

# Building a Scalable and Sustainable Approach to Evaluate Climate-related Health Impacts in Massachusetts



*Preparing for the Impacts of a Changing Climate on Public Health in New Jersey: A workshop for Public Health Practitioners*

Friday June 3, 2016

Marc A. Nascarella, PhD  
**Massachusetts Department of Public Health**



# Outline



1. MA Climate Initiatives
2. Climate Health Impacts
3. CDC BRACE Framework
4. MA Climate Assessment
5. Tools for Local Health

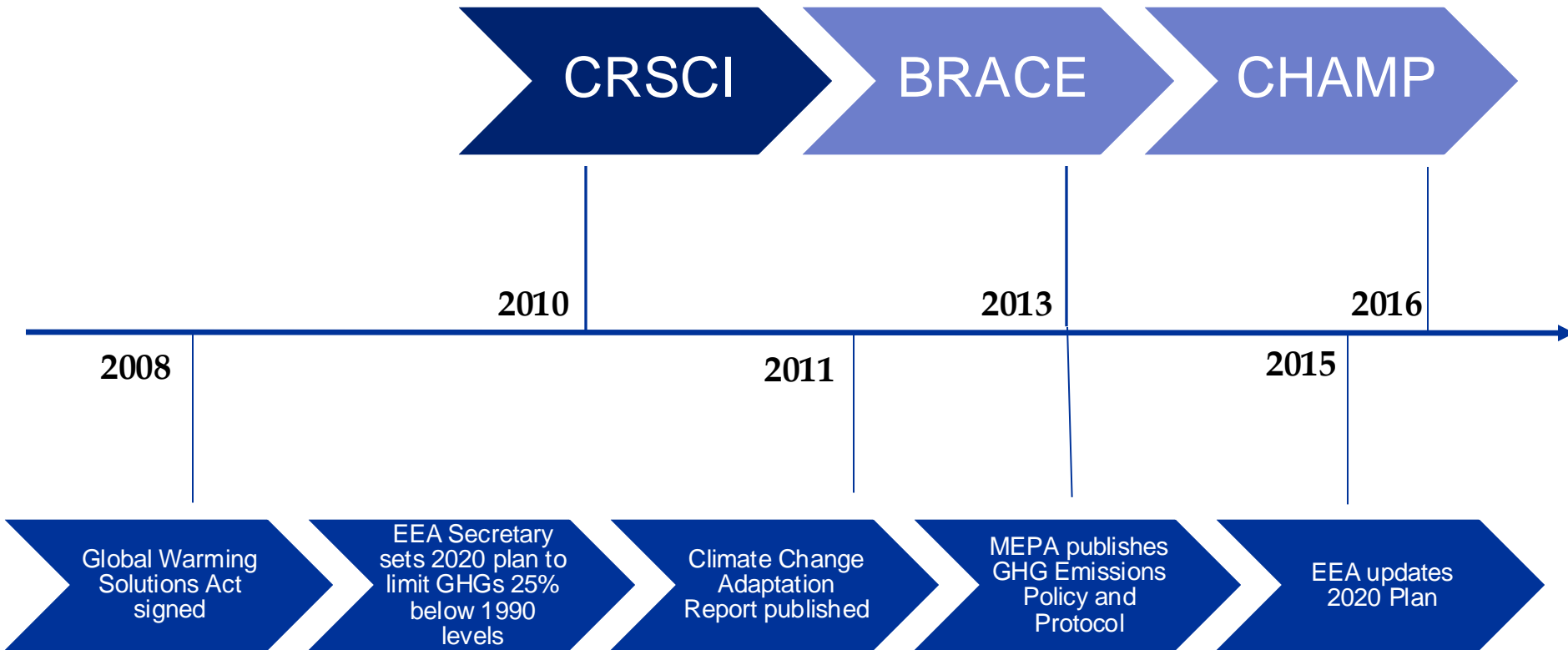




# Timeline

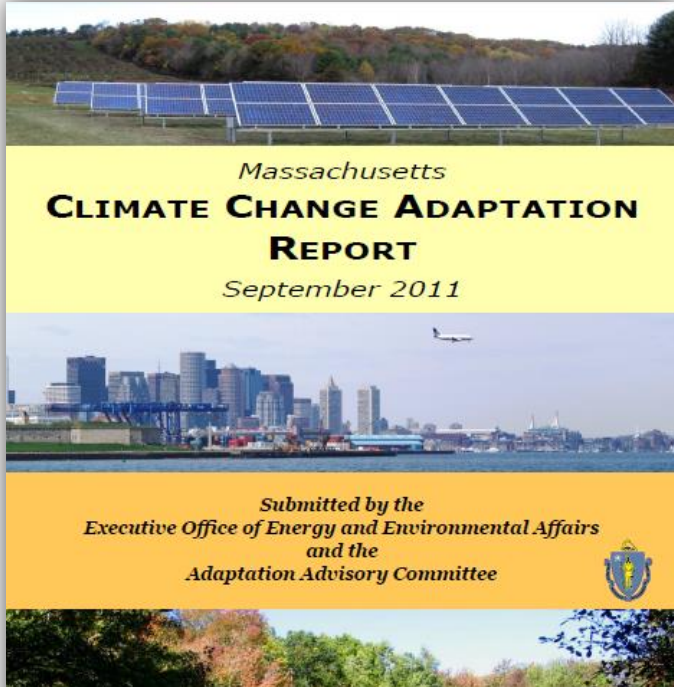


## CDCs Climate and Health Program and Key Legislative and Regulatory Milestones in Massachusetts





# Planning for Climate Adaptation



Parameter	Current Conditions (1961–1990)	Predicted Range of Change by 2050	Predicted Range of Change by 2100
Annual temperature <sup>1</sup> (°C/°F)	8/46	2 to 3 / 4 to 5	3 to 5/5 to 10**
Winter temperature <sup>1</sup> (°C/°F)	-5/23	1 to 3 / 2 to 5	2 to 5 / 4 to 10**
