Capacity to Address the Health Impacts of Climate Change in Massachusetts

Findings from a Statewide Survey of Local Health Departments



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SECTION 1:

Introduction

Introduction

The purpose of this report is to summarize results of a comprehensive survey aimed at assessing the capacity of local health departments in Massachusetts to respond to the public health impacts associated with climate change, and to develop plans for reducing these health impacts.

Public health impacts include, but are not limited to, heat waves, droughts, storms (including floods), water-borne diseases, food-borne diseases, vector-borne infectious diseases, quality or quantity of freshwater available, health care services for those with chronic medical conditions, food safety and security, and unsafe or ineffective sewer and septic system operation. The impact of climate change is expected to contribute to the burden on environmental public health resources *(Frumkin et al., 2008)*. Successful adaptation to climate change will depend on enhancing efforts to provide a comprehensive understanding of potential health effects that may result from the influence of changes in long-term weather patterns.

Such efforts will involve:

- Educating the public health workforce and the general public to prepare for the effects of climate change and, thus, reduce public health impacts
- Ongoing use of targeted surveillance of both health outcome and environmental data to identify where and how climate effects will influence the patterns of environmentally related diseases
- Continued interagency collaboration

In January of 2014, Governor Deval Patrick announced the establishment of a $50 million investment aimed at addressing vulnerabilities in public health, transportation, energy and Massachusetts' built environment due to the impact of climate change on the Commonwealth. Given evidence suggesting that the effects of climate change on public health will be most directly felt at the local level, the Governor directed the Department of Public Health (DPH) to identify areas of special concern, draft model strategies to address these areas and to enhance education and training efforts.

Massachusetts was one of the first states in the nation to move forward with an assessment and broad plan to address climate change. In August 2008, Massachusetts Governor Patrick signed the Global Warming Solutions Act (GWSA) into law. The GWSA required the Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, to set economy-wide greenhouse gas (GHG) emission reduction goals for Massachusetts *(Regional Greenhouse Gas Initiative, 2013)*.

In addition, the GWSA required that the EOEEA convene a multi-sector advisory panel to draft a report to analyze strategies for adapting the predicted impacts of climate change in the Commonwealth *(EOEEA & AAC, 2011)*. The Massachusetts Department of Public Health/ Bureau of Environmental Health (MDPH/BEH) co-chaired the group responsible for the Health and Human Welfare Chapter of the EOEEA Climate Change Adaptation Report.

The panel findings indicated that Massachusetts may be impacted by increasingly intense weather patterns including flooding from surges of coastal waters and high intensity precipitation events, increase in average ambient temperature, with several more days of extreme heat during the summer months, and sea level rise that may be compounded by thermal expansion of the oceans, the melting of ice on land (such as in Greenland) and the collapse of the West Antarctic Ice Sheet. Higher temperatures, especially the higher number of extreme heat days, will also have a negative impact on air quality and human health.

In general, impacts from climate change on human health can include respiratory illnesses, exacerbation of allergies and asthma, an increase in vector-borne diseases, and increase in illnesses associated with degraded water quality.

Recognizing the critical need for public health systems to adequately prepare for and respond to the health impacts of climate change, the U.S. Centers for Disease Control and Prevention (CDC) initiated the Climate Ready States and Cities Initiative, designed to assess and build capacity of state and local health departments to address the public health consequences of climate change. MDPH was one of ten state and municipal health departments to be awarded a three-year cooperative agreement to enhance state and local public health efforts to address health issues associated with climate change. The funding provided for the department to conduct a needs and capacity assessment of local boards of health across the Commonwealth in 2010.

Unlike many states in the U.S., Massachusetts has local boards of health (LBOH) for each of its 351 cities and towns. Evidence indicates that the health effects of climate change will be felt most directly and severely at the local level; thus, local health departments will need to prepare to serve as the front line for delivering health services to the public *(Maibach et al., 2008)*.

Local public health systems may have to better understand and prepare for the health impacts of climate change. To assess the capacity of local health officials to respond to climate change-related health impacts throughout the state, the MDPH/BEH developed a survey that was distributed to each municipality, in collaboration with the MDPH Emergency Preparedness Bureau. This report documents the results of the MA LBOH survey, MDPH/BEH's literature review on the relevant health effects of climate change, and recommended strategies to support planning efforts to mitigate public health impacts related to climate change.

BACKGROUND ON CDC'S CLIMATE READY STATES AND CITIES INITIATIVE (CRSCI)

Environmental impacts of climate change have been clearly documented *(Frumhoff et al., 2007)*. To date, however, little attention has been given to the public health impacts of climate change and the ability of public health systems to absorb and respond to these challenges. The effects of global climate change are expected to substantially contribute to the burden on state and local public health agencies.

The public health community recognizes the need for a proactive approach to address the serious and complex impacts on human health resulting from climate change *(Frumkin et al., 2008)*. Effective climate change adaptation and mitigation strategies will involve a multi-sectoral roster of public and private entities, elected officials and the general public *(Gould & Dervin, 2012)*.

By applying the Essential Public Health Services (EPHS) specifically to climate change-related health issues, the CDC delineated three core climate and health program functions:

1. Translate Climate Change Science

to inform states, local health departments and communities.

2. Create Decision Support Tools

to build capacity to prepare for climate change.

3. Serve as a Credible Leader

in planning for the public health impacts of climate change *(CDC, 2013)*.

The CDC's Climate and Health Program has developed a framework to guide public health agencies in developing adaptation plans. CDC's Building Resilience Against Climate Effects (BRACE) framework provides a process to "forecast climate trends, define disease burden, develop specific intervention methods, and evaluate impacts of change for at-risk populations" within defined geographic areas *(Luber, 2011; CDC, 2013)*.

The five steps in the iterative BRACE framework enable public health departments to identify emerging environmental public health challenges, determine the areas of greatest need, assess adaptation/mitigation strategies, implement those most suitable to address the specific needs of the local at-risk populations, review policies that have been implemented and revise the approach as needed. The five steps include:

1) **Forecasted Impact & Vulnerability Assessment:** Identify the range of climate impacts, associated potential health outcomes, & vulnerable populations and locations within a jurisdiction
2) **Health Risk Assessment:** Estimate/quantify the additional burden of health outcomes due to Climate Change
3) **Intervention Assessment:** Identify the most suitable health interventions
4) **Health Adaptation Planning & Implementation:** Develop and implement a plan that introduces health system program changes that address the health impacts of climate change
5) **Evaluation:** Periodic review to ensure that the projections continue to be sound and the adaptations are still suitable and ensuring that climate change is considered in broader public health planning and implementation activities and to ensure that public health is considered in broader climate change planning and implementation activities.

The literature review identified climate variables and health impacts grouped into three major categories:

1. **Temperature Increase**
2. **Changes in Precipitation Patterns**
3. **Increase in Frequency and Intensity of Extreme Weather Events**

LITERATURE REVIEW

Climate Variables and Health Impacts

There is ample evidence to predict how climate change will specifically affect Massachusetts communities. Heat will gradually increase over time, affecting the regional climate and related health outcomes such as an increase in the incidence of heat-related morbidity and mortality; water-borne illnesses; and vector-borne zoonotic diseases (VBZD) among others *(Executive Office of Energy and Environmental Affairs [EOEEA] & Adaptation Advisory Committee [AAC], 2011)*. The changing climate will potentially increase the frequency and severity of extreme weather events, which will impact population health, the surrounding ecosystem, and the affected areas' infrastructure. Poor air and water quality will exacerbate existing illnesses and will be particularly problematic for vulnerable populations.

Increase in Temperature

Increases in average temperature in MA will lead to increases in excessively hot days *(EOEEA & AAC, 2011)*. By 2101, Massachusetts may witness an increase in average temperatures by as much as 10˚F, while temperatures over 90˚F may increase six-fold and temperatures over 100˚F could increase more than tenfold *(EOEEA & AAC, 2011)*. Long-term exposure to temperature variability is a significant problem that is expected to become more severe, particularly for vulnerable populations *(Zanobetti et al., 2012)*. Populations that are more vulnerable to heat events include: the elderly, especially those living alone; lower income individuals; and, those with pre-existing medical conditions, such as respiratory disease and Type II diabetes. Lack of air conditioning availability and geographic areas without vegetation coverage increase the health risks of these vulnerable populations during excessive heat days.

The elderly have shown higher mortality rates during heat waves, with increasing vulnerability related to long-term exposure *(Zanobetti et al., 2012)*. Individuals with preexisting health conditions are also more susceptible to heat-related illnesses including cardiovascular disease, Type II diabetes, renal disease, nervous disorders, emphysema, epilepsy, cerebrovascular disease, pulmonary conditions, mental health conditions and death *(Fouillet et al., 2006; Hutter et al., 2007; Semenza et al., 2012; Stafoggia et al., 2008)*. A study in Boston, MA found an association between increased outdoor temperatures and greater severity in heart disease for individuals already being treated for heart problems *(Wilker et al., 2012)*.

High temperatures decrease outdoor air quality via formation of ground level ozone *(Jerrett et al., 2009)*. Due to the increase in average temperatures, ozone (both ground level and atmospheric) is more likely to form and more frequently exceed healthy levels in both urban and rural environments *(Environmental Protection Agency [EPA], 2012)*. Increases in ground level ozone — the primary ingredient in smog — contribute to poor outdoor air quality and may exacerbate existing respiratory and cardiovascular conditions significantly associated with increased mortality *(Jerrett et al., 2009)*. Other ground level pollutants can also exacerbate respiratory diseases among vulnerable populations, though some studies question whether air pollution will continue to rise *(Tagaris et al., 2007)*. Rising temperatures and CO_2 levels will also cause plants to produce more pollen, which can exacerbate asthma and other respiratory illnesses. Amplified pollen production is also expected to intensify allergic responses in symptomatic allergic individuals *(Cecchi et al., 2010)*.

Incidence of vector-borne diseases — including Lyme disease, babesiosis, malaria, dengue fever, yellow fever, eastern equine encephalitis and West Nile Virus — may also rise due to climate change *(Martin, 2010)*. Over the winter, the increase in minimum temperature will reduce tick die-off. Over the summer months, breeding season for mosquitoes will be extended. Additionally, rising temperatures will expand the geographic range of these vectors to include communities that may not have historically been affected by vector-borne diseases. Sea surface temperatures may also rise by as much as 8˚F by 2100, making harmful, aquatic microorganisms a significant problem over the next century *(EOEEA & AAC, 2011)* as they produce toxins which can cause liver, digestive, neurological, and skin diseases *(EOEEA & AAC, 2011; Paerl & Huisman, 2008)*. People who swim in water with toxin-producing cyanobacteria and protists, or people who eat shellfish from these areas, are susceptible to increased morbidity and mortality.

Increased Precipitation

In addition to rising heat patterns, increased precipitation is expected for MA and can affect public health in many ways. Extreme precipitation can increase runoff, releasing toxic chemicals and pathogens from the ground and contaminating drinking and recreational water sources. Heavy rainfall in the summer also contributes to potential breeding sites for mosquitoes, amplifying opportunities for mosquito-borne diseases to spread *(Martin, 2010)*. It is anticipated that winter precipitation will more frequently take the form of rain, and is expected to increase by as much as 30 percent by the end of the century *(EOEEA & AAC, 2011)*.

Anticipated changes in precipitation, combined with an increase in temperature, will affect the food supply and agriculture in Massachusetts. Heavy rainfall in the spring may cause crop and soil damage, while droughts during the growing season in areas without proper irrigation will hinder crop growth. Areas already affected by pests (e.g., the corn earworm), invasive weeds (e.g., Kudzu), and plant disease (e.g., Stewart's Wilt, carried by the flea beetle) will be impacted in greater number due to rising temperatures. Crops that grow best in cooler temperatures, including potatoes and apples that comprise much of the Northeast agricultural economy, will be greatly impacted. Some species of cranberries, apples, and blueberries also rely on long winter chill periods for optimal development. Heat stress hinders dairy production, which will become increasingly problematic to the $3.6 billion dairy industry of the Northeastern U.S. as temperatures climb. Outbreaks of food-borne disease caused by Escherichia coli and Salmonella are also expected to increase due to climate change *(Frumhoff et al., 2007)*.

The habitats of commercially important marine life in Massachusetts will shift northward due to temperature change: cod is expected to disappear altogether from waters off of Cape Cod by 2100, while lobster fisheries are projected to decline dramatically over the next 40 years. Shellfish diseases (e.g. lobster-shell disease), vibrio parahaemolyticus, harmful algal blooms, and invasive species have caused contamination problems in fisheries of the Northeast in the past and are projected to increase in frequency as sea temperatures continue to rise *(Frumhoff et al., 2007)*. Massachusetts public health and marine fisheries agencies began implementing vibrio control plans on Cape Cod in 2012 and expanded such controls statewide in 2013. The impacts of climate change on food systems (e.g., higher prices) will likely be greater among some populations including elder adults and lower-income families.

Increases in frequency and intensity of extreme weather

Floods, droughts, hurricanes, "nor'easters," and tornadoes — examples of extreme weather — will impact Massachusetts more frequently in the future due to climate change. Injury, death, and structural damage to buildings and infrastructure are direct effects of climate change, while bacterial proliferation, lack of safe drinking water, mold growth in buildings due to flooding, and even mental health disorders are examples of likely indirect effects. For example, Massachusetts continues to rank 1st or 2nd in prevalence of pediatric asthma across the nation *(Massachusetts Department if Pubic Health [MDPH], 2009)*. Higher precipitation rates and flooding events may also increase mold spore counts that can at minimum exacerbate symptoms in those with pre-existing respiratory disease.

Heavy rains can lead to contamination of well water and the release of contaminants from septic systems *(Curriero et al., 2001)*. Drinking water supplies and sewage systems will be overburdened by extreme rainfall, creating an environment ripe for contamination from human sewage and animal waste *(Rose et al., 2001)*. Even today, municipal water systems can become overburdened by extreme rainfall events.

