levels of government large amounts of money; 2) locals already know much of how and where they are vulnerable; and 3) there is a need to work towards solutions immediately to avoid additional unnecessary costs and risk. While Groton and state and federal government agencies are continuing the adaptation processes that were initiated during these workshops, it will take additional and continued stakeholder involvement and support for coordinated and successful adaptation to occur. This report speaks to other lessons learned and contains insight and resources so other communities (especially coastal communities) can begin or continue their adaptation planning process. Materials from these workshops (i.e. presentations, agendas) can be found [here](#).



Aerial photograph of Avery Point

Background

Prominently featured in the October 10, 2010 report of the Interagency Climate Adaptation Task Force is that “coordination and collaboration is necessary between all levels of government and stakeholders” to build a more resilient nation. Intergovernmental coordination is critically important to the northeast because the New England states operate under a form of “home rule” in which the states have legislatively granted authority to towns to pass laws and ordinances. This means that the majority of land use decisions are made by town boards such as planning or zoning boards/commissions. States retain certain authorities such as in Connecticut, where the Department of Environmental Protection (CT DEP) has been granted the authority to require permits for all activity taking place below the high tide line. Many of these same activities also require permits from the U.S. Army Corps of Engineers.

Recognizing the importance of multi-governmental collaboration in regards to building resilience, through the Long Island Sound Study, ICLEI-Local Governments for Sustainability USA (ICLEI) and the Connecticut Department of Environmental Protection (CT DEP) partnered with the Groton, Connecticut to conduct an analysis of how and if federal, state, and local stakeholders could collaborate to enhance resilience towards climate change at the local level. The Long Island Sound Study (LISS) is a National Estuary Program and is eligible for EPA grants under a new climate change initiative called [Climate Ready Estuaries](#). The CT DEP Office of Long Island Sound Programs (OLISP) devised the project concept and received approval from the LISS to develop an application. It was proposed that ICLEI be engaged to be the lead in organizing the workshops and also to share their experience with regards to introducing municipalities to adaptation planning. Funding for this project was provided by the U.S.

Environmental Protection Agency through the “Climate Ready Estuaries” program. The Climate Ready Estuaries program works with the [National Estuary Programs](#) and other coastal managers to: 1) assess climate change vulnerabilities; 2) develop and implement adaptation strategies; 3) engage and educate stakeholders; and 4) share the lessons learned with other coastal managers¹. This project advanced these four priorities through a lens that focuses on coastal climate change issues at the local level, with a focus on intergovernmental cooperation and identifying roles to foster resilience at all levels.

The project’s main aims were to:

- Understand how to prioritize vulnerabilities so that lawmakers have a framework to utilize when selecting projects that are competing for limited financial resources;
- Determine if and how existing laws and regulations need to consider future rates of sea level rise and erosion in order to protect the priority vulnerable areas that sustain the local, state, and regional economies;
- Identify synergies and begin fostering collaboration between all levels of government in order to increase local resilience towards climate related vulnerabilities; and
- Share lessons learned through the process with other communities in the region.

Groton was selected as the geographic focus of this project because:

- The town has taken steps to address pressing challenges, most notably the Town Council creation of a Task Force on “Climate Change and Sustainable Communities” to develop strategies for climate mitigation and adaptation;
- Groton offered a unique mix of federal, state and municipal coastal climate changes issues, including inundation from sea level rise at the Navy Base, Groton- New London Airport, Groton Reservoir, state parks such as Bluff Point, vulnerable commercial areas such as downtown Mystic and developed coastal barrier beaches; and
- Lessons learned from Groton would provide valuable guidance to the Governor’s Steering Committee on Adaptation working groups, especially Infrastructure and Natural Resources, and be replicable by other municipalities throughout the Northeast.

The remainder of this document describes the process, results, and recommended next steps for Groton as well as other municipalities interested in initiating an adaptation effort. This report does not represent the end of adaptation planning for Groton but is instead a summary of their process to-date and guidance for their next steps, as well as next steps for State and Federal entities in the journey to building local resilience towards climate change.

Process

In order to foster collective understanding of vulnerabilities and potential actions to increase resilience towards climate change in Groton, the project team organized three workshops - one each focusing on:

- The climate adaptation planning process and projected global, regional and local climate changes;
- Identification of vulnerabilities from projected changes in global and regional climate; and
- Identification of potential actions that could be used to increase resilience towards existing and projected changes



Participants at the first Groton Workshop

¹ Source: <http://www.epa.gov/climatereadyestuaries/>

in global and regional climate.

Over 100 individuals attended the workshop series, including representatives from federal government, regional entities, state agencies, the Town, academia, private corporations, and residential groups ([Appendix Two](#)). The aim of the project was to bring these disparate groups together to evaluate and advance understanding around how Groton is vulnerable to climate change (in particular, sea level rise) and to work collaboratively to begin devising strategies for increasing the Town's resilience. This process was also intended to serve as a model for other local governments across the Northeast, documenting lessons learned, best practices, and to the extent relevant, replicable models other local communities could employ when undertaking climate adaptation planning. Even though nearby towns were not able to participate in this project (due to size constraints), the project team made concerted efforts to empower others to replicate the Groton process and recommends Groton share their lessons and progress with their neighboring communities to enhance and leverage efforts.