Summer temperature <sup>1</sup> (°C/°F)	20/68	2 to 3 / 4 to 5	2 to 6 / 4 to 10**
Over 90 °F (32.2 °C) temperature <sup>2</sup> (days/yr)	5 to 20	—	30 to 60
Over 100 °F (37.7 °C) temperature <sup>2</sup> (days/yr)	0 to 2	—	3 to 28
Ocean pH <sup>3,4</sup>	7 to 8	—	-0.1 to -0.3 <sup>†</sup>
Annual sea surface temperature (°C/°F)	12/53 <sup>5</sup>	2/3 (in 2050) <sup>5</sup>	4/8
Annual precipitation <sup>1</sup>	103 cm/41 in.	5% to 8%	7% to 14%**
Winter precipitation <sup>1</sup>	21 cm/8 in.	6% to 16%	12% to 30%**
Summer precipitation <sup>1</sup>	28 cm/11 in.	-1% to -3%	-1% to 0%**
Streamflow—timing of spring peak flow <sup>1</sup> (number of calendar days following January 1)	85	-5 to -8	-11 to -13**
Droughts lasting 1–3 months <sup>1</sup> (#/30 yrs)	13	5 to 7	3 to 10**
Snow days (number of days/month) <sup>1</sup>	5	-2	-2 to -4**
Length of growing season <sup>1</sup> (days/year)	184	12 to 27	29 to 43