A number of urban areas in Massachusetts still have combined sewer systems designed to carry both storm water and sanitary wastewater to a sewage treatment plant. Wastewater is generally treated before being discharged, but intense rains overpower the systems resulting in a situation known as a "combined sewer overflow" in which contaminants, chemicals and pathogens are released directly into the water *(Kessler, 2011)*.

Floods are the most frequent natural disaster and the leading cause of death from natural disasters in the United States. Due to high population density, infrastructure, and economy near the shoreline, Massachusetts is vulnerable to flooding impacts *(EOEEA & AAC, 2011)*. Sea level rise will increase the threat of flooding on MA coastal communities by intensifying the effects of storm surges *(Karl et al., 2009)*. Sea level rise is occurring three to four times faster along the U.S. northeast coast than it is globally *(Sallenger et al., 2012)*. Flooding has indirect impacts on public health via damage to key infrastructure. The MBTA, a critical transportation hub for Boston and surrounding communities and the nation's oldest system of its kind, is not flood-proof; a flood in 1996 caused the closure of a subway line and resulted in over $70 million in damages and repairs. Logan International Airport is built on wetlands and thus is susceptible to flooding and the effects of sea-level rise *(Frumhoff et al., 2007)*. Increased residential flooding will lead to increased mold growth from basement flooding and roof incursions which are associated with exacerbation of asthma, allergies and even neurological problems.

While overall precipitation is expected to increase, episodes are expected to be more intense and less frequent. This leads to the possibility of another type of water extreme: droughts. Droughts will be detrimental to Massachusetts, damaging agriculture and the economy in addition to depleting the drinking water supply *(Frumhoff et al., 2007)*. Many populations are more vulnerable to the public health impacts of drought, including older adults, low-income families, and communities that rely on private well water *(EOEEA & AAC, 2011)*.

OTHER SURVEYS OF HEALTH DEPARTMENTS

MDPH/BEH also reviewed available national surveys of state and local health departments regarding their perceptions around climate change, impacts on public health, and local health capacity to respond to climate change related health impacts. Surveys reviewed include those conducted by the Association of State and Territorial Health Officers (ASTHO), George Mason University, and the Public Policy Institute of California. Questions from these surveys helped inform the design of the Massachusetts survey.

The ASTHO survey assessed perceptions of climate change among state health departments, current climate change response strategies, functional capacity to respond to impacts of climate change, and resource needs pertaining to adaptation and mitigation *(ASTHO, 2009)*. ASTHO surveyed the chief health officer from each state and territory health agency and received responses from 41 states and 2 territories (response rate = 72%).

Almost three-quarters (73%) of respondents believed that their jurisdiction would experience public health issues due to climate change, but almost 77% reported that climate change was not one of their agency's top ten priorities. Approximately 80% of respondents stated that they were already conducting activities within their jurisdiction that respond to vector-borne illness, food-borne illness, and/or extreme weather, and more than 50% were dealing with water quality issues *(ASTHO, 2009)*.

More than 50% of respondents believed that their jurisdiction had adequate capacity for the surveillance of water-borne, food-borne, and vector-borne diseases, as well as respiratory illness morbidity and mortality. However, less than half of respondents believed that they had adequate capacity for surveillance of air quality, mental health conditions, extreme weather events, health effects from particulate matter, and/or heat/cold morbidity and mortality. All respondents expressed a need for more funding; 94% expressed a need for more staff, and 86% expressed a need for more training *(ASTHO, 2010)*.

A George Mason University study focused on the attitudes of local health departments. Investigators used the membership database from the National Association of County and City Health Officials (NACCHO) for their survey. NACCHO members (n=2,296) were stratified into several categories (e.g., size of jurisdiction, region of country) and then selected randomly within these categories. The eventual selected members for the survey totaled 217. Of these, 133 members completed the survey (response rate = 61%).

While the majority of respondents believed that climate change is a growing problem, few stated that climate change was a priority within their local health department. Many survey respondents believed that they were lacking the expertise, the funding, and/or the staff to respond to the public health impacts of climate change. Most health departments were not actively moving towards adaptation, and many of them will require assistance in order to do so. There was a lack of action among local health directors in reducing GHG emissions within their own departments *(Maibach et al., 2008)*.

Lastly, the Public Policy Institute of California conducted a survey of local health officials within California to assess their perceptions of climate change as well as the extent of climate change preparation within their local public health agencies. In California, there are 61 local health departments, one in each of the state's 58 counties and in three cities. Completed surveys were received from 34 local health departments, a 57% response rate but representing just over three-quarters of the state's population.

Despite the prevailing belief that climate change is a significant threat, local health officials responding to the survey believed that they are poorly prepared to deal with the impacts of climate change. Some jurisdictions had adaptation or mitigation strategies in place such as disease surveillance, heat emergency plans, and vector control. Respondents indicated that they are in need of funding as well as technical resources to analyze possible health impacts *(Bedsworth, 2008)*.

ADAPTATION AND MITIGATION STRATEGIES

Adaptation and mitigation strategies can be readily viewed via the BRACE framework developed by CDC. BRACE focuses on how best to enhance the evidence base, expand capacity, and integrate surveillance systems in order to adequately prepare for and respond to the public health impacts of climate change. Adaption and mitigation strategies are categorized as follows:

1. **Implementing Cross-cutting, Long-term Strategies**
2. **Reducing Greenhouse Gases**
3. **Diminishing the Impact of Extreme Heat on Health**

Implementing cross-cutting, long-term strategies

While discrete mitigation strategies are likely to be most effective, it will take long-term planning across many sectors of government to fully reduce the impacts of climate change. Partnerships and collaborations among government agencies at the local and state level, as well as with non-profits and the private sector to leverage resources and competencies will be critical to success *(Frumkin et al., 2008)*. Adapted housing and zoning standards may increase the resilience of buildings along the coast to flooding *(EOEEA & AAC, 2011)*. Local transportation agencies need to be involved in adaptation and mitigation efforts as well, given the impact of climate change on transportation infrastructure *(U.S. Department of Transportation [US DOT], 2011)*. Water resource authorities, agricultural agencies, utility providers, housing authorities, transportation services, city planners, emergency preparedness experts, and public health officials need to collaborate with one another to ensure integration of all perspectives into emergency planning efforts.

Cross-cutting adaptations to extreme weather include establishing stricter building codes in flood prone areas, warning systems, flood redirection, disaster policies and planning, educational and preparatory materials, evacuation plans, and relief and recovery effort plans. Certain coastal populations are more vulnerable, as many of the structural weather adaptations currently in place were not built to withstand the extreme weather events of the present and future *(EOEEA & AAC, 2011)*.

The EOEEA Climate Change Adaptation Report suggests several adaptations to reduce the impact of flooding. In coastal areas, developing watersheds that account for local natural hydrology will help build a natural defense against flooding and also restore the ecosystem *(EOEEA & AAC, 2011)*. (A watershed is the area of land where ground water collects. Natural hydrology refers to water features that are ecologically in place as opposed to artificial expansion via paving over an area and creating a central storm water drainage system. Prior to paving, rainwater is naturally absorbed over broad areas, thus producing less runoff. Using features of a locale that are already in place allows an ecosystem to behave closer to its natural state and therefore be better defended and preserved *(EPA, 2012; EOEEA & AAC, 2011)*. In the future, it may be necessary to reevaluate water management and septic systems to ensure that they will resist the effects of climate change in flood-prone areas *(EOEEA & AAC, 2011)*.

Educating the public and community planners on safe and eco-friendly land use (e.g., reducing usage of chemical fertilizers and pavement) may also reduce the impact of flooding on water quality and infrastructure damage, should flood prevention fail *(EOEEA & AAC, 2011)*.

Local/municipal health departments in Massachusetts currently take broad approaches to climate change adaptation regarding prevention and response to extreme weather events by emphasizing education, proper land use, emergency preparation and management, public education, and/or outreach *(EOEEA & AAC, 2011)*. Educating and informing the public is a key mitigation strategy often overlooked by public health professionals, primarily due to competing priorities and scarce resources. There is a significant disconnect between what public health officials know about the health threats associated with climate change, and what the public knows.

The public is largely unaware that climate change threatens human health, much less its own health and the health of other members of their community (Maibach et al., 2008). Community planners and municipal engineering departments also need to be involved from the very beginning in assessing how new development projects will impact — and be impacted by — climate change.

Reducing greenhouse gas emissions

The Global Warming Solutions Act requires MA agencies to reduce greenhouse gas (GHG) emission levels by 2020 (Regional Greenhouse Gas Initiative, 2013). Reduction of GHGs emissions will have a positive impact on public health outcomes, including reductions in premature deaths and reduced morbidity from cardiovascular disease, and road traffic accidents as a result of active transport *(Woodcock et al., 2009)*.

Emission reduction targets can be met in a variety of ways, including via creation of a market incentive through a regional cap. MA is part of the Regional Greenhouse Gas Initiative, a cap and trade market based emissions reduction strategy. This regional cap allows entities operating in the state to trade emission reduction credits they gain from becoming less energy intensive to entities that are not in compliance with regional regulations. This reduces emissions over time because the number of credits available gradually decreases, and theoretically the value of these credits will increase. Reducing GHG emissions via reduction targets, cap-and-trade policies, and other measures may contribute to slowing the rate of temperature rise and the future impacts thereof (Chou, 2012).

Diminishing the impact of extreme heat on health

Extreme heat impacts, including death, can be reduced by providing cooler environments *(Curriero et al., 2001; Reid et al., 2012; Braga et al., 2001)*. Air conditioning is one modality that can reduce the health effects of heat. Air conditioners also reduce the amount of particulate matter in the air, as a byproduct of cooling, thus simultaneously increasing indoor air quality. Some MA municipalities have public cooling centers that can be made available to vulnerable populations without access to air conditioning. Accurate data on the availability and utilization of air conditioning systems in MA homes and public buildings do not currently exist.

Five cities in Japan have undertaken the "Green Curtain Project," growing climbing plants to reduce indoor heat exposure *(Martinez et al., 2011)*. Chicago has implemented a "cool roofs" program, specially treating building roofs to decreases sunlight absorption, thereby reducing indoor heat exposure and cooling the city as a whole. Chicago is also installing high-albedo pavement, a surface that reflects sunlight rather than absorbing it, decreasing the city's overall temperature *(Hayhoe & Wuebbles, 2011)*. Planting foliage that survives in warm weather (either at ground level or via "green roofs") can decrease GHG emissions, provide shade and decrease the risk of heat-related illnesses and death *(Hayhoe & Wuebbles, 2011; Reid et al., 2009)*.

Slowing the rising incidence of vector-borne diseases is a critical mitigation strategy. Vector-borne disease occurrences (e.g., West Nile Virus, Eastern Equine Encephalitis, and Lyme disease) are required to be reported to MDPH. Maintaining mosquito surveillance throughout the state and educating the public about personal prevention practices (e.g., use of insect repellent, covering skin with long sleeves and pants, checking for ticks after outdoor exposure, avoiding outdoor activities at dusk, etc.) can greatly help reduce outbreaks of vector-borne disease. Due to increases in heavy rainfall, the public should also be educated regarding mosquito habitats (e.g., stagnant water) in order to stem breeding activity *(EOEEA & AAC, 2011)*.

SECTION 2:

Methodology

Methodology

This section summarizes MDPH/BEH's methodology to survey of local health departments (LBOH). The survey was informed by a comprehensive review of the scientific literature, review of other surveys in the literature on public health agency capacity to respond to climate change effects, and existing adaptation on mitigation strategies that could inform the MDPH LBOH survey design.

SURVEY DEVELOPMENT

The literature review, coupled with review of surveys used in other geographic areas allowed MDPH/BEH to create a survey instrument to assess local capacity. The goal of the survey was to assess the current capacity and needs of local public health to respond to anticipated impacts of climate change, and identify future efforts that state health officials must undertake to support local health departments to monitor and address climate change health impacts across the Commonwealth.

The major factors considered in the design of the survey questions included:

- Evidence-based projected climate change impacts in Massachusetts as determined during the literature review *(EOEEA & AAC, 2011)*;
- Responsibilities of LBOH (based on statutory and regulatory requirements) *(Centers for Disease Control and Prevention [CDC], 2010)*;
- Time and resource constraints associated with the existing local public health infrastructure and operations; and
- Previously vetted surveys of state and local health department capacity to address climate change impacts. Questions were borrowed or adapted from surveys used by others to enable comparison between MA data and other geographic areas (e.g., Chicago, California), specifically:
  - » George Mason University (GMU) study of local health directors across the U.S. *(Maibach et al., 2008)*
  - » Public Policy Institute of California study of local health departments in California *(Bedsworth, 2008)*
  - » Association of State and Territorial Health Officials (ASTHO) study of 43 state and territorial health agencies across the U.S. *(ASTHO, 2009)*

The final survey instrument focused on three broad domains:

1. Community Characteristics

including: the respondent's views on climate change; water sources and sewage treatment methods; availability of air conditioning in the community; and vulnerable populations.

2. Community Capacity and Resources

including: ability to address the public health effects of climate change; existing or planned mitigation or adaptation activities; communication strategies during emergencies; plans for outreach to vulnerable populations during emergencies

3. Possible Public Health Risks and Related Efforts to Reduce Public Health Impacts

of climate change in the community, including: data sources and surveillance methods; frequency of inquiries and responsive actions; specific areas in which assistance from MDPH/BEH could be useful.