Existing Climate Changes Affecting the Northeast

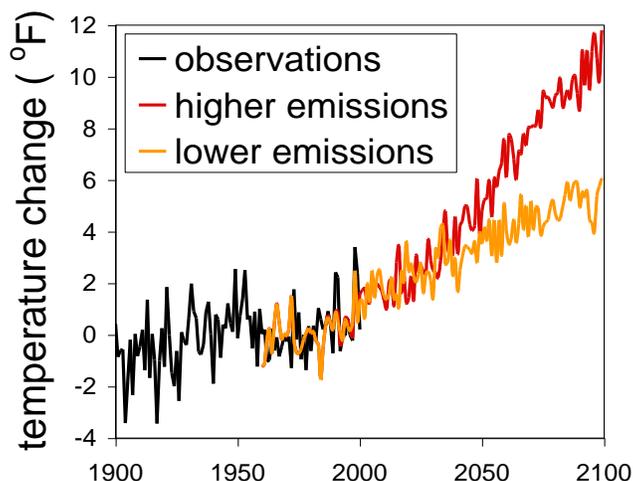
During the January 27, 2010 workshop, Dr. Gutierrez from the U.S. Geological Survey, and Dr. Kirshen from Battelle Memorial Labs, identified changes in climate that are already affecting the Northeast region, including²:

- Annual average temperature increases of almost 2°F since 1970;
- Significant increases in average winter temperature, warming at 1.3°F per decade since 1970;
- Decreasing snowpack and lake ice;
- Indicators of spring are arriving earlier than ever before;
- Extreme heat in summer is becoming more frequent and intense;
- During the 20th century, global sea-level rose at an average rate of 1.7 millimeters per year – however, recent observations indicate that sea-level rose at a rate of 2.5 millimeters per year between 2003-2008³; and
- Average historic rates of erosion for Long Island Sound shores are 1 to 3 feet per year.

Existing Climate Change and Weather Patterns Affecting the State of Connecticut

After looking at *existing* regional climate and weather patterns, Ron Rosza, formerly with CT DEP, identified changes in climate that are already affecting the Groton region⁴⁵:

- **Shoreline erosion** – the present day shoreline is 100 feet inland from the 1888 level;
- Storm intensity, including increased global intensity of **hurricanes** which will affect Connecticut when one makes land fall;
- **Sea level rise** – Dr. Scott Warren's analysis of sea level rise trends at the New London tide gauge indicate that sea level rise has doubled



Observed and model-based changes in annual average temperature for the Northeast (in °F) relative to 1961-1990 average temperature. Modeled historic and future temperatures represent the average of the GFDL, HadCM3, and PCM models. **Source:** NECIA/UCS, 2007 (see: www.climatechoices.org/ne/)

² Impacts are from the 'Northeast Climate Impacts Assessment', produced by Union of Concerned Scientists.

³ (Cazenave et al., 2009).

⁴ These impacts are from the 'Northeast Climate Impacts Assessment', produced by Union of Concerned Scientists.

⁵ More detailed climate information can be found in Appendix Four

since 1980 to approximately 4 mm/yr, which is more in other areas; and

- **Tidal marsh migration** – numerous examples from around the coast indicate an accelerated rate of tidal marsh migration onto the uplands.

Coastal Processes 101

In order to understand what sea level rises mean for Connecticut, a PowerPoint presentation on coastal processes was prepared and presented by Ron Rozsa, and included the following findings:

- The area of land for all coastal towns in the state of Connecticut continues to decrease as rising seas flood the upland;
- As sea level rises, water depths increase and so waves attack the shore at a more landward location causing erosion;
 - Average erosion rates under historic sea level rise rates of ~2 mm/yr are one to three feet per year
 - Rates of erosion are influenced by factors such as surficial geology.
 - Sandy outwash is the most erodible, followed by glacial till. The least erodible is bedrock
 - As fetch increases, so does the rate of erosion

Future Changes in Climate Likely to Affect the Northeast

Dr. Kirshen and Dr. Gutierrez further elaborated on projected *future* climate change, highlighting those changes that could affect the Northeast region, including:

- A total of 80 days over 90°F in Hartford, by late-century, under a high greenhouse gas emissions scenario; the number of days over 100°F could increase to 28 by late-century compared to 2 days currently on average, over 100°F.
- The southern and western parts of the Northeast could experience as few as 5 to 10 snow-covered days in winter, compared with 10 to 45 days historically.
- Conservatively, global sea-levels could rise by 3 feet (1 meter) by the end of the 21st century.
- Precipitation intensity is projected to increase 8 to 9 percent by mid-century, and 10 to 15 percent by the end of the century.
- The number of heavy precipitation events is projected to increase by 8 percent by mid-century, and 12 to 13 percent by the end of the century.
- By the end of the century, short-term droughts are projected to occur annually in Connecticut, under a higher greenhouse gas emissions scenario.
- Increases in the spread of vector-borne diseases such as West Nile Virus and Lyme disease.
- Increase in pollen allergens.
- Significant shifts in fisheries ranges and numbers for a variety of species, including economically valuable cod and lobster.
- Ecosystem shifts in elevation and latitude – which could lead to habitat loss or change, and extinctions (up to 30% extinction rate with an additional 1.8 to 5.4 degrees Fahrenheit increase in temperature ((1 to 3 degree Celsius)).

“We are already committed to future sea level rise – even if the world stopped emitting greenhouse gas emissions tomorrow, sea level would continue to rise for several centuries.”

~Dr. Ben Gutierrez, USGS

Climate-Related Vulnerabilities Identified for the Town of Groton

Once Dr. Kirshen, Dr. Gutierrez, and Ron Rozsa had a chance to present on existing and future climate and weather related effects in the Northeast and in the State of Connecticut, participants had the

opportunity to share their thoughts and perspectives about *existing* impacts. This part of the workshop was critical as it allowed participants to understand how they are already vulnerable to weather and climate. This understanding was necessary in order to build momentum and support for planning for *future* climate and weather impacts (workshop two).