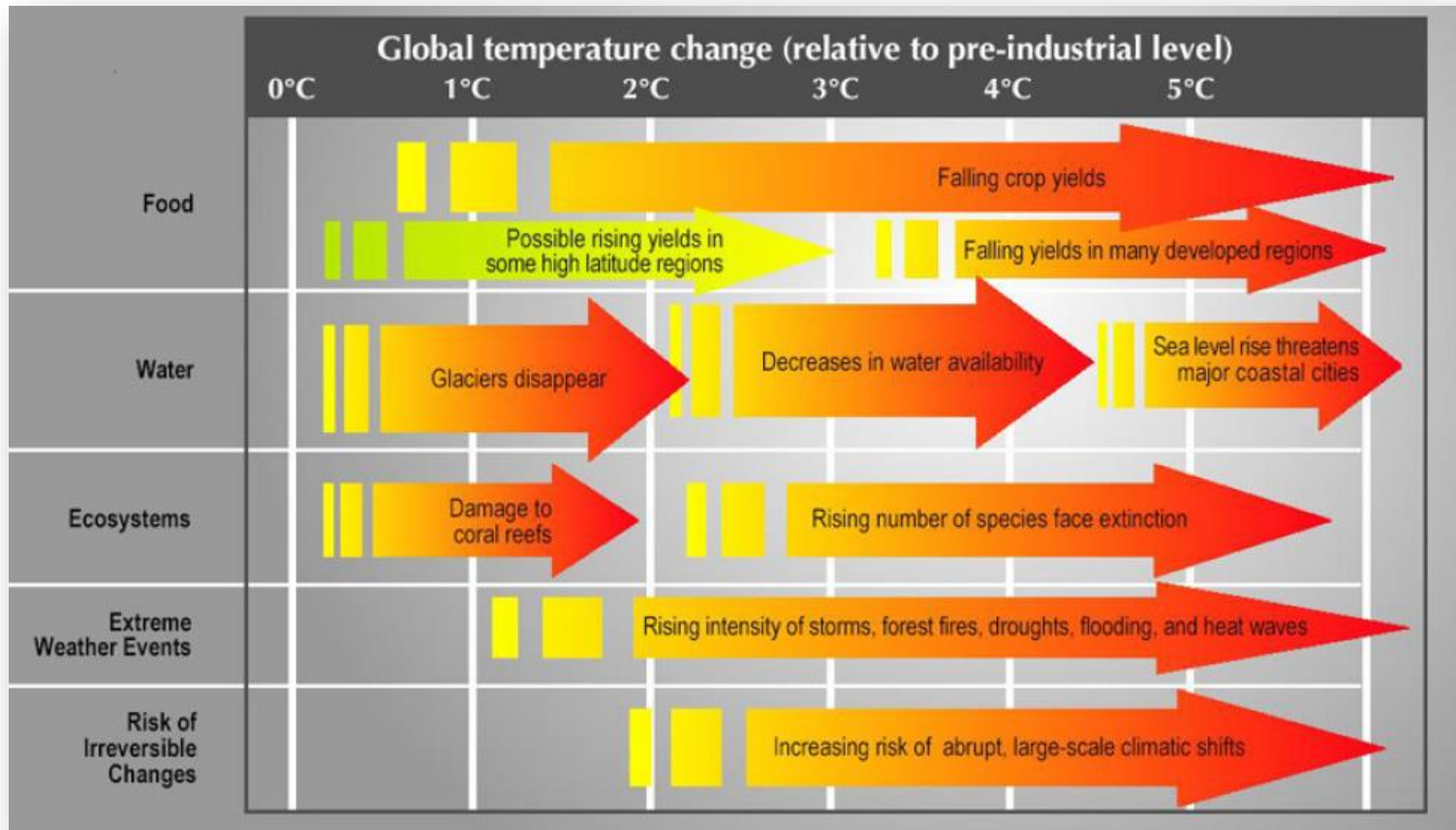
**Table 1: Changes in Massachusetts' Climate**

Sources: 1-Hayhoe et al., 2006; 2-Frumhoff et al., 2007; 3-IPCC, 2007; 4-MWRA, unpublished; 5-Nixon et al., 2004  
 Note: All numbers have been rounded to the nearest whole number. Unless otherwise indicated, the predictions for the year listed as 2050 are for the period between 2035–2064. \* Global data; \*\*Predictions for period between 2070–2099