The survey asked about the level of surveillance, planning, and intervention associated with the following issues:

- Heat stress
- Hazardous weather events
- Indoor air quality
- Food supply/agricultural issues
- Vector-borne diseases
- Water and sewer issues

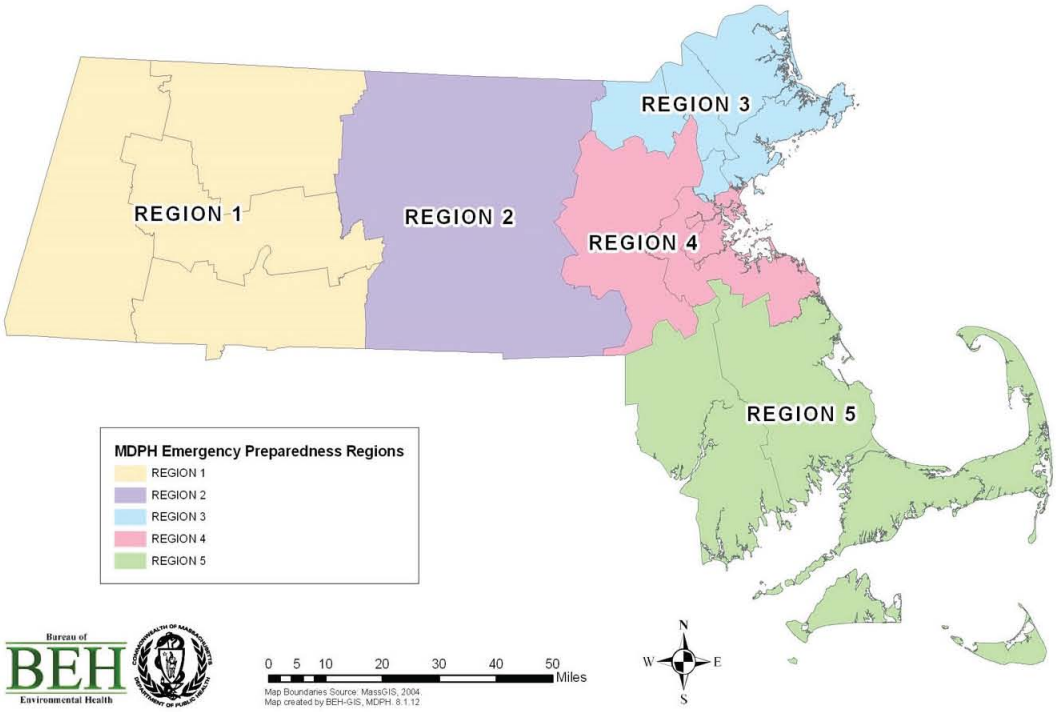
SURVEY DISTRIBUTION

Based on MDPH/BEH's extensive experience working with LBOH, it was determined that the survey would be distributed most effectively through the coordinators of each of the MDPH 15 Emergency Preparedness Regional Coalitions (EPRC) in the Commonwealth and the City of Boston. The 351 municipalities are members of the five Emergency Preparedness (EP) Regions. These Regions are as follows: Western MA (Region 1), Central MA (Region 2), North Shore/ Northeastern MA (Region 3), Boston/Metro Boston/Metro West (Region 4); and South Shore, Cape and Islands (Region 5). (See **Figure 1** for a map of these EP Regions.) On June 27th, 2011, the survey was emailed to the DPH Emergency Preparedness Bureau (EPB) regional coordinators, who then emailed the survey tool to local health officials within their regions with the intention to reach all cities and towns across the Commonwealth. MDPH/BEH scheduled meetings with the 15 EPRCs between July and September 2011 to promote survey participation and increase response rate. At these meetings, MDPH/BEH gave a presentation on climate change impacts in MA, distributed surveys and answered questions.

DATA COLLECTION AND ENTRY

Completed surveys were submitted to MDPH/ BEH via fax, email, regular mail or completed by telephone. Trained MDPH/BEH interns tracked the completion of survey by LBOH and entered survey responses into a customized Microsoft Access databases. Inconsistent or missing data were noted. Municipalities with incomplete or missing surveys were contacted by telephone and provided the opportunity to complete the survey over the phone, schedule a subsequent call to complete the survey, or to submit it by email, fax, or regular mail. Follow-up continued through May 2012. MDPH/BEH staff developed a customized database for logging and tracking calls to local health departments that interfaced with Microsoft Outlook.

FIGURE 1: MDPH EMERGENCY PREPAREDNESS REGIONS



Once data entry was independently verified by a third party to detect and correct errors and ensure data integrity, data were transferred from Microsoft Access to Microsoft Excel, with subsequent independent review. Submitted surveys were stored both electronically and on paper. Completed surveys were categorized by the five EP Regions.

SURVEY ANALYSIS

As noted earlier, MDPH/BEH conducted an extensive review of scientific literature and key reports on the impacts of climate change in preparation for the development of the survey. The literature review identified the most relevant climate change-related public health threats, public health services needed at the community and regional levels to address expected impacts, key reports on climate change impacts in Massachusetts, and national surveys used to assess state and local capacity to address climate change impacts in the U.S.

Survey questions were analyzed using descriptive statistics to present the count and/or percentage of individual response options, both by EP Region and statewide. These analyses were reviewed by a third party within MDPH/BEH for quality assurance, ensuring that the data were captured and displayed correctly in the graphs that were created. In some cases, response options were collapsed to create a more straightforward picture of the data. For example, "strongly agree" and "agree" responses were grouped together as were "strongly disagree" and "disagree" responses (e.g., for questions 2, 2a, 2b, 2c). Qualitative responses to the open-ended questions 18 and 19 were reviewed and common themes were tallied. Comparison across related questions was also performed to examine the relationship between health officials' beliefs regarding whether their jurisdiction would experience "one or more serious public health problems as a result of climate change" and whether the community was reported to have adequate resources, capacity or specific plans to address public health issues resulting from climate change.

SECTION 3:

Results

Results

The results of the survey are presented for the state as a whole (227 jurisdictions) as follows: (1) Survey Response Rate; (2) Community Characteristics; (3) Baseline Operations, Emergency Planning, and Communication; and (4) Public Health Risks and Efforts to Reduce Public Health Impacts That Could be Affected By Climate Change. A summary report of survey findings by each of the EP Regions is presented in a separate document.

STATEWIDE SURVEY RESPONSE RATES

Of the 351 cities and towns in Massachusetts, 227 completed a survey, an overall statewide response rate of 65% (representing 69% of the state's population).

Table 1 provides the number of municipalities by EP Region that participated in the survey, population based on 2010 Census, and response rate by EP Regions and Statewide. While Region 3 (North Shore) and Region 4 (Boston, Metro Boston, Metro West) contain the fewest municipalities among the five Regions (48 and 62, respectively), these two EP Regions are the most densely populated, and had the highest response rates (81% and 76%, respectively).

TABLE 1: RESPONSE RATE TO MDPH/BEH CLIMATE CHANGE SURVEY BY REGION AND STATEWIDE

Region	Description	Number of Municipalities in EP Region	Response Rate
Region 1	Western Massachusetts	96	60%
Region 2	Central Massachusetts	74	59%
Region 3	North Shore	48	81%
Region 4	Boston, Metro Boston, Metro West	62	76%
Region 5	South Shore	71	55%
Statewide		351	65%

Statewide Perception of Climate Change

FIGURE 2. IN THE NEXT 20 YEARS, IT IS LIKELY THAT YOUR JURISDICTION WILL EXPERIENCE ONE OR MORE SERIOUS PUBLIC HEALTH PROBLEMS AS A RESULT OF CLIMATE CHANGE

Figure 2 presents survey results related to the perception that climate change may impact municipalities in Massachusetts. Sixty percent (60%) of responding jurisdictions "agreed" or "strongly agreed" that their community is likely to experience as a result of climate change, while only 14% disagreed. About a quarter (26%) of the LBOH were unsure.

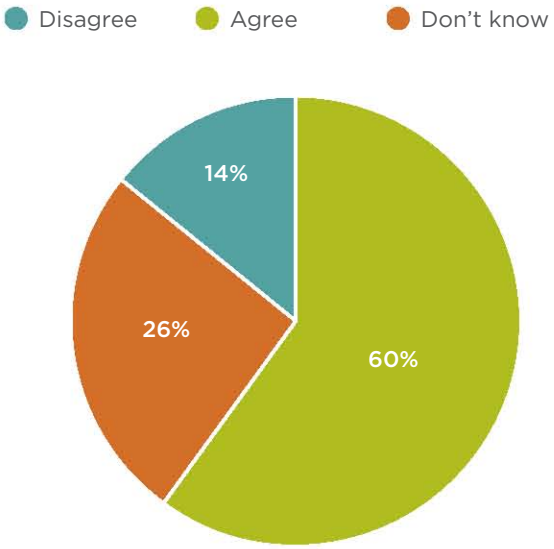


FIGURE 3. PREPARATION FOR THE PUBLIC HEALTH EFFECTS OF CLIMATE CHANGE HAS BEEN IDENTIFIED AS AN IMPORTANT HEALTH DEPARTMENT PRIORITY

Statewide, only 24% of LBOH identified preparation to address health effects associated with climate change as a priority in their health department whereas 69% indicated it was not a priority (**Figure 3**).

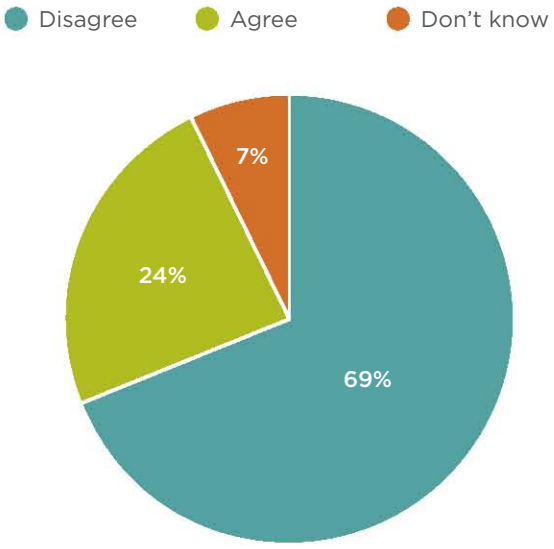


FIGURE 4. COMMUNITY HAS ADEQUATE RESOURCES TO ADDRESS PUBLIC HEALTH IMPACTS AS A RESULT OF CLIMATE CHANGE

Figure 4 demonstrates that slightly more than one fifth of LBOH (21%) believed their community had adequate resources to address public health issues related to climate change.

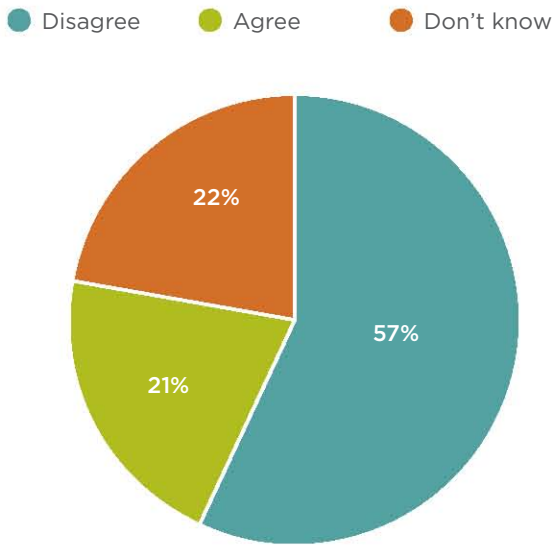
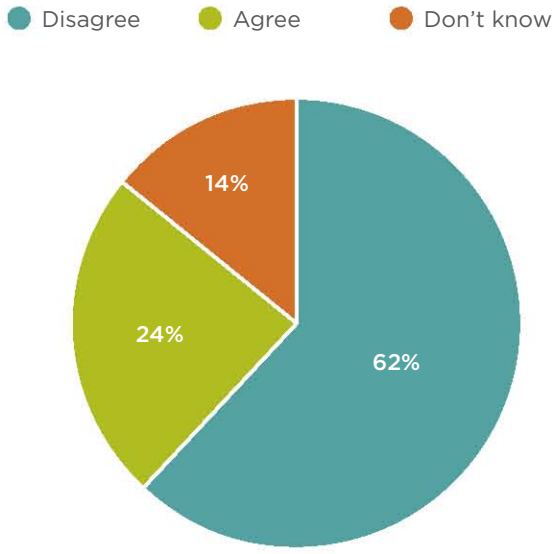


FIGURE 5. COMMUNITY'S HEALTH DEPARTMENT STAFF CURRENTLY HAS EXPERTISE TO ASSESS POTENTIAL PUBLIC HEALTH IMPACTS ASSOCIATED WITH CLIMATE CHANGE

Of the participating LBOH, 62% felt their staff did not have the expertise needed to assess potential local public health impacts of climate change, while 14% were unsure. Only 24% of local health officials reported feeling that their staff was sufficiently qualified to assess such potential public health impacts (See **Figure 5**). Of note, some LBOH indicated that funds and/or additional personnel would be needed to address public health impacts of climate change.



Overall comparison of LBOH perception and capacity to address climate change

Comparison of results revealed an inverse relationship between whether the respondents felt whether public health problems would result from climate change in the next 20 years and their perception of adequate resources to address climate change issues. **Table 2** shows that of the 60% of the officials who believed that public health consequences of climate change would significantly impact their jurisdiction over the next two decades did not believe their community had adequate resources to address these issues. The LBOH officials who did not believe climate change would impact the health of their communities in the next 20 years (14%) were about evenly divided as to whether they have adequate community resources (44% agree and 38% disagree).

TABLE 2. VIEW OF WHETHER THERE ARE ADEQUATE RESOURCES TO ADDRESS HEALTH IMPACTS OF CLIMATE CHANGE

	Believe public health problems will result from climate change in next 20 years (percent)	Perception of adequate resources (percent)
Agree	60%	22%
Disagree	14%	44%

SOURCES OF DRINKING WATER, SEWAGE TREATMENT METHODS, AIR CONDITIONING USE, AND KNOWLEDGE OF VULNERABLE POPULATIONS

Sources of Drinking Water

Increased precipitation in Massachusetts as a result of climate change has the potential to contaminate water sources from runoff and the release of contaminants from septic systems. While overall precipitation is expected to increase in Massachusetts, episodes are expected to be more intense but less frequent. This leads to the possibility of another type of water extreme: droughts. Droughts will be detrimental to Massachusetts, damaging agriculture and the economy in addition to depleting the drinking water supply *(Frumhoff et al., 2007)*. Clearly some members of the MA population are more vulnerable to the public health impacts of drought, including older adults, low-income families, and communities that rely on private well water *(EOEEA & AAC, 2011)*.