When assessing existing and future climate vulnerabilities, participants used weather and climate information provided by Drs. Kirshen and Gutierrez, as well as information from a new tool called COAST. COAST is a tool being developed by the New England Environmental Finance Center (EFC) with the support of Battelle Memorial Institute and focuses on helping decision makers assess costs and benefits of adapting to sea level rise. The COAST tool incorporates a variety of existing data sets including U.S. Army Corps of Engineers Depth-Damage functions, NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model and other flood methods, projected sea level rise scenarios over time, property values, and infrastructure costs, into a comprehensive GIS-based picture of potential economic damage. It assists coastal municipalities in selecting adaptation actions by displaying the implementation costs and location-specific avoided costs associated with particular adaptation actions.



New London/Groton Flooding

The light blue area in these maps depicts today's 100-year flood zone for New London and Groton (i.e., the area of these cities that is expected to be flooded once every 100 years). With additional sea-level rise by 2100 under the higher-emissions scenario, this approximate area is projected to flood once every 17 years, on average; under the lower-emissions scenario, once every 32 years. The 100-year flood at the end of the century (not mapped here) is projected to inundate a larger area of these cities, especially under the higher-emissions scenario.

Based on scientific information combined with the modeling done through the COAST tool and participant knowledge about existing and projected future climate impacts, workshop participants identified the following as specific climate related impacts likely to affect Groton:

- More frequent river and coastal flooding;
- Increased occurrence of sewer overflows;
- Loss of coastal habitats and resources (wetlands);
- Increased coastal erosion;
- Reduced drinking water quality and supply caused by salt water intrusion as well as increased precipitation, flooding, drought, and erosion;
- More frequent flooding that could prevent access to and reduce function of Groton-New London Airport;
- Access to state parks such as Bluff Point and Haley Farm could be hampered by flooding;
- Access to UCONN-Avery Point campus may be impaired during storm events;
- Docks and marina facilities could be damaged by flooding and sea level rise;
- Increased economic impacts related to infrastructure replacements, loss of employment hours, additional emergency service personnel, and others arising from no action scenarios;
- Sections of Amtrak railroad could flood under certain sea level rise and storm flooding scenarios;
- Mystic River bridge may experience additional openings for smaller boats as bridge clearance diminishes with sea level rise;
- Shellfishing and fish spawning could be drastically reduced and/or collapse; and
- Overall quality of life, aesthetics, and enjoyment of citizens may be reduced.

Specific Locations Vulnerable to Climate Related Impacts

Once general types of vulnerability were identified, workshop participants began focusing on specific locations, systems, or infrastructure that were vulnerable. Recognizing time constraints, this process did not focus on identifying all possible vulnerabilities, but instead focused on areas vulnerable to sea level rise and inland flooding.

This section summarizes the key vulnerabilities identified during the workshops by sector. Groton is encouraged to conduct a more detailed analysis of how each of these systems is vulnerable to climate change and then move forward with preparing those systems for climate related impacts⁶.



Flooding during May 30, 2010 storm event

Transportation:

In general, multiple forms of transportation infrastructure are at risk, including roads, drainage, bridges, airport, railroads, etc. Many of these vulnerabilities came to life after the May 30, 2010 500-year storm event caused extensive road and bridge flooding and destruction. Based on this event and historic knowledge, participants in the Groton workshops identified the following as specific areas that were vulnerable to climate related impacts.

- Poquonnock Road
- Fort Hill Road
- Groton Long Point Road
- Route 649 Amtrak railroad underpass
- Route 117 at Route 1
- Route 1 at Fishtown Road
- Route 1 at Poquonnock Bridge
- Route 27 at Mystic River Bridge
- Mystic River Bridge

Other Infrastructure

Workshop participants also looked at other types of infrastructure including wastewater and water facilities, residential units and commercial locations. Below is a list, broken down by category, of additional infrastructure vulnerabilities identified by workshop participants.

Other Town/City Infrastructure

- Reservoir and Water Treatment Plant
- Wastewater Treatment Plant and Pump Stations – 30% of pump stations are along the coastline
- Claude Chester Elementary School
- Cutler Middle School

Residential Locations

- Mumford Cove

⁶ Tools to help the Town of Groton and other Town's conduct a more detailed analysis include ICLEI's Adaptation Database and Planning Tool (ADAPT), USAID's Guidebook on Adapting to Coastal Climate Change, and the Coastal Services Center's suite of sea level rise planning tools

- Groton Long Point
- Noank
- Eastern Point
- Mystic

Commercial Locations

- Downtown Mystic
- Poquonnock Bridge
- Airport Industrial Park
- Electric Boat and Pfizer

Ecological Resources

In addition to built systems, participants spent a good amount of time thinking about which natural systems might be vulnerable to existing and/or future changes in climate. The following represents a preliminary list of vulnerability natural systems (note: this list is not exclusive).

- Birch Plain Creek – Baker Cove
- Fort Hill Brook – Mumford Cove
- Eccleston Brook – Palmer Cove
- Groton Long Point Marshes

Emergency Services

Last, but certainly not least, participants looked at social systems that might be vulnerable to climate change. A clear emphasis was placed on ensuring the continuity of emergency services during and future disaster event. As such, workshop participants identified two primary sectors in the emergency services space that are currently and/or will be vulnerable in the future to climate related impacts:

- Police and Fire Operations
- Emergency Medical Services

Potential Actions to Help Build Preparedness to Climate Change in the Town of Groton

The next step in the workshop series was to provide participants with opportunities to identify potential strategies Groton, state agencies, and other key stakeholders could employ to increase local resilience towards sea level rise and coastal flooding. Some of the commonly denoted adaptation strategies identified by participants included:

- Relocate/Elevate vulnerable roads and infrastructure – ensure emergency access and preservation of public safety during extreme events;
- Develop Memorandums of Understanding with state personnel regarding funding of local police costs incurred to protect safety along vulnerable state owned road infrastructure during and after storm



Participants during the second Groton workshop

events, so that police can also monitor other hazardous areas;