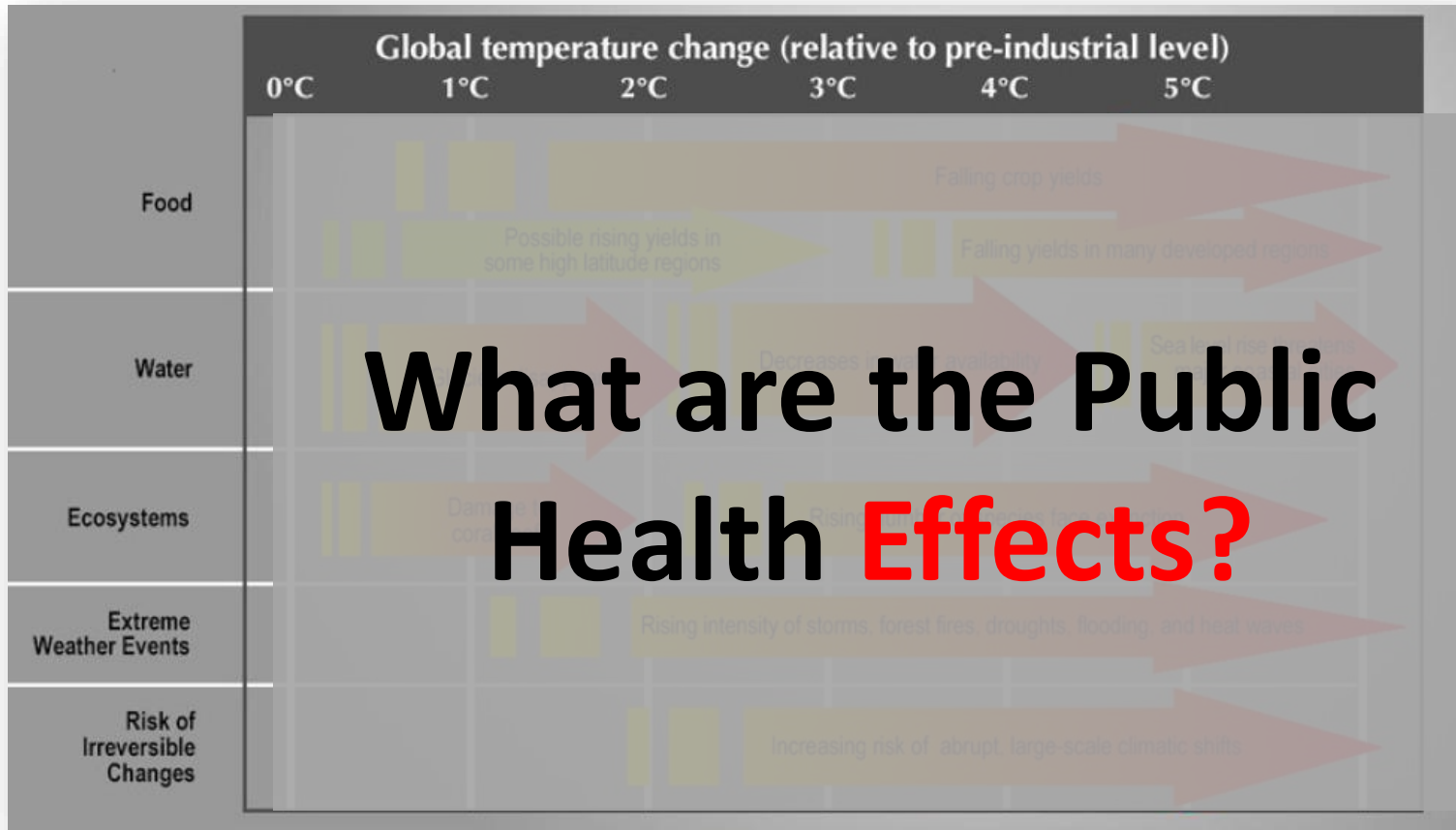
# Climate Change Hazards



(Source: Nicholas Stern (2006), "Stern Review on the Economics of Climate Change")