Thus, it will be important for LBOH to have accurate knowledge of the number and types of water sources relied upon by the communities they serve. As shown in **Figure 6**, over 70% of the LBOH respondents reported that they are served by more than one water source (e.g., municipal surface/ground water and private wells). Approximately 80% of MA communities have at least some residents on private well water.

About half of the communities participating in the survey reported that they receive municipal drinking water from groundwater sources and about one-quarter of responding communities are served by municipal supplies dependent upon surface water (**Figure 7**). Although only a small fraction of the communities receive drinking water through the Massachusetts Water Resources Authority (MWRA) this system serves roughly 38% of the total population in Massachusetts *(Massachusetts Water Resources Authority, 2013)*.

FIGURE 6. NUMBER OF DRINKING WATER SOURCES IN MASSACHUSETTS COMMUNITIES

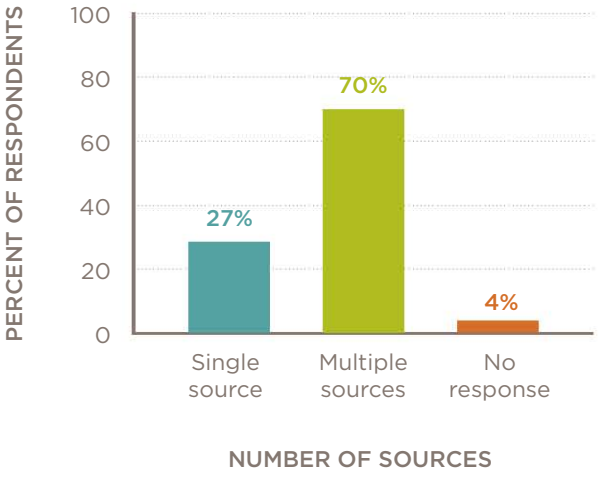
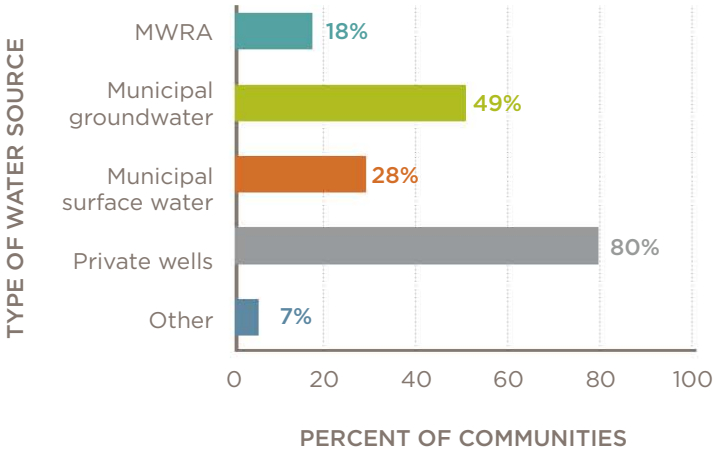


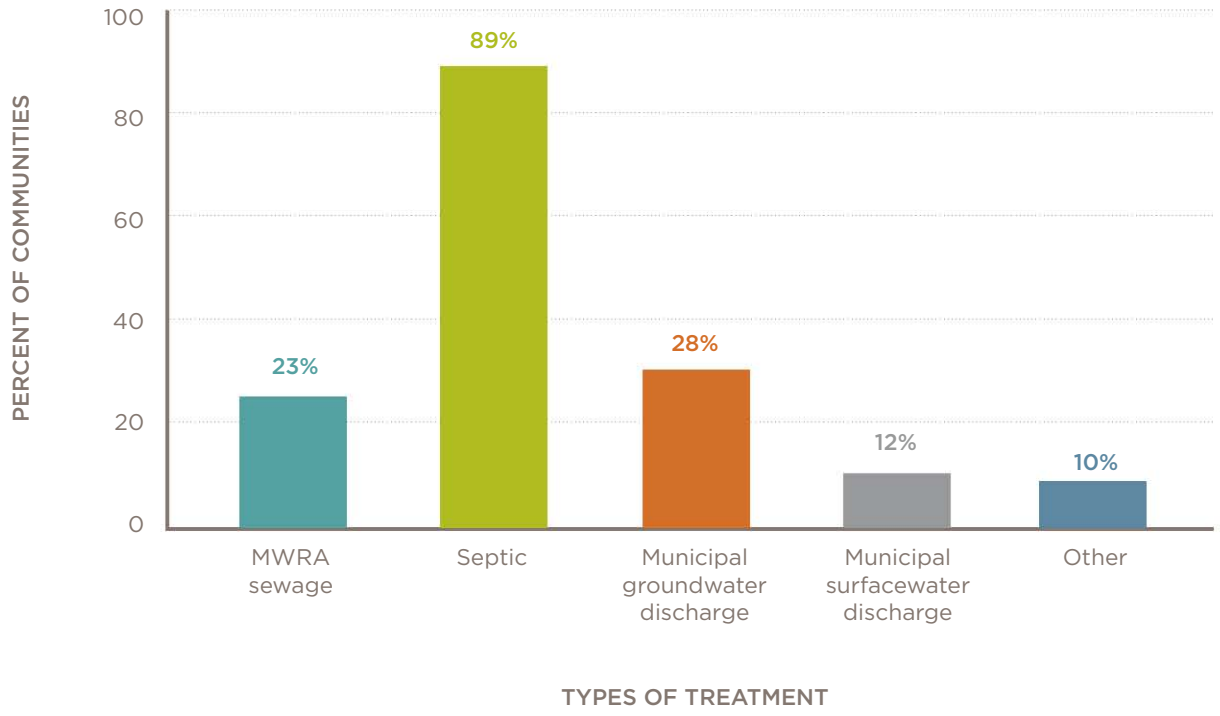
FIGURE 7. SOURCES OF DRINKING WATER IN MASSACHUSETTS COMMUNITIES



Sewage Treatment Methods

Sewage treatment will be an important component of adaptation planning given that some treatment methods may be more vulnerable than others (e.g. flooding may impact septic systems and drinking water wells). Sewage treatment methods in Massachusetts communities (**Figure 8**) include septic systems (89%), municipal groundwater discharge (28%), and MWRA (23%). It is important to note that a number of MA communities have multiple sources of sewage treatment.

FIGURE 8. SEWAGE TREATMENT METHODS IN MASSACHUSETTS COMMUNITIES



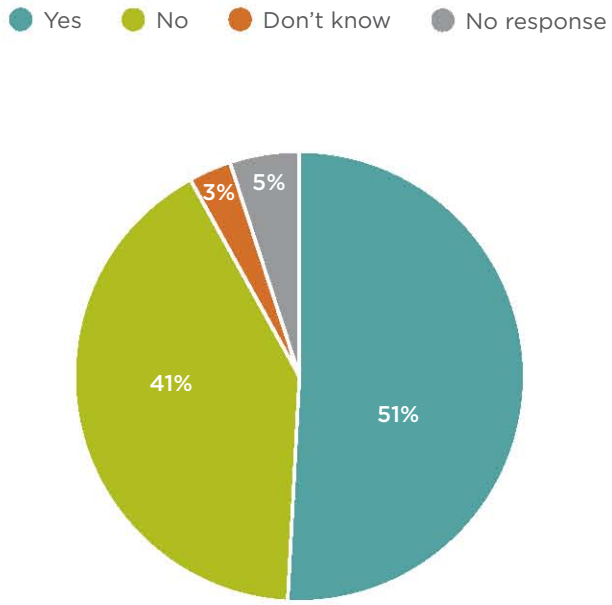
Air Conditioning Use in Homes and Schools

The majority of local health officials (61%) did not have information about the percent of residential air conditioning in their communities.

According to the survey results from the communities that responded to questions about the availability of air conditioning in schools, 41% of respondents said air conditioning was not available in any school in their community, while over 51% of school systems have air conditioning in schools (**Figure 9**).

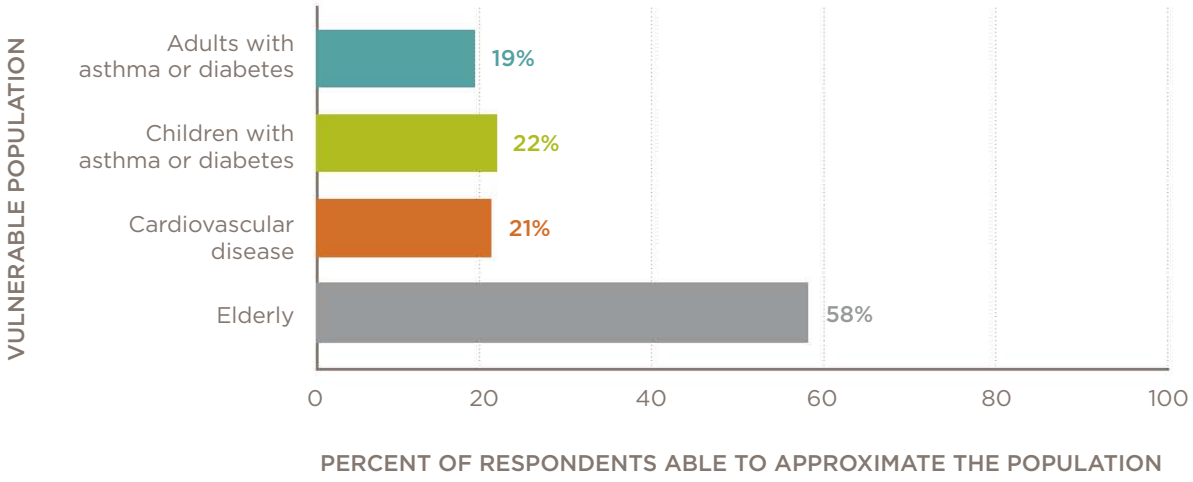
With respect to vulnerable populations, LBOH officials had the most extensive information about the elderly population in their communities; 58% of respondents were able to quantify this subpopulation. Statewide, roughly 80% of participating LBOHs were not aware of the percentage of residents in their community with other vulnerabilities, such as those with cardiovascular disease, asthma or diabetes (See **Figure 10**); these populations are at increased risk of health impacts associated with climate variability.

FIGURE 9. ESTIMATE OF AIR CONDITIONING AVAILABILITY IN SCHOOLS ACROSS MASSACHUSETTS



Knowledge of Vulnerable Populations

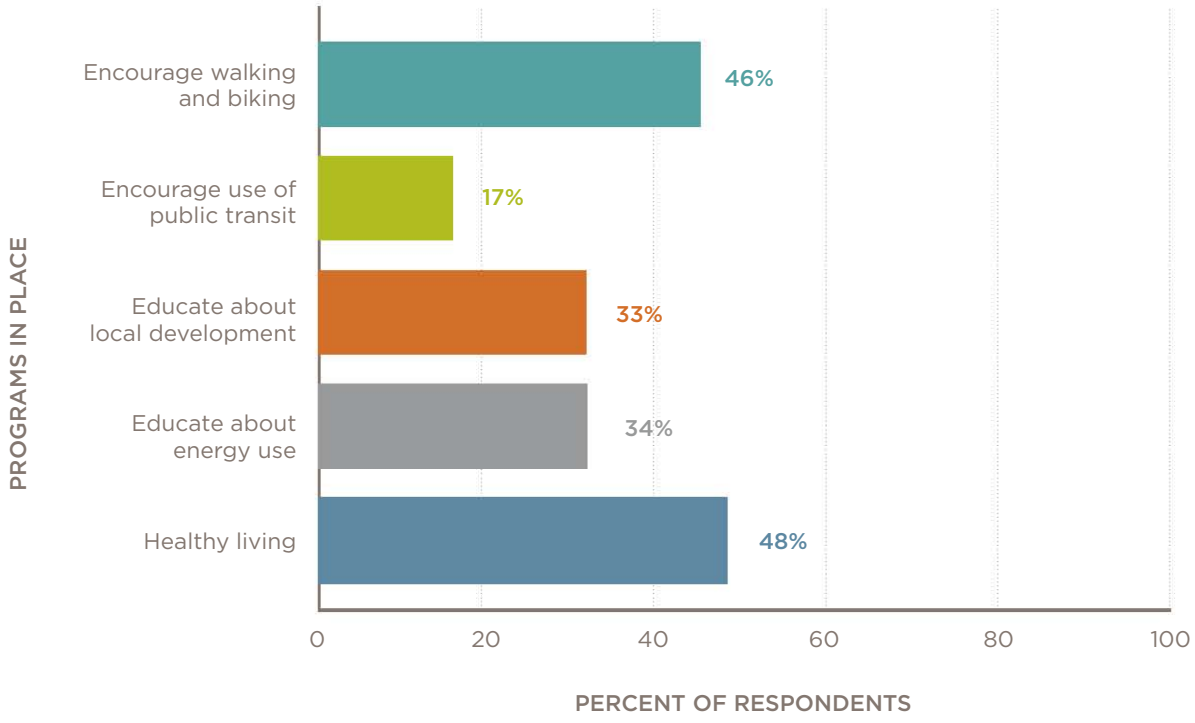
FIGURE 10. KNOWLEDGE OF LOCAL HEALTH DEPARTMENTS ABOUT THE PERCENTAGE OF VULNERABLE RESIDENTS IN THEIR COMMUNITY



Current Community Programs

The survey gathered information about resources that communities devote to programs that educate and promote healthy living, active transportation (i.e., encouraging walking/biking), and energy use. **Figure 11** shows that the most common efforts focused on promoting healthy living and active transportation (48% and 46% respectively). About one third of responding communities devote resources to educate residents about home energy use and local development. Promotion of public transit is lower probably because of the limited availability of this option outside of urban areas in the Commonwealth.