- Stormwater runoff reduction program designed to control peak discharges and to require post-development rates of runoff to be no greater than pre-development conditions in most circumstances;
- Flood-proofing of existing buildings;
- Conversion of land upriver to wetlands in order to accommodate increased sea level rise;
- Creation of incentives for retreat zoning and/or zoning and redevelopment restrictions and building code changes or enforcement to prevent building in the most vulnerable locations;
- Educational programs that alert residents about climate change and vulnerable areas of the Town;
- Purchase of vulnerable land or land that will act as a buffer by Groton;
- More stringent building and engineering design standards that anticipate future climate conditions, as opposed to just existing conditions;
- Beach nourishment;
- Installation of flood/tide gates at locations such as Groton Long Point and Mumford Cove;
- Creation of a comprehensive watershed management plan for debris and culverts, in partnership with Amtrak and CTDOT;
- Improved road condition reports during extreme events, in order to help the school district and other agencies to identify the safest transportation routes;
- Identification of Town, State, and Federal funding available to make the improvements to infrastructure that is deemed highly vulnerable;
- Integrate climate preparedness into the Capital Planning process, Master Plan of Conservation and Development update process, the zoning regulations revision, and streetscape project; and
- Investigate the logistical challenges of incorporating climate change, adaptation, and preparedness into school curriculum.



Mark Tedesco from EPA presenting during the first workshop

Leveraging Existing Climate Adaptation Initiatives

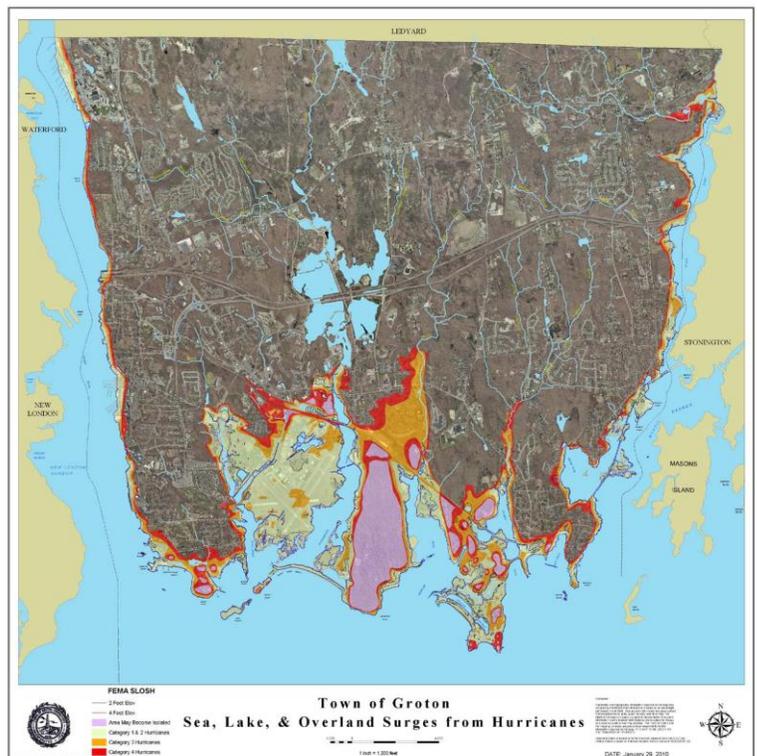
The project was designed such that collaboration between existing efforts at various levels (regional, state, federal, local, etc.) could build off on one another and, to the extent possible, avoid duplication. As such, the project team worked to ensure that stakeholders working on existing adaptation efforts that affected the Groton region were invited to the three-part workshop series. Examples of some related efforts that already existed and that informed the Groton process include:

- The Connecticut Governor's Steering Committee on Climate Change, and specifically the Adaptation Subcommittees including Infrastructure, Public Health, Natural Resources and Agriculture. Multiple chairs and members of the committees attended the series which gave benefit to both processes.
- Sentinel Monitoring of Climate Change in Long Island Sound, a bi-state and federal initiative to determine climate change indicators and management techniques for the sound and its coastal eco-regions. This work is partially funded by the Climate Ready Estuaries program through the Long Island Sound Study. Many workgroup members attended the workshop series.

- Groton’s Climate Taskforce, Energy Efficiency and Conservation Block Grant and climate internship opportunities are just a few of the existing initiatives the town staff and committees were working on.

In addition to integration with existing efforts, this work also inspired several new climate efforts. The following efforts were spawned by or benefitted from the Groton workshops:

- Climate change considerations and some proposed actions to address these considerations are included in the State of Connecticut’s Natural Hazard Mitigation Plan.
- CT DEP State Parks Division performed a vulnerability assessment of their coastal properties with assistance from Office of Long Island Sound Programs staff.
- State Department of Transportation staff continues to work with Groton staff on identifying and building the resilience of vulnerable transportation areas in the town.
- Office of Long Island Sound Programs started an internal climate change group to examine current policies and procedures with respect to climate impacts and adaptation.
- CT DEP staff from different departments have started coordinating on climate-related efforts, including OLISP, the Air Bureau, and the Planning Office. This has resulted in merging of multiple adaptation and mitigation initiatives, as well as the formation of the Municipal Climate Outreach group that includes multiple Groton workshop attendees.
- Groton is continuing to seed adaptation into existing planning mechanisms including their town Plan of Conservation and Development, Streetscape project, and active climate taskforce initiatives.
- The Town of Groton received a SOAR intern from Three Rivers Community College. The intern previously worked with the Town of New London and is being paid by the Emily Hall Tremaine Foundation grant to the CT DEP and CT Clean Energy Fund.
- ICLEI and CT DEP, through the Long Island Sound Study, were awarded another EPA Climate Ready Estuaries grant to develop ART: an Adaptation Resource Toolkit. ART will focus on integrating climate adaptation tools, resources, and information for local communities into a single central database for Connecticut municipalities.
- ICLEI and CT DEP have also partnered to launch a Connecticut Climate Network for municipalities. This network will facilitate information exchange between local communities and will be instrumental in the design of ART.
- During the final Groton workshop, participants were asked to make a single commitment to what they would do to help build resilience towards climate change through their professional or personal capacities. To-date, many Groton attendees have held true to the individual commitments, resulting in even more mitigation and adaptation efforts. If funding allows, the Team would like to reconvene the stakeholders in this project to assess their progress in meeting their personal commitments.



Recommended Next Steps for Groton

The following section identifies the proposed next steps for Groton.

- Identify a staff person and/or agency to lead adaptation coordination.
- Continue to develop the Town's capacity, along with its GIS mapping capabilities, to facilitate analysis of sea level rise and storm surge impacts on key sectors, planning areas and systems.
- Conduct a thorough Town-wide vulnerability assessment, using stakeholder input and engagement techniques. The process needs to respect existing budget and staff demands currently placed on Town departments while also being inclusive and participatory.
- Pursue funding sources at CT DEP, Clean Energy Fund, and others to increase municipal capacity when staff and resources are limited.



Participants in the first Groton workshop

- Work with the Town Administration to establish a working climate preparedness committee, including municipal department heads and other key technical personnel, to evaluate community vulnerabilities, establish preparedness targets, and prioritize actions.
- Create a Town-wide climate action plan that includes strategies to both reduce greenhouse gas emissions and to prepare for climate change impacts. Be sure to identify strategies that are robust, adjustable, align with existing community priorities, and provide co-benefits.
- Engage CT DOT and Councils of Government to discuss altering criteria for funding of STP-URBAN program and other infrastructure grants to incorporate adaptation criteria.
- Integrate climate change considerations into all Town-wide planning (i.e. master, community, revitalization, capital improvement, etc.).
- Provide staff to serve on the Adaptation Resource Toolkit Steering Committee to help share lessons learned in Groton and to learn about new and existing adaptation tools and resources that can help the Town move forward with building resilience towards climate change.
- Continue refinement of an outreach strategy regarding climate preparedness and deliver preparedness messages to the public and stakeholders via resources and programming at the library, other regular Town communication channels, and other innovative outreach techniques.
- Continue researching what others are doing and share information regionally. The Naval Submarine Base in Groton has an adaptation strategy, and there are many communities worldwide who have started implementation of adaptation strategies as well. Groton staff should identify

existing resources that can assist in their planning needs, and share lessons learned with their neighboring towns and regionally when applicable.

Recommendations for State, Federal and other Stakeholders

This section includes recommendations for adaptation work that should be continued and/or started by state, federal, academics and non-governmental organization, including:

- The state and federal real estate in Groton and beyond need vulnerability assessments and adaptation plans. Development of these plans will require funding and data.
- While some high quality modeling and data exists, work still needs to be done to enhance our understanding of climate impacts. Funds are essential to provide all levels of government with the requisite data for adaptation planning. Funds wisely spent in advance would keep down impacts and associated costs. Specific examples of modeling include but are not limited to: Sentinel Monitoring of Climate Change in Long Island Sound which is using monitoring data and expert scientists to identify how climate is changing to inform adaptation strategies; completion of the UConn Surge model including integrating wave heights; short term deployment of wave buoys in key near-shore zones so that the data are available to identify appropriate flood and erosion control responses; modeling to identify how sea level rise will alter the tidal characteristics of Long Island Sound since the geometry of the Sound may magnify the effect of sea level rise; and better modeling of species and ecosystem impacts.
- Great partnerships were formed or strengthened through the workshop processes that have the potential for manifesting unprecedented adaptation planning results. These partnerships should be supported and formalized as they coordinate and leverage existing efforts, and can serve as models for others. Some examples include the federal and bi-state (CT and NY) Sentinel Monitoring for Climate Change in Long Island Sound efforts, the DOT discussions with local, federal and state partners including DEP to explore and remedy impacts to transportation infrastructure, and the OLISP formation of an internal climate change group to examine existing policies and procedure with respect to adaptation.
- If not already in motion, CT DEP and CT DOT should develop a working group to continue to explore the likely impacts of climate change to transportation infrastructure along the shore.
- Currently the Flood Control and Beach Erosion Act requires municipalities to establish Flood and Erosion Control Boards in order to access state funding for flood and erosion control projects. It's highly recommended that these groups use future projections in sea level rise and changes in coastal storms to evaluate their risk. Where needed, the legislature should provide funding to assist in the evaluation of adaptation planning for shoreline areas.
- State and Federal agencies should undertake an analysis of existing programs/laws to evaluate if these create impediments to address the most urgent/pressing local resiliency issues. If impediments exist, efforts should be taken to remove or lessen those barriers.

Lessons Learned

Throughout this year-long process, numerous invaluable lessons were learned which will not only help Groton continue its momentum in building local preparedness towards climate change, but which will also be instrumental in helping other communities replicate the work done in Groton. These lessons include:

A. Importance of open and clear lines of communication combined with the value of face-to-face meetings

Understanding a community's vulnerability and building resilience towards climate change will require the collaboration of multiple stakeholders. Traditionally, many of the stakeholders critical for this process are stakeholders that do not have a long history of collaboration. Recognizing this, having clear, open, and well thought out channels for communication are critical for ensuring all voices are heard, respected, and involved in the adaptation process.

Moreover, experience has demonstrated that face-to-face meetings and engagement can provide significantly more value than remote communication (assuming the time spent face-to-face is well structured.) This was a critical piece of the Groton process and while we strove to increase collaboration between federal-state-regional-and local stakeholders, one of the unique things that came out of this project was collaboration at the federal-federal, state-state, and local-level level. This type of collaboration would have either not happened or been extremely limited if the group did not have the opportunity to meet face-to-face.