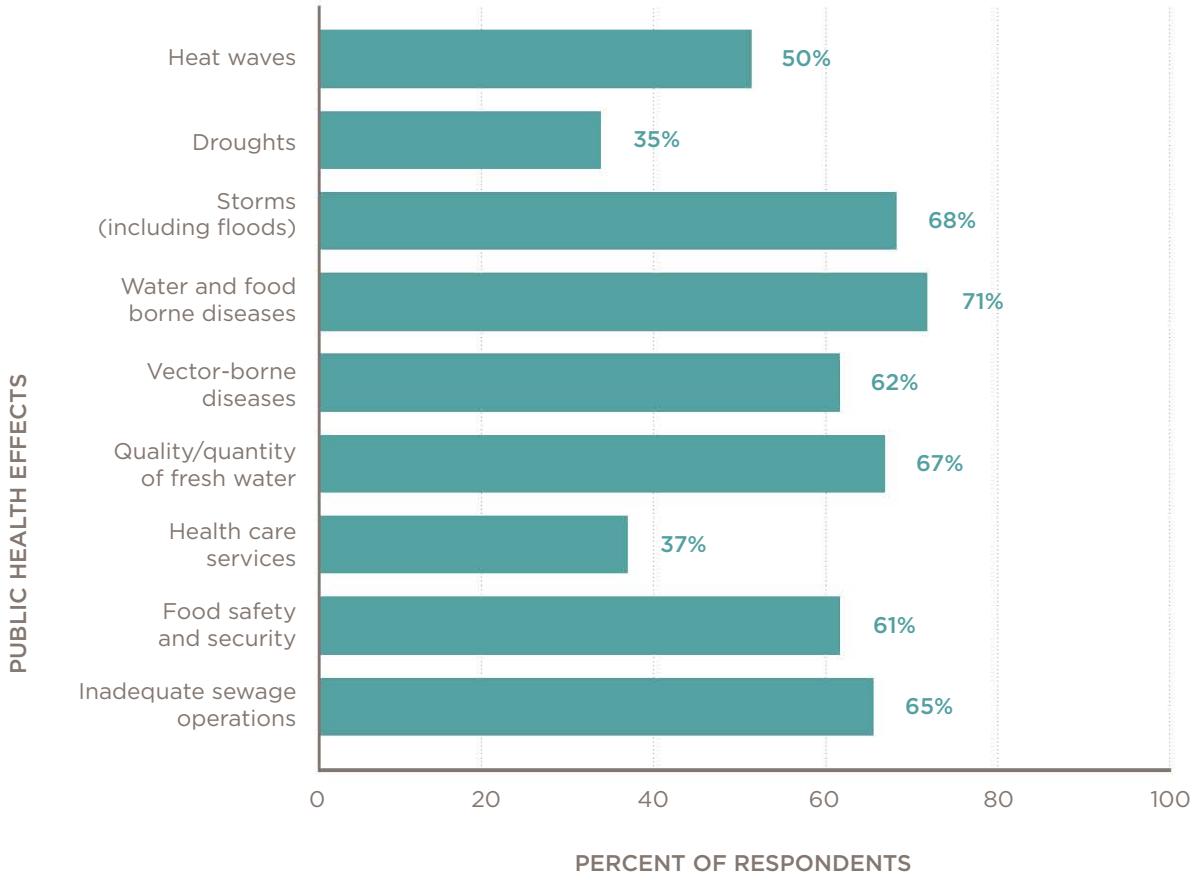
FIGURE 11. CURRENT COMMUNITY RESOURCES FOR, OR PROMOTION OF, OTHER HEALTH-RELATED PROGRAMS



Plans to Address Specific Climate-related Public Health Consequences

Over two-thirds of participating LBOH had plans, or felt they had the capacity to develop plans, to address water and food borne diseases (71%), storm responses (68%), and freshwater availability and safety (67%), as illustrated below in **Figure 12**. About half the LBOH that responded to the survey believe they have adequate resources to address heat waves (50%) in their community. LBOH identified gaps in planning and/or capacity to address health care services for chronic conditions (37%) and droughts (35%).

FIGURE 12. ADEQUATE CAPACITY OF LOCAL HEALTH DEPARTMENTS TO ADDRESS PUBLIC HEALTH EFFECTS OF CLIMATE CHANGE



Community Plans to Mitigate Environmental Impact

Approximately 37% of respondents indicated that their community had an initiative in place to mitigate the impacts of climate change (See **Figure 13**). Of communities with such initiatives (60%), the most common approaches are energy efficiency in government buildings (74%), increasing sustainable/ renewable energy in the community (61%), and increasing energy efficiency requirements for residential/commercial buildings (See **Figure 14**).

FIGURE 13. SPECIFIC PLANS IN PLACE TO ADDRESS MITIGATION OF CLIMATE CHANGE IN COMMUNITIES

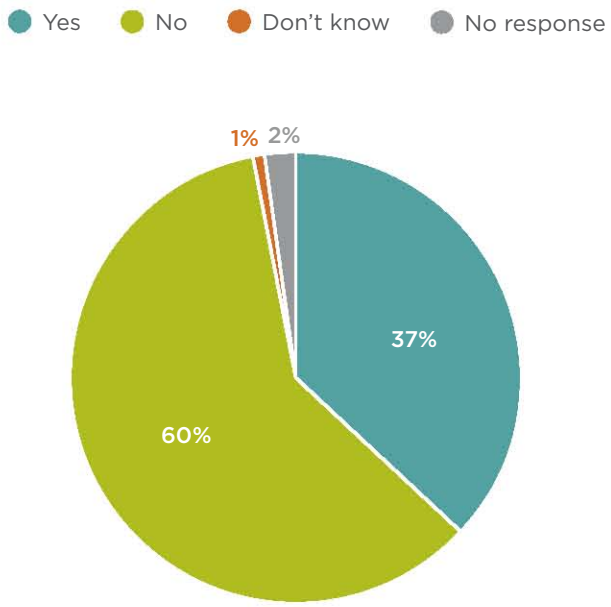
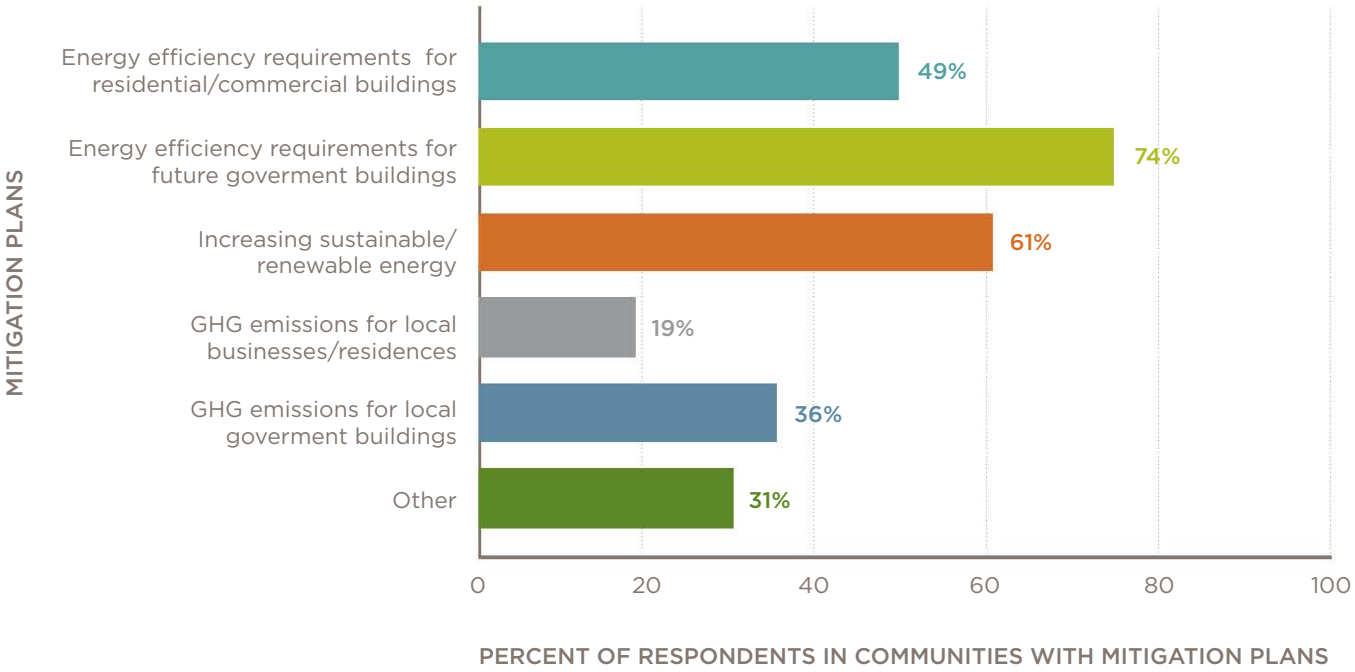


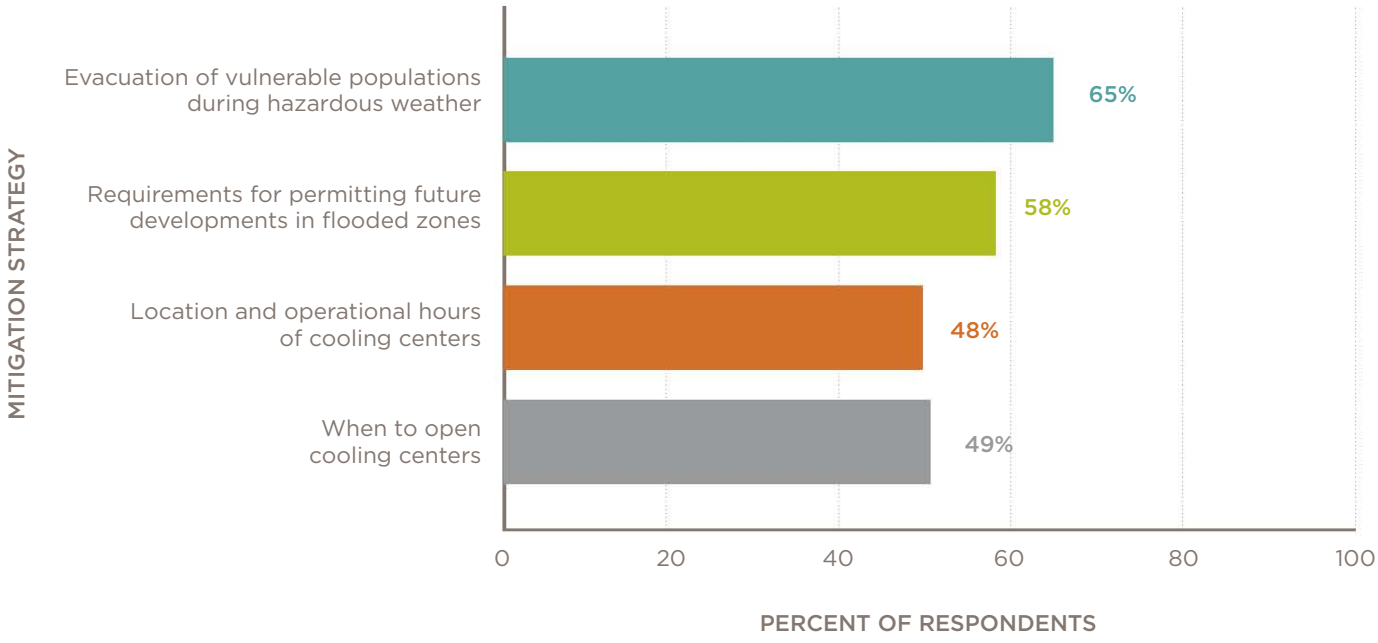
FIGURE 14. TYPES OF PLANS TO MITIGATE COMMUNITY'S OWN IMPACT ON CLIMATE CHANGE



Plans for Specific Strategies

Half of responding LBOH (n= 111) had plans, or were drafting plans, to develop usage criteria, identify locations, and determine operational hours for cooling centers in the event of heat waves (See **Figure 15**). Regulations of future land use development in flood zones were being considered or underway in 58% of reporting communities. Over 65% of the respondents indicated that evacuation of vulnerable populations during hazardous weather conditions as the highest priority of the three mitigating strategies listed (i.e. establishing cooling centers, land use permitting and requirements, and evacuation plans).