B. Importance of working with non-traditional partners

Building resilience towards climate change will involve working with multiple individuals, agencies, and organizations that are critical to making a community function. This includes working with entities that are not traditionally involved in decision-making – such as vulnerable populations, real-estate developments, insurers, and non-profit partners. In messaging to groups, it is crucial to consider their concerns. The Groton process provide a window into how important the building of new partnerships and relationships was and will continue to be in helping communities prepare for climate change.

C. Start with Existing Community Vulnerabilities

Many communities are already experience weather and climate related vulnerabilities today. Instead of focusing on what your community might be like in 2050 or 2100, local communities should start their climate conversations by focusing on today's vulnerabilities and how climate change could exacerbate and/or create new vulnerabilities in the future. This has proven to be a more effective way to engage stakeholders and audiences in the resilience building process.

D. Value of Assessing Vulnerability

In a world of limited budgets and capacity, having information that allows communities to identify which systems or areas within their community are the most vulnerable to climate change is important. A vulnerability assessment is a way for communities to gain this insight. Vulnerability assessments allow communities to take information on existing and projected changes in climate and analyze how those changes will affect them. Vulnerability assessments can be extremely detailed or very general. The level or rigor of the analysis depends on the needs and abilities of the local community⁷.

The Groton process combined multiple types of modeling (CHAMP for coastal communities, UCONN Surge Modeling, HAZUS, COAST, etc.) as well as local observation of the current problem areas (road and other areas vulnerable to flooding) to establish a preliminary and low cost vulnerability assessment. State and federal staff also provided input and expertise for areas of critical interest, such as transportation. This process can be replicated in other towns by pulling together existing resources, staff and experts. It is likely that other communities will discover that there are existing resources and initiatives that could be merged/enhanced and further built upon at little cost. In absence of any modeling, COAST and other tools demonstrated that to estimate future impacts, you can roughly equate them to today's large event happening more frequently in the future (i.e. expect today's 500 year storms to be the future 100 or 50 year storms).

⁷ Tools to help communities assessing climate vulnerabilities include ICLEI's Adaptation Database and Planning Tool (ADAPT), USAID's Guidebook on Adapting to Coastal Climate Change, and the Coastal Services Center's suite of sea level rise planning tools

E. Importance of Planning with Imperfect Information

While our ability to understand future climate is improving, science will never be able to tell us with 100% accuracy exactly what the climate will be like in 2050. However, even without this information, local communities can begin planning for existing and likely future climate impacts. The Groton model of pulling together the climate experts to provide guidance on what future climate could be like and discussing a range of potential impacts with stakeholders was extremely useful as it provided an opportunity for stakeholders to brainstorm and reflect on what impacts could be in their area of expertise. Stakeholders did not get caught up in the exact range of future changes (i.e. what exactly will the average daily temperature be in 2050), but instead focused on planning for a range of future scenarios.

F. Value of Cross-Sector Collaboration

When assessing vulnerability, a natural tendency is to bring together experts in each system to speak about vulnerabilities (i.e. public health officials talking to one another about public health vulnerabilities). However, the Groton process demonstrated that bringing together people with various types of expertise to discuss issues led to more thoughtful discussion and the identification of sometimes complex vulnerabilities.

F. Challenges of Truly Valuing Ecosystems

When exploring vulnerabilities and identifying strategies for increasing resilience, participants in the Groton process articulated a challenge with estimating the true value of ecosystems. For example, not only do beaches, dunes and wetlands act as a storm surge and sea level rise buffers, but they have economic value as well since coastal Connecticut generates substantial tourism and aquaculture revenue. The beauty and resources available are also a reason property values are so high in coastal areas. Strategies such as armoring the shoreline, which might have been recommended if one merely strove to protect existing infrastructure, will destroy that natural function and degrade the wetlands. While the Groton process did not identify a solution to this problem, participants regularly articulated a need to have a better process to understand the true value of ecosystems.

G. Challenges in Removing Perverse Incentives to Build in Vulnerable Places

In coastal communities across the United States some of the most valuable real estate is located in close proximity to the coast. Continuing to live and build in extremely vulnerable locations creates both a financial challenge but also can create a public safety situation. For example, homes located in a flood plain or that have a primary point of access that regularly floods may experience limited to no public safety support in case of an emergency if emergency personnel are physically unable to access the site. Furthermore, debris from homes can further damage other infrastructure in a storm surge, as evidenced by past storm events. However, these homes are often the most expensive homes in a community and provide an important tax base for the city/town. This creates a conundrum for local communities and is something that numerous entities are striving to devise answers to⁸. Complicating this issue is the tendency of people to underinsure or not insure because they perceive that someone else, generally the government, will compensate them for their loss.

H. The Importance of Regional Collaboration

While the Groton process focused on working across geo-political boundaries to build the Town's resilience towards climate change, one of the key revelations from this project was the realization that

⁸ For example, Georgetown Law Center is currently research strategies local communities can take to protect their residents and communities from sea level rise.

true adaptation needs to happen at the local, regional, and state level. The reason for this is that many areas likely to be affected by climate change are managed at a regional or sub-regional level. For example, the Town of Groton has limited ability to act to increase the resilience of its roads to existing and increased flooding. However, the State Department of Transportation has more authority to act. Recognizing this, local communities will need to engage surrounding municipalities, counties or regional planning agencies, and relevant state agencies to collaborate to truly build resilience towards climate change.

Appendix One: Glossary of Terms

Definitions are based on the IPCC's 4th Assessment Report (<http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-app.pdf>) and *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*. (<http://www.cses.washington.edu/cig/fpt/planning/guidebook/gateway.php>).