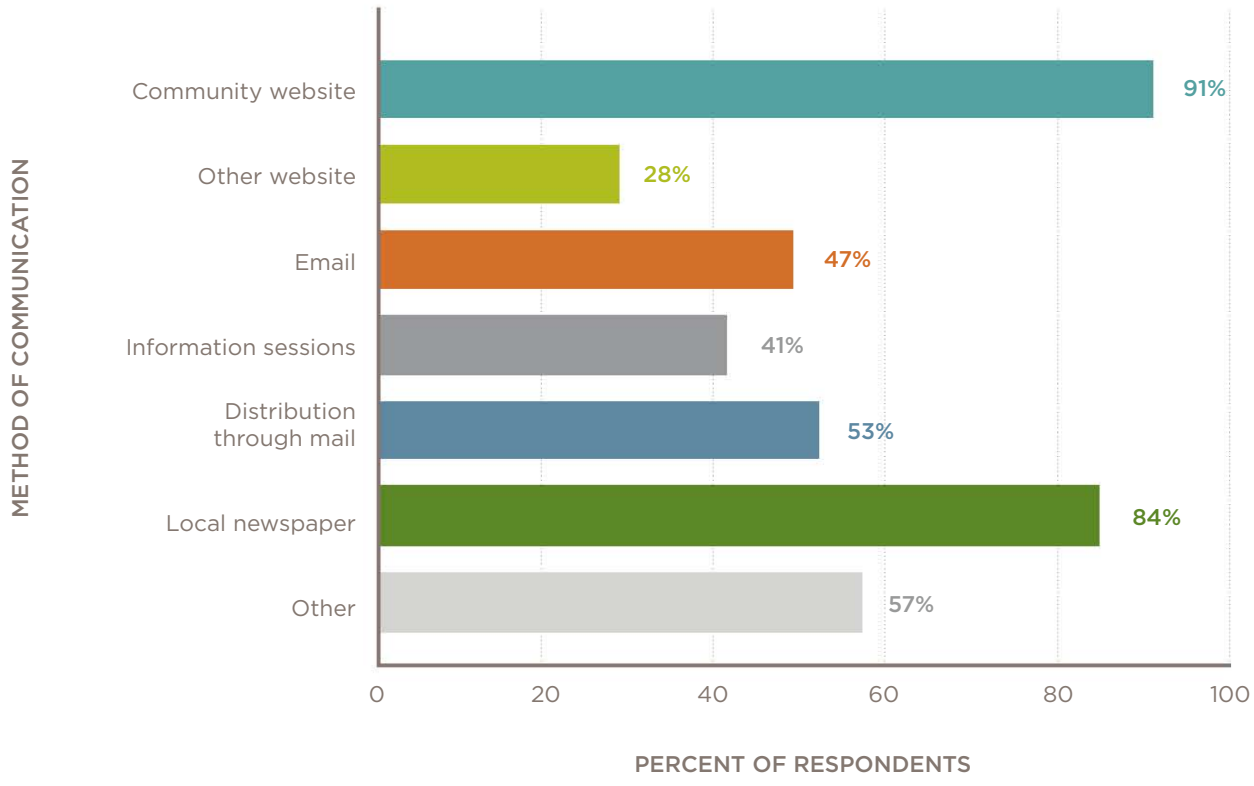
FIGURE 15. COMMUNITIES WITH PLANS OR DEVELOPING PLANS TO REDUCE PUBLIC HEALTH IMPACTS OF CLIMATE CHANGE



Communication methods with the general public

As shown in **Figure 16**, community websites and local newspapers were reported to be the most popular venues for general health information among responding municipalities with more than 80% of participating health officials reporting routine use of these venues.

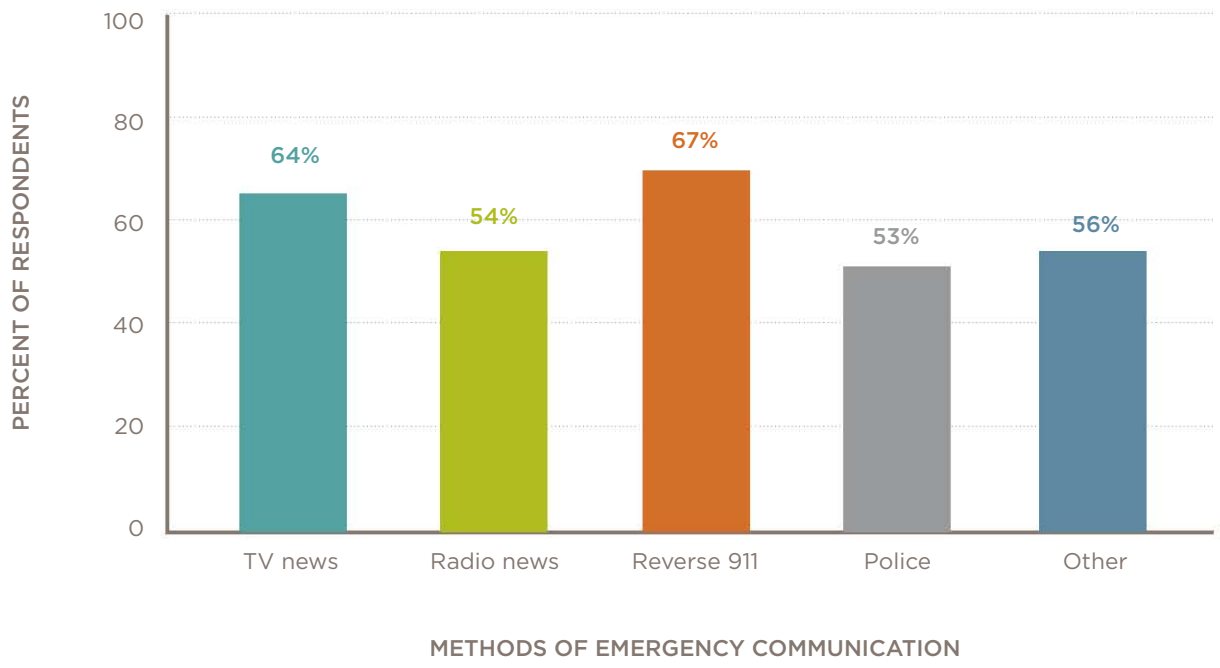
FIGURE 16. METHODS USED BY LOCAL HEALTH DEPARTMENTS TO COMMUNICATE ABOUT HEALTH INFORMATION TO THE GENERAL PUBLIC



Communication Methods During Public Health Emergencies

Urgent public health information, such as boil water orders, extreme heat warnings, and flooding warnings, is most often communicated via a reverse 911 system (67%) and television news broadcasts (64%) according to local health officials. Radio newscasts and police communications were utilized by just over half of survey respondents. Use of emergency modes of communication can be seen in **Figure 17**.

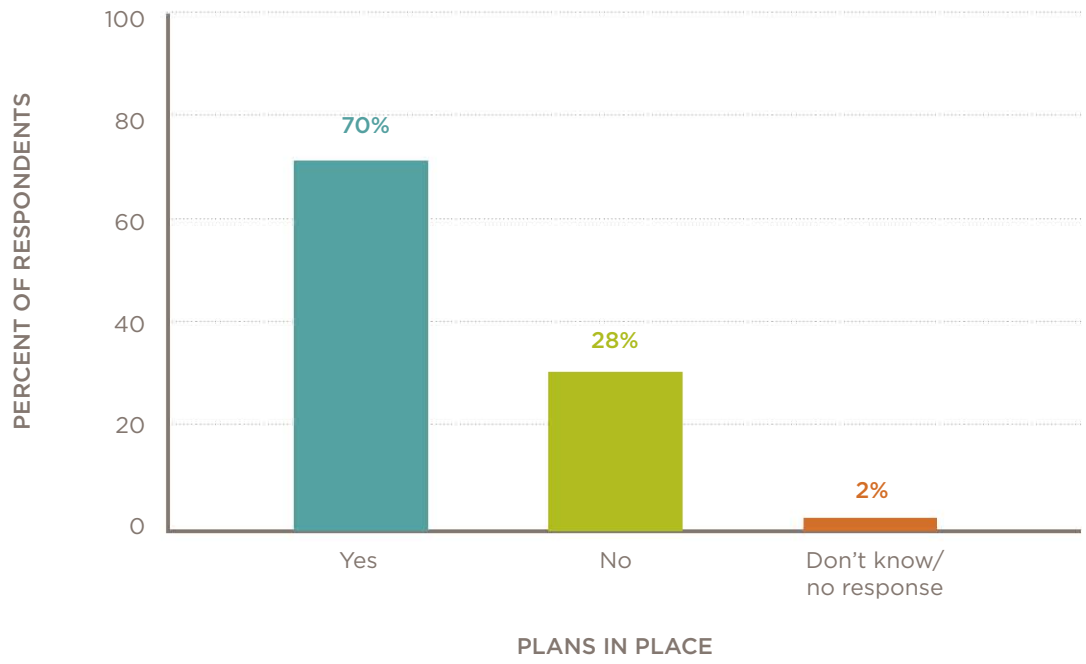
FIGURE 17. METHODS USED BY LOCAL HEALTH DEPARTMENTS TO COMMUNICATE WITH RESIDENTS DURING PUBLIC HEALTH EMERGENCIES



Outreach Plan for Vulnerable Popluations During Public Health Emergencies

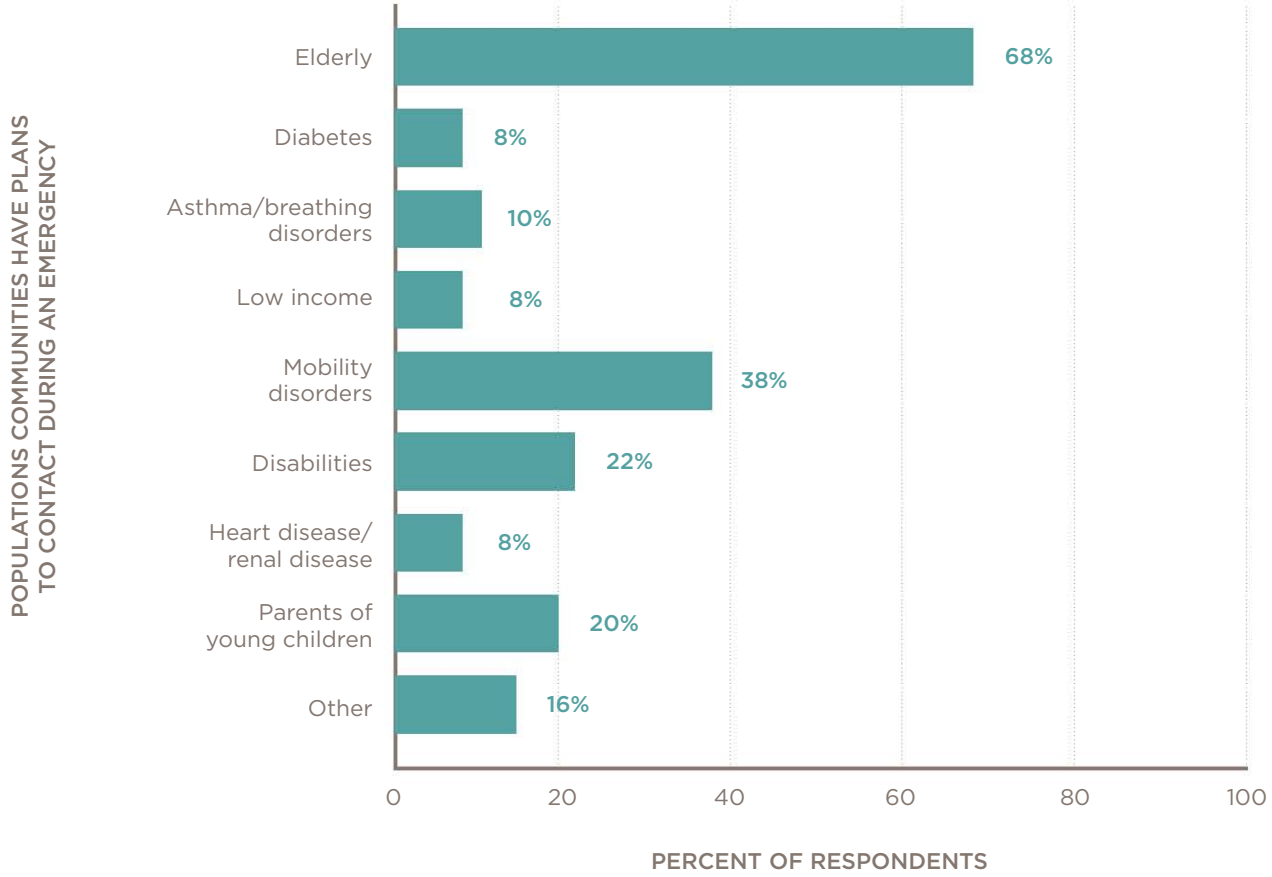
Statewide, 70% of LBOH reported having a plan in place to contact vulnerable populations during public health emergencies (See **Figure 18**), however, as reported earlier, information is lacking for many populations most vulnerable to climate impacts (e.g. those with asthma and/or other respiratory disease, those with cardiovascular disease and importantly residents with a diagnosis of Type II Diabetes).