Action – A step or measure that a local government can take to increase their resiliency to a climate change impact in their identified planning area.

Adaptive Capacity –The ability of built, natural, or human systems to accommodate changes in climate (including climate variability and climate extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Climate Adaptation – Any measure or act that reduces the negative impacts of climate change or increase new opportunities. There are three ways to adapt to climate change – to anticipate, react spontaneously, or plan.

Climate Mitigation – Refers to any measure or activity taken to reduce greenhouse gas emissions.

Goal – What a local government wants to accomplish in priority planning areas through preparedness actions.

Hazard Mitigation – Action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.

Impact – The effects of existing or forecasted changes in climate on built, natural, and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts (impacts that may occur given a projected change in climate, without considering adaptation) and residual impacts (impacts of climate change that would occur after adaptation).

Planning Area – Areas in which a government or community manages plans, or makes policy affecting the services and activities associated with built, natural, and human systems. Examples of planning areas include water supply, wastewater treatment, public health, road operations, transportation systems, forestry, parks, etc.

Priority Planning Areas – Planning areas which a community or government determines to be most important given community's vulnerabilities to climate change and the associated risk.

Resilience – The ability of a system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Sensitivity – the degree to which a built, natural, or human system is directly or indirectly affected by changes in climate conditions or specific climate change impacts. If a system is likely to be affected as a result of projected climate change, it should be considered sensitive to climate change.

Storm Surge – An abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

Storm Tide – The water level rise due to the combination of storm surge and the astronomical tide. (NOAA National Hurricane Center)

Systems –The built, natural, and human networks that provide important services or activities within a community or region. Built systems can refer to networks of facilities, buildings, and transportation infrastructure such as roads and bridges. Natural systems can refer to ecological networks of fish, wildlife, and natural resources like water. Human systems refer to networks of public health clinics, courts, and government.

Vulnerability – Susceptibility of a system to harm from climate change impacts. Vulnerability is a function of a system's sensitivity to climate and the capacity of that system to adapt to climate changes. Systems that are sensitive to climate and less able to adapt to changes are generally considered to be vulnerable to climate change impacts.

Appendix Two: Registration List for Workshops

First Name	Last Name	Agency	One	Two	Three
Jared	Balavender	Department of Environmental Protection-Seasonal			Y
Marcia	Balint	DEP-OLISP-Planning	Y	Y	Y
Juliana	Barrett	CT Sea Grant	Y	Y	Y
Paul	Bates	Harbor Management Commission	Y		
Ron	Beck	US Coast Guard		Y	
David	Bjerklie	USGS	Y		
David	Blatt	DEP-OLISP-Planning	Y	Y	Y
Frank	Bohlen	UCONN- Marine Sciences	Y	Y	
Kirk	Bosma	Woods Hole Group		Y	Y
George	Bradner	State of CT Dept of Insurance	Y	Y	Y
George	Calkins	Ledge Light Health District		Y	
Cheryl	Chase	DEP-OLISP-Permitting	Y	Y	Y
Robert	Clapper	DEP - State Parks and Public Outreach	Y		Y
Joe	Cooper	Univ. of Southern Maine		Y	
Paul	Corrente	CT DOT	Y		
Bill	Cummings	CT Post	Y		
John	DeCastro	CTDOT	Y	Y	
David	Dickson	CT Sea Grant College Program		Y	
Syma	Ebbin	Groton Task Force on Climate Change	Y	Y	Y
Mikaela	Engert	Planner, City of Keene, NH		Y	
Edith	Fairgrieve	Groton Task Force on Climate Change and Sustainable Community	Y		
Todd	Fake	UCONN- Marine Sciences	Y	Y	Y
Janet	Freedman	Rhode Island	Y		
Mariellen	French	Groton Task Force on Climate Change and Sustainable Community	Y	Y	Y
Bill	Glazier	Task Force on Climate Change and Sustainable Community	Y	Y	Y
Michael	Goetz	FEMA Region 1	Y	Y	Y
Wes	Greenleaf	Groton Public Schools	Y	Y	Y
Michael	Grzywinski	DEP-OLISP-Permitting	Y		
Ben	Gutierrez	Coastal and Marine Geology Program, USGS	Y	Y	
Greg	Hanover	Public Works, Town of Groton	Y	Y	
Adrienne	Harrison	NOAA	Y		Y
Louise	Harrison	EPA/USFWS for LIS	Y	Y	Y
Mary Beth	Hart	CT DEP	Y	Y	Y
Michael	Hughes	ICLEI USA	Y	Y	Y
Rick	Huntley			Y	
Diane	Ifkovic	CT DEP	Y		
Nan	Johnson	FEMA Region 1 - Risk Analysis Branch		Y	Y
Deb	Jones	Office of Planning and Development Services, Groton	Y	Y	
Robert	Kafalenos	U.S. DOT / FHWA	Y	Y	Y
Pamela	Kilbey-Fox	State of CT Department of Public Health	Y	Y	Y
Paul	Kirshen	Battele	Y	Y	Y
Colleen	Kissane	CT DOT	Y		
Dave	Kozak	CT DEP OLISP	Y	Y	Y
Charles	La Chance	CT DOT	Y	Y	
DeAva	Lambert	CT DEP – OLISP			Y
Andrew	MacLachlan	USFWS	Y		
Sharon	Marino	Fish and Wildlife Service		Y	Y
Lynne	Marshall	Naval Submarine Medical Research Laboratory	Y	Y	Y
Ed	Martin	Shellfish Commission	Y		
Sam	Merrill	New England Environmental Finance Center	Y	Y	Y
Karen	Michaels	CT DEP	Y		Y
Jessica	Morgan	CT DEP	Y	Y	
Mike	Murphy	Office of Planning and Development Services, Groton	Y	Y	Y