FIGURE 18. COMMUNITIES WITH OUTREACH PROGRAMS IN PLACE FOR VULNERABLE POPULATIONS DURING EMERGENCIES



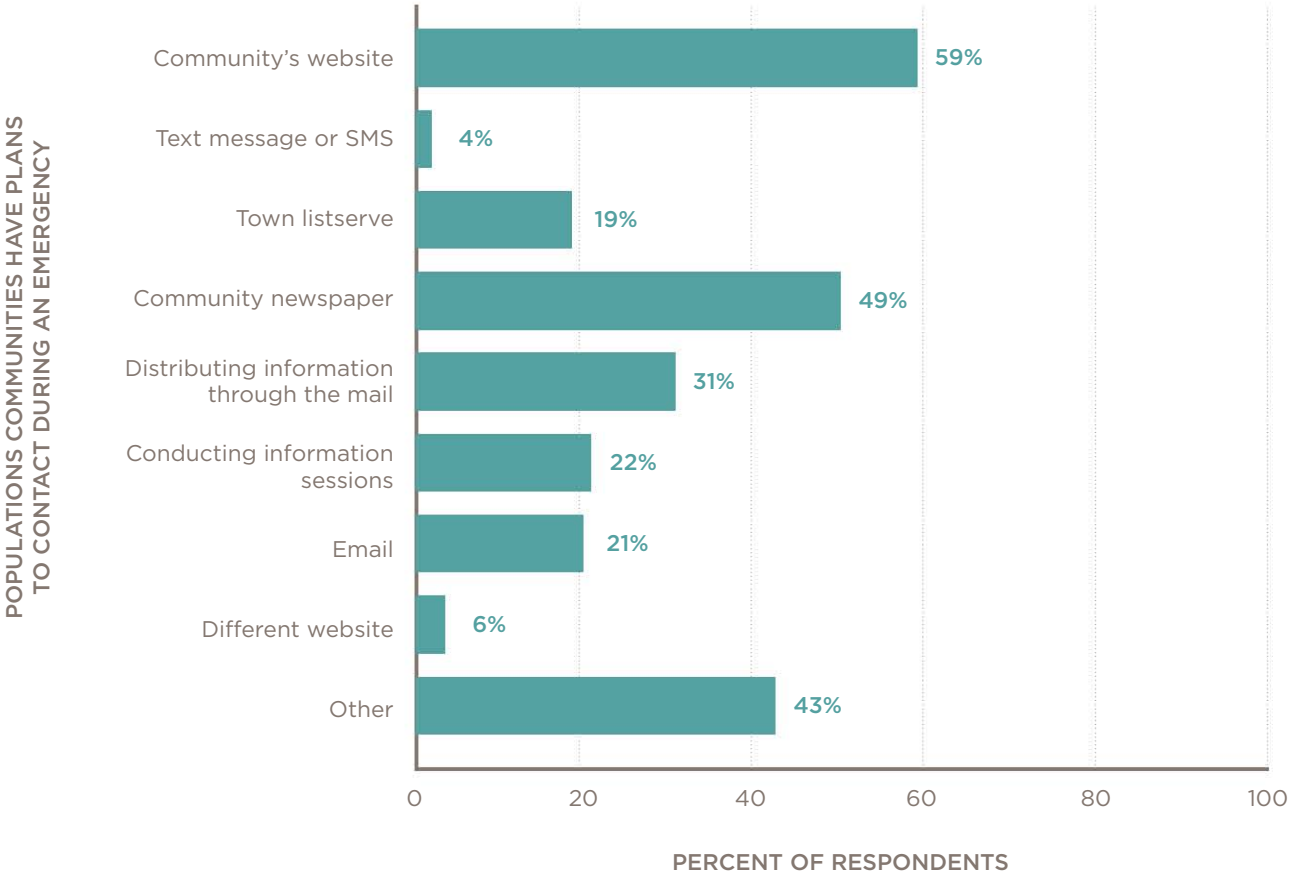
The elderly population was most commonly targeted by emergency communication outreach plans, as indicated by 68% of LBOH (see **Figure 19**). Individuals with mobility disorders were included in such plans by 38% of responding LBOH. Other potentially vulnerable groups were infrequently included in LBOH emergency outreach plans.

FIGURE 19. CAPACITY OF COMMUNITIES TO CONTACT VULNERABLE POPULATIONS



Similar to methods used for reaching the general population during an emergency, the most common emergency communication methods used by LBOH were community websites (59%) and community newspapers (49%) (**Figure 20**).

FIGURE 20. METHOD OF OUTREACH TO VULNERABLE POPULATIONS DURING AN EMERGENCY



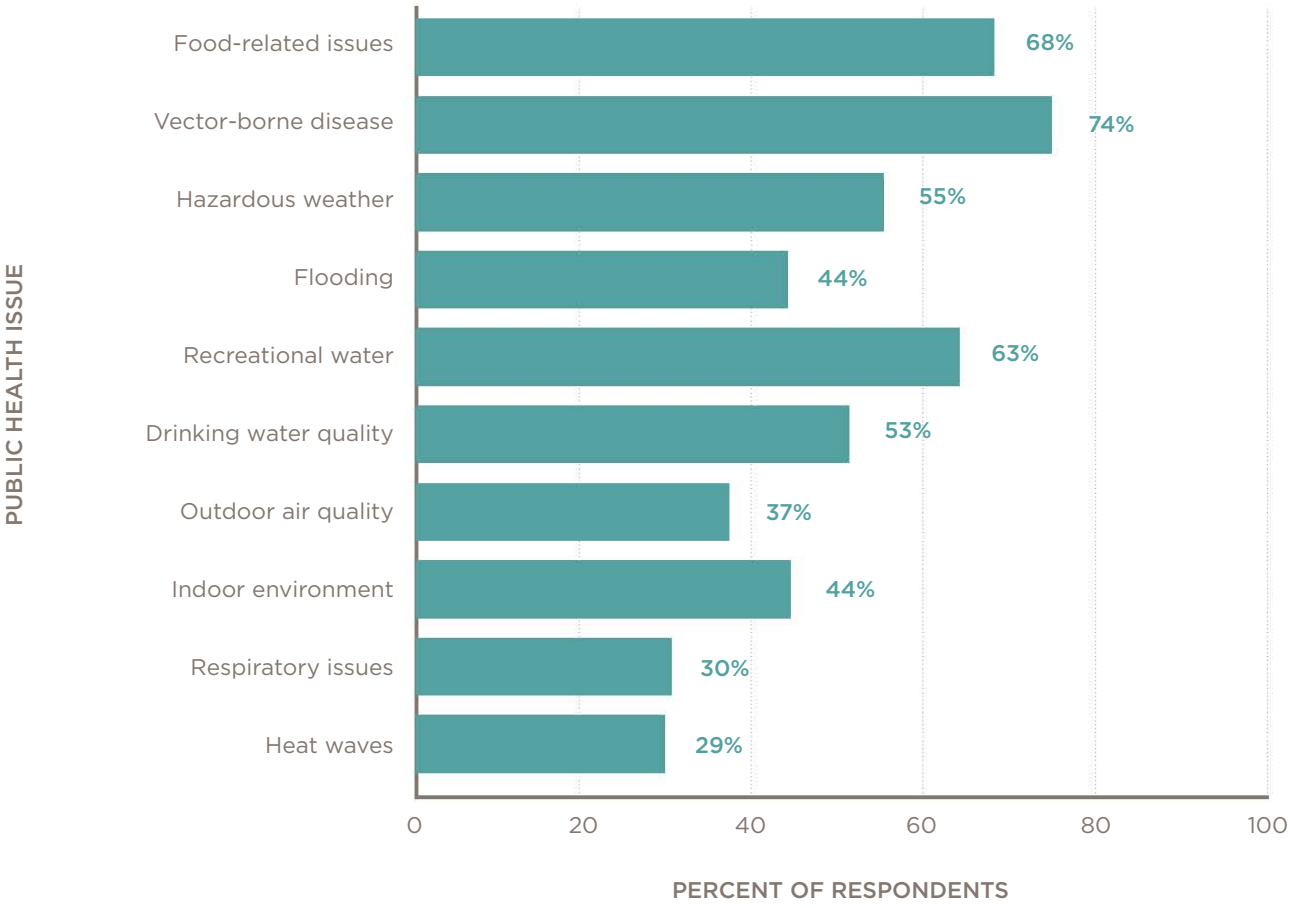
PUBLIC HEALTH RISKS AND EFFORTS TO REDUCE PUBLIC HEALTH IMPACTS THAT COULD BE AFFECTED BY CLIMATE CHANGE IN MASSACHUSETTS COMMUNITIES

Most Frequent Public Health Issues Addressed by LBOH

Figure 21 displays how often LBOH reported being contacted about or addressing ten climate-related public health issues. It is worth noting that it was very uncommon that parts of this question were left unanswered; in other words, there was a frequency estimate for each health category on the vast majority of the surveys for this question.

Vector-borne diseases, food borne illnesses, and recreational use of water were the most common issues that came up for LBOH over the year. Hazardous weather and drinking water quality were the next most common issues addressed by LBOH (affecting over half of participating LBOH). In contrast, one-third to half of participating LBOH's reported that they have never been contacted about respiratory illness, outdoor air quality or heat waves.

FIGURE 21. REGULARITY THAT LOCAL HEALTH DEPARTMENTS ARE CONTACTED OR TAKE ACTION DURING A YEAR ON PUBLIC HEALTH ISSUES ASSOCIATED WITH CLIMATE CHANGE



Surveillance Activity

Of the ten public health impacts associated with climate change included on the survey, five were monitored by more than half of responding LBOH (See **Figure 22**). Surveillance activities conducted by LBOH were directly reflective of the most commonly addressed problems, described previously. The most frequently tracked issues, in rank order, were: vector-borne diseases (72%); food borne illnesses (67%); and drinking water quality (65%). Safety of recreational water sources and severe weather events were monitored by more than half of participating LBOH (58% and 56%, respectively).

Indoor and outdoor air quality, respiratory conditions and extreme heat were tracked by a small minority of respondents. The utility of community specific health and environmental data contained on the MDPH/BEH Environmental Public Health Tracking (EPHT) portal (Massachusetts Department of Public Health, 2009) should prove invaluable for enhancing the availability and use of local data to better address these issues. Data included on the EPHT portal include pediatric asthma, hospitalization (e.g., for asthma, cardiovascular outcomes), drinking water quality, birth defects, air quality, and other parameters.

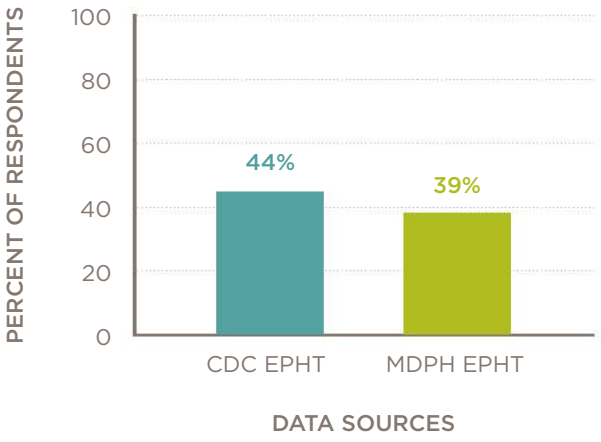
FIGURE 22. COMMUNITY USE OF SURVEILLANCE DATA TO MONITOR THE PREVALENCE OF PUBLIC HEALTH IMPACTS ASSOCIATED WITH CLIMATE CHANGE

Knowledge of Sources of Surveillance Data

Although state and federal surveillance systems to monitor the prevalence of diseases that may have at least some environmental health risk factors are readily available, **Figure 23** shows that less than half of LBOH officials were familiar with these resources. Forty-four percent (44%) were aware of the CDC's National Environmental Public Health Tracking Program (CDC EPHT) *(Centers for Disease Control and Prevention, 2012)*.

Thirty nine percent (39%) were aware of/familiar with MDPH's state-specific EPHT portal, which contains health and environmental data on a community and census tract level for some health outcomes *(Massachusetts Department of Public Health, 2009)*. In a related question, over 80% of LBOH reported that access to surveillance data would be helpful if it were provided to them (see **Figure 24**).

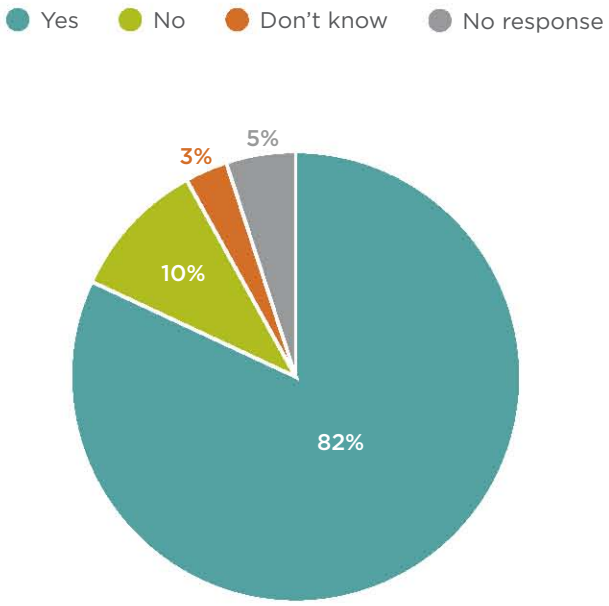
FIGURE 23. LOCAL HEALTH DEPARTMENT'S FAMILIARITY WITH SOURCES OF PUBLIC HEALTH SURVEILLANCE DATA



CDC EPHT:
CDC Environmental Public Health Tracking (EPHT) Portal

MDPH EPHT:
Massachusetts Environmental Public Health (EPHT) Portal

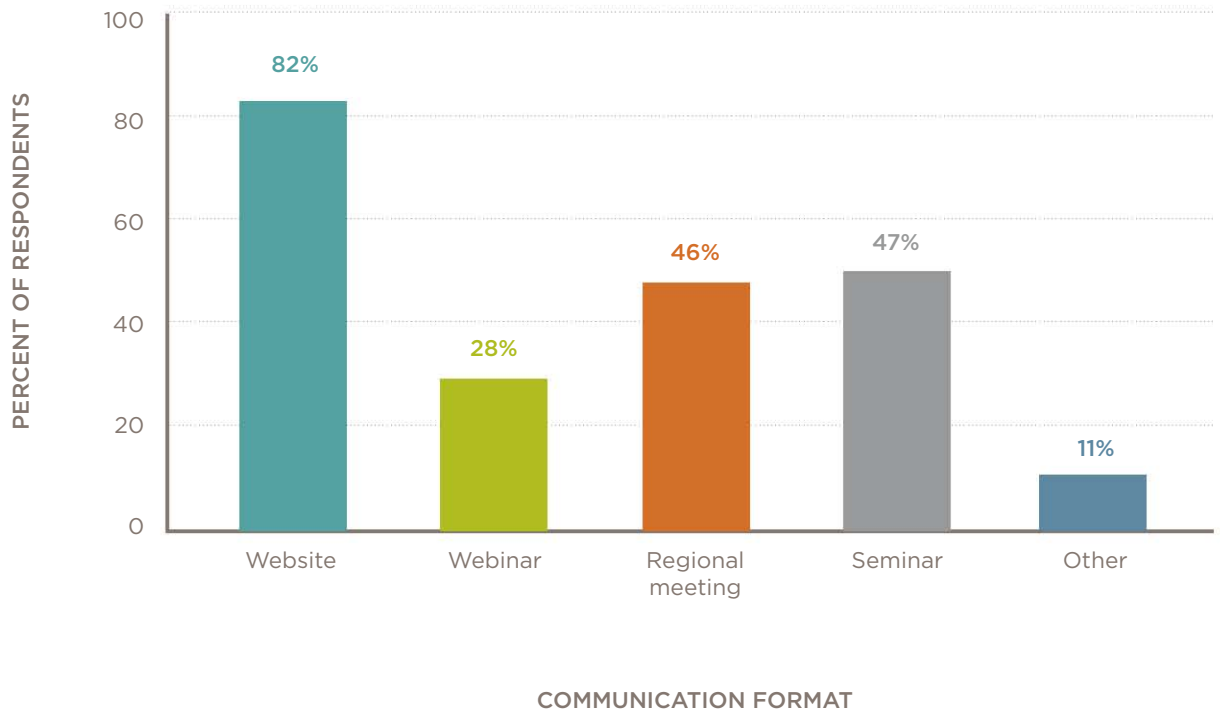
FIGURE 24. WILL ACCESS TO PUBLIC HEALTH SURVEILLANCE DATA BE USEFUL TO LOCAL HEALTH DEPARTMENTS?