Mark	Neri		Y		
Rick	Norris	Office of Planning and Development Services, Groton	Y	Y	Y
Kevin	O'Brien	DEP-OLISP-Technical Services	Y	Y	
Jim	O'Donnell	UCONN Avery Point		Y	
Mark	Oefinger	Manager, Town of Groton	Y	Y	
Jen	Pagach	DEP-OLISP	Y	Y	Y
Mark	Parker	DEP-LIS Study	Y	Y	Y
Tristan	Peter-Contesse	EPA Climate Ready Estuaries	Y	Y	Y
Dennis	Popp	City of Groton Mayor	Y		
Jeff	Pritchard	Groton Town Planning Commission	Y	Y	Y
Brae	Rafferty	Conservation Commission	Y	Y	Y
Roslyn	Reeps	DEP Office of Planning and Program Development		Y	Y
Gerald	Robinson	Groton Task Force on Climate Change and Sustainable Community	Y		
Julie	Rose	EPA Long Island Sound	Y	Y	
Ron	Rozsa	NERACOOS	Y	Y	Y
Joe	Sastre	Town of Groton Emergency Communications			Y
Terri	Schnoor	CT DEP	Y		Y
Dave	Scott	Inlands Wetlands Commission	Y	Y	
Majorie	Shansky	Attorney	Y		
Paulann	Sheets	Groton Task Force on Climate Change and Sustainable Community	Y	Y	
Sally	Snyder	DEP - State Parks		Y	
Steve	Sosensky	Attorney		Y	
Paul	Stacey	DEP- Planning and Standards		Y	Y
Zell	Steever	Task Force on Climate Change and Sustainable Community	Y	Y	Y
Alan	Stevens	Bureau of Aviation and Ports - CT DOT	Y	Y	Y
Ann	Straut-Esden	Bureau of Water Protection and Land Resuse, CT DEP	Y	Y	
Missy	Stults	ICLEI	Y	Y	Y
John	Sutherland	Groton Task Force on Climate Change and Sustainable Community			Y
Mark	Tedesco	EPA Office of Long Island Sound Programs	Y	Y	
Christine	Tedford	CT DEP-Intern		Y	
Brian	Thompson	DEP OLISP (Office of Long Island Sound Programs)	Y	Y	Y
Thomas	Trombley	USGS	Y	Y	
Nathaniel	Trumball	UCONN - Avery Point	Y	Y	
Robert	Turner	Federal Highway Administration	Y		
Scott	Warren	ConnCollege (retired)	Y		
Allison	Webster	ICLEI USA		Y	
Noel	Wehner	Groton Utilities	Y		
Adam	Whelchel	The Nature Conservancy	Y	Y	
Bob	Westhaver	Groton Task Force	Y	Y	
Michael	Whitney	UCONN	Y	Y	
Norm	Willard	US EPA	Y	Y	Y
Betsey	Wingfield	Bureau of Water Protection and Land Reuse			Y
Bruce	Wittchen	CTOffice of Policy and Management		Y	Y
Roger	Wolfe	CT DEP Wetlands Habitat and Mosquito Management Program	Y	Y	
Gary	Yohe	Wesleyan University		Y	
Catherine	Young	Groton Airport	Y	Y	Y

Appendix Three: Recognition and Publicity on Process

The success of the Groton project has been recognized and shared at workshops nationally and internationally, as well as featured in multiple publications. The following is a short list of the recognition received in 2010:

Presentations

- Resilient Cities 2010 presentation in Bonn, Germany by Michael Murphy
- Madison Rotary Club March 18, 2010 presentation by Jennifer Pagach
- Highlighted on May 3, 2010 at the Global Oceans Conference, Paris, France as part of a panel on innovative climate change adaptation work at the state and local level in the US
- Tijuana Estuary Adaptation Workshop in San Diego, CA on May 14, 2010 presented by Missy Stults to regional entities, municipalities, and practitioners on the Groton
- Massachusetts State Climate Protection Network in Boston, MA on June 4, 2010, presentation by Missy Stults to ICLEI members and State representatives
- Washington, D.C. Climate Ready Estuary (CRE) partner meeting July 7, 2010 presentation by Jennifer Pagach to National Estuary Programs
- Climate Change Adaptation for Coastal Communities Training on October 22, 2010 at URI in Rhode Island presentation by Missy Stults and Jen Pagach to state and federal staff
- Climate Adaptive Planning and Program Actions presentation at the Planning for Community Climate Change Adaptation conference hosted the Rhode Island Department of Environmental Management on October 28, 2010, presentation delivered by Michael Murphy
- Restore America's Estuaries annual meeting November 16, 2010 presented by Jeremy Martinich, EPA Climate Ready Estuaries program
- Connecticut Climate Network November 22, 2010 presentation by Jennifer Pagach at Naugatuck Valley Community College to local government and multiple CT partners
- UCONN Adult Education Series on Climate presentation Fall 2010 by Jennifer Pagach

Publications

- April 2010 Coastal Management News article "Connecticut Helps Towns with Climate Change Adaptation"
- ArcUser Fall 2010 magazine, article by Sam Merrell, Paul Kirschen, et. al., on modeling used in workshops
- Fall 2010 Sound Health article by Robert Burg, Long Island Sound Study
- October 2010 and February 2011 Sound Outlook issues dedicated to climate work in Connecticut and Groton
- The Groton process was featured as a case study in the upcoming Adaptation Subcommittee Recommendation Report to the Legislature.
- Fall/Winter 2010 Wrack Lines, a Connecticut Sea Grant publication featured Groton's climate efforts
- Winter 2010/11 edition of the Northeast Section of the American Institute of Professional Geologists featured Groton as a Connecticut climate effort