Types of Educational Preferences

When asked how MDPH could be helpful, local health officials felt that development of a website with relevant information was most desired by LBOH for obtaining information. Following that, regional meetings and seminars were viewed as useful by equal proportions of LBOH (46% and 47%), 28% of responding LBOH suggested that MDPH could provide education and training materials for LBOH staff (See **Figure 25**).

FIGURE 25. COMMUNITY PREFERENCES FOR DEVELOPING, DISPLAYING, OR PRESENTING PUBLIC HEALTH INFORMATION



SECTION 4:

Discussion

Discussion

The overall survey response rate was 65%, representing 69% of the MA population. Participation rates varied across the five EPRC Regions. While Region 3 (Northeastern MA) and Region 4 (Boston, Metro Boston, Metro West) contain the fewest municipalities among the five Regions (48 and 62, respectively), these two Regions are the most densely populated, generally have greater resources and had the highest response rates to this survey (81% and 76%, respectively).

The Western MA Region is the largest in terms of land mass, least densely populated, contains the largest number of municipalities (27% of communities in the state) and possesses the fewest resources, yet returned the greatest number of individual surveys (58).

Although the majority (60%) of LBOH participating in the survey believe that their community is likely to experience serious climate-related public health impacts most local health departments in the Commonwealth have not prioritized planning to address such. To complicate the lack of planning, local officials reported that they feel unprepared and under-resourced and/or lack the expertise to adequately respond to these issues. Only half the LBOH reported they had capacity (or had plans) to address five of the nine specific climate change impacts that may affect public health identified in the survey (i.e., heat waves, droughts, storms (including floods), water-borne diseases, food-borne diseases, vector-borne infectious diseases, quality or quantity of freshwater available, health care services for those with chronic medical conditions, food safety and security, and unsafe or ineffective sewer and septic system operation).

Almost half (47%) of LBOH in Region 4 (Boston, Metro Boston, Metro West) prioritized preparing for climate change-related public health problems. In the remaining four Regions of the state only 14% - 21% of LBOH counted this among their top priorities. LBOH in Boston, Metro Boston, Metro West were likewise more confident in the expertise of their staff to assess the impacts of climate change on local public health (32%) than LBOH in the rest of the Commonwealth.

While all of the EP Regions indicated significant needs for resources to address this issue, Region 5's lack of capacity was the most striking: only 8% of LBOH in Southeastern MA felt their community possessed adequate resources to respond to the impacts of climate variability. Similar gaps in LBOH staff proficiency were reported in Southeastern MA with 13% of respondents reporting ample expertise compared to 24% statewide, highlighting the greatest opportunity for LBOH staff training in Region 5.

Examples of public health impacts associated with these climate effects include heat stress, cardiovascular and respiratory effects and gastrointestinal illnesses, among others. The survey also identified some gaps in LBOH knowledge regarding the extent of vulnerable populations in their community, the availability of air conditioning in homes, as well as lack of capacity of LBOH to address increases in heat waves and droughts, and ability to communicate with vulnerable residents during a power outage.

However, it is important to note that 25% of the respondents identified climate change as a top priority for their agency. In addition, some local health officials reported they are beginning to engage in adaptation planning.

For example, half (50%) of LBOH reported that they have, or are developing, specific adaptation plans for siting cooling centers for operation during heat events; 59% of LBOH reported development of local flood zone regulations, and 66% reported having plans in place for evacuation of vulnerable populations during hazardous weather events. The local public health infrastructure in MA also analyzes surveillance data to track diseases at the community level and a large proportion of respondents found that access to surveillance systems (e.g., the MDPH/BEH Environmental Public Health Tracking data) would be useful.

Those LBOH who did not believe climate change would affect their jurisdictions in the next 20 years rated their communities similarly to LBOH in communities who believe their jurisdictions would be affected, in terms of adequate capacity or having existing plans to address a majority of health effects associated with climate change. For the adaptation strategies employed locally (i.e., setting cooling center location and hours, requiring permits for developments in flood zones, and evacuation of vulnerable populations during hazardous weather) health officials who believe climate change will result in significant public health threats more frequently reported having developed, or are taking steps to develop plans, compared to those who did not believe in climate change. Notably, LBOH officials demonstrated similar concerns and reported roughly equal levels of capacity to address specific public health consequences independent of their personal beliefs regarding the potential future impact of climate change on public health.

Overall, the survey results from local health officials in Massachusetts are similar to findings of the ASTHO, George Mason University (GMU) and Public Policy of California (PPIC) studies. Although the majority (60%) of responding jurisdictions in MA believe that their community is likely to experience serious climate-related public health problems — a finding midway between ASTHO (73%) and GMU results (50%) — most local health departments in the Commonwealth have not prioritized these problems, feel unprepared and under-resourced and lack the expertise to adequately address these issues.

Three quarters of LBOHs in MA reported that climate change was not one of their agency's top ten priorities, a proportion almost identical to that of the state health departments surveyed by ASTHO (77%) *(ASTHO, 2009)* and similar to GMU's results *(Maibach et al., 2008)*.

Many local health officials surveyed by GMU and PPIC felt poorly prepared and lacked the expertise to respond to the health impacts of climate change (Maibach et al., 2008; Bedsworth, 2008), analogous to the MA finding that just 24% of LBOHs across the Commonwealth reported ample expertise in this area among staff. Similarly, a large majority (86%) of state health departments expressed a need for more training on the ASTHO survey *(ASTHO, 2009)*. Nearly all respondents to the ASTHO, GMU and PPIC surveys expressed the need for more funding and additional staff to address this emerging problem. LBOHs in Massachusetts strongly indicated a gap in community resources to address the health impact of climate change: only 22% felt existing resources were adequate, 59% expressed that resources were inadequate and 20% did not know.

While the majority of state health department respondents to the ASTHO survey had begun conducting activities to respond to certain climate-related public health threats (50-80%), more than half reported inadequate capacity to do so for many health consequences *(ASTHO, 2009)*. At the local level, the GMU and PPIC surveys revealed that most health departments were not engaged in adaptation activities *(Maibach et al., 2008; Bedsworth, 2008)*.

In MA, more local health officials are beginning to engage in adaptation and mitigation planning than would be predicted by GMU and PPIC f indings. Half (50%) of LBOHs reported that they have, or are developing, plans to create cooling centers during extreme heat events; 34% of LBOHs reported development of flood zone regulations and 34% noted plans for evacuation of vulnerable populations during hazardous weather events.

The overall findings of the MDPH/BEH LBOH survey suggest that the need to support increased capacity, training and technical assistance for LBOH need not focus on convincing local health officials that climate impacts are important. Rather, efforts should be directed toward prevention of, and preparation for, specific health consequences. Thus, support for climate change-related adaptation planning may be maximized by reframing the issues in terms of response planning for specific environmental events known to be climate-related (e.g., heat waves, flooding) without explicitly naming these efforts as "climate change" responses. For example, it would be beneficial for all communities if they were to receive training and technical assistance for best practices in adaptations to such events, i.e. identification of cooling centers, protection of food establishments from flooding, housing impacts associated with storms and so on.

From a broader perspective, the issues related to effectively addressing the additional burden on LBOH from climate change cannot be fully addressed without considering the fact that health departments in Massachusetts are becoming increasingly burdened with responsibilities that exceed the available resources. Some health departments are currently unable to provide many essential public health services due to understaffing and under-training *(Hyde & Tovar, 2006)*. For these reasons, the selection of best practices for adaptation of climate change health effects should initially focus on strategies that are less resource intensive.

Results of the MDPH/BEH survey also provide insight in the implementation of adaptation strategies to address public health-related climate change vulnerabilities identified in the Massachusetts Climate Change Adaptation Study. For example, while LBOH report that they are rarely contacted about heat waves, it is one of the impacts of climate change that will be felt across all regions of the state. While there are methods of mitigating the effects of heat on public health, the implementation of these strategies takes planning. For example, in many communities schools are the emergency shelters but, according to the MDPH/BEH survey results, slightly less than half of responding communities have schools with air conditioning. LBOH also reported vector-borne diseases and water-related issues among the top health concerns that they are contacted about in their community. The recent findings of the National Climate Change Assessment Report states that there is increased evidence that climate change has contributed to the expanded range of mosquitoes infected with certain vector-borne disease (e.g., West Nile Virus, Eastern Equine Encephalitis, EEE). This increase in virus activity was specifically observed in Massachusetts last summer with an unprecedented expansion in the geographic range of infected mosquitoes pools in areas thought to be previously at low risk. This is evident again this summer with mosquitoes infected with EEE already found in western Massachusetts. Further, Massachusetts, and in particular, the Southeast region of the state, experienced a substantial increase in both EEE-infected mosquito pools and harmful algal blooms last summer.

Substantial opportunities exist for MA LBOH to enhance their capacity to prepare for and address the health effects of climate change, particularly with the appropriate tools and technical assistance. Gaps in knowledge areas were demonstrated by the significant proportions of "do not know" responses to several survey questions. Clear educational opportunities were demonstrated by respondents, particularly around:

- Skills, competencies and resources necessary to address public health impacts of climate change at the local level
- Specific skills-building to enhance staff capacity
- Predicted environmental vulnerabilities of essential resources (e.g., water and food safety)
- Knowledge of relevant community resources (e.g., air conditioning, cooling centers)
- Identification of subpopulations vulnerable to specific health effects of climate change
- Surveillance resources and approaches for specific environmental and health threats
- Evidence-based adaptation strategies that target reductions in public health impacts
- Health communication efforts to educate the public and notably during emergencies
- Web-based approaches to technical assistance would clearly be of value as LBOH reported this as a primary means of receiving and distributing information.

In the spring of 2013 MDPH/BEH convened a one-day symposium in southeastern Massachusetts featuring Dr. George Luber of the US Centers for Disease Control as a keynote speaker (Climate Variability and Health Impact Assessment: Tools for Planning and Adapting for the Future). The purpose of the symposium was to provide key information on potential health impacts that all communities are projected to face as a result of climate change, as well as provide tools that municipalities can use to plan for and adapt to such impacts and notably those issues more specific to Region V. MDPH/BEH plans to conduct similar events in the other Massachusetts regions during the next year.

Survey Limitations

A survey of this nature has several limitations. Response rate was unequal across Regions, so statewide data may be weighted towards Regions with higher response rates.

Resource and staff constraints of smaller health departments may have limited their ability to participate in the survey or respond to follow up emails and calls. There were also cases of non-response because some officials anecdotally reported that they did not believe that climate change was a significant public health issue in their community.

Overall, the results of the statewide survey highlight important implications with regard to MA state (MDPH/BEH) and local (LBOH) planning to address the impacts of climate change. The gaps revealed in public health capacity at the local level point to the current lack of capacity of many community health departments.The CDC's framework for evaluating climate change health impacts at the state and local level (Building Resilience Against Climate Effects or BRACE) could serve as a helpful resource for identifying the action planning approach to address these gaps and enhance LBOH capacity to address the public health effects of climate change and can be applied to the recommendations outlined in the final section of this report.

SECTION 5:

Recommendations

Recommendations

A variety of efforts are either underway or planned to help facilitate capacity to respond to climate variability and impacts at the local level. These include two broad categories:

RESOURCE DEVELOPMENT

- The Patrick Administration's investment in adapting to and mitigating the effects of climate change in the Commonwealth expanded initiatives that address specific vulnerabilities in public health. Resources were provided to address bacterial contamination of recreational waters, bacterial contamination of oysters and shellfish; increased risk of vector-borne diseases. The Governor also emphasized the need to support local health partners in their efforts to protect public health from the health impacts of climate change at the community level.
- In line with the Patrick Administration's directive to assess potential areas where climate change could have a negative impact on the Commonwealth's infrastructure, MDPH should create region-specific vulnerability maps identifying and quantifying specific environmental and public health threats for each EPRC Region in MA.
- MDPH should research and review existing tool kits (e.g., from the CDC) and develop a toolkit for MA LBOH including:
  - » Guidance for LBOH staff
  - » Checklists
  - » Directions for accessing surveillance data
  - » Model adaptation/mitigation strategies, templates of best practices
  - » Public education and outreach materials
- MDPH should develop a website to provide access to free downloadable resources on climate change (including the toolkit recommended above).

EDUCATION/TRAINING

- MDPH should conduct regional educational symposiums for LBOH staff and potential local cross-sector partners. Topics should include:
  - » Emerging weather patterns related to climate change in each Region of MA
  - » Health impacts associated with these events
  - » Introduction of the CDC's framework: Building Resilience Against Climate Effects (BRACE) (Luber, 2011)
  - » Competencies needed at the local level to monitor and address these issues
- MDPH should conduct other symposiums and/or educational venues as resources allow.
- State and local public health officials should educate policy makers on the anticipated public health effects of climate change and local impact on MA communities.
- State and local public health officials should develop a plan for coordinated public education and awareness-raising for the general public.

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