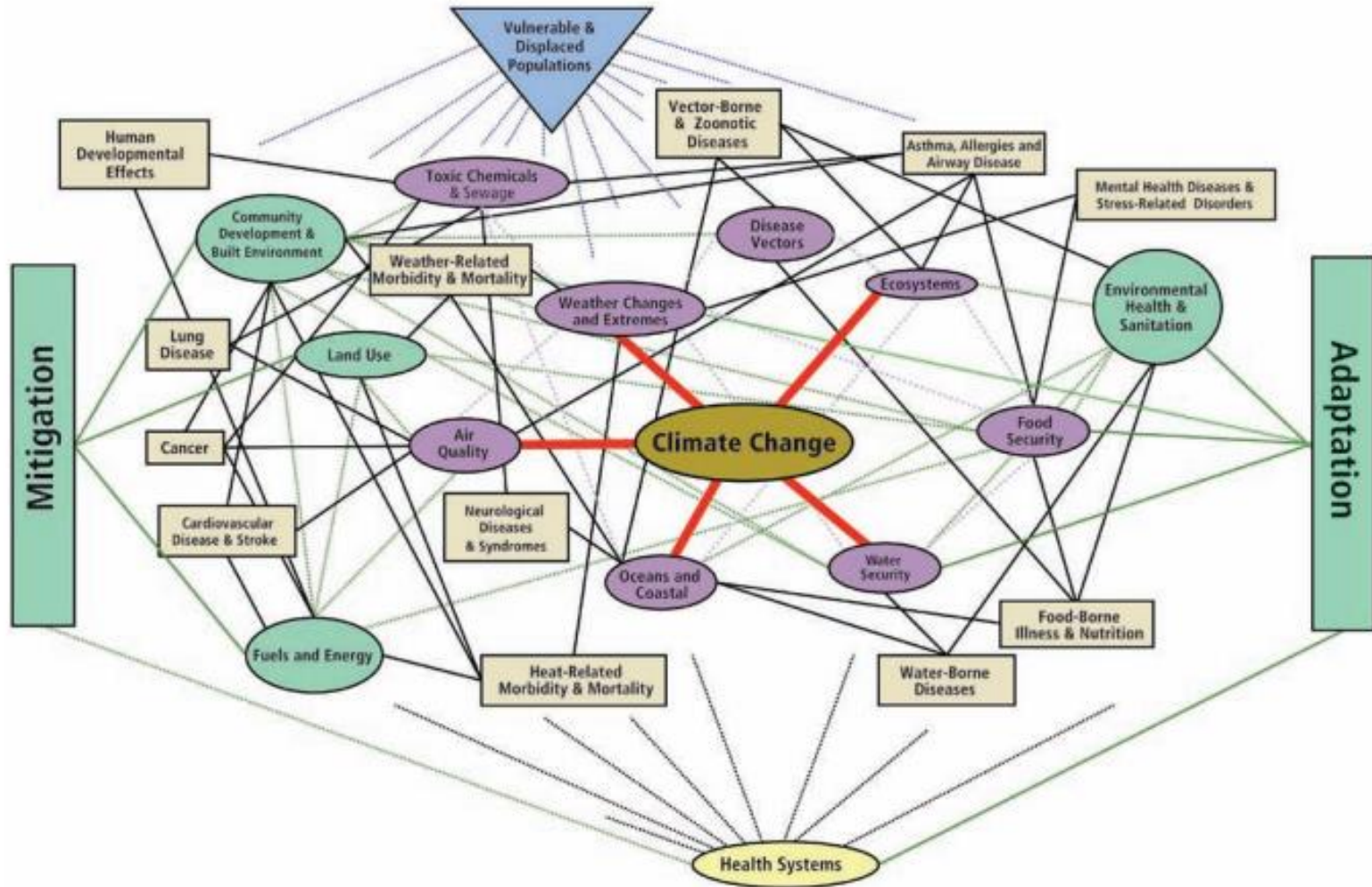
# Climate Change Hazards



(Source: Nicholas Stern (2006), "Stern Review on the Economics of Climate Change")



# Climate-Related Impacts



(Source: NIEHS "A Human Health Perspective on Climate Change", EHP, 2010)



# BRACE Framework



*Int. J. Environ. Res. Public Health* **2014**, *11*, 6433–6458; doi:10.3390/ijerph110606433

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Article

## Building Resilience against Climate Effects—A Novel Framework to Facilitate Climate Readiness in Public Health Agencies

Gino D. Marinucci <sup>1</sup>, George Luber <sup>1</sup>, Christopher K. Uejio <sup>1,2</sup>, Shubhayu Saha <sup>1</sup> and Jeremy J. Hess <sup>1,3,4,\*</sup>

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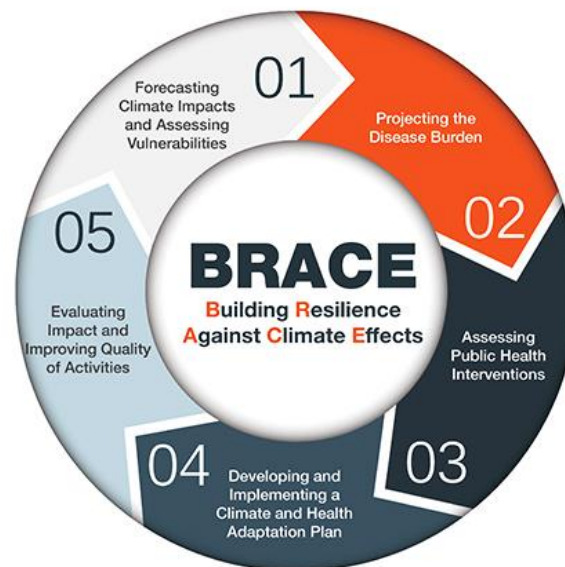
<sup>3</sup> Department of Environmental Health, Rollins School of Public Health at Emory University, Atlanta, GA 30322, USA

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Received: 8 April 2014; in revised form: 3 June 2014 / Accepted: 6 June 2014 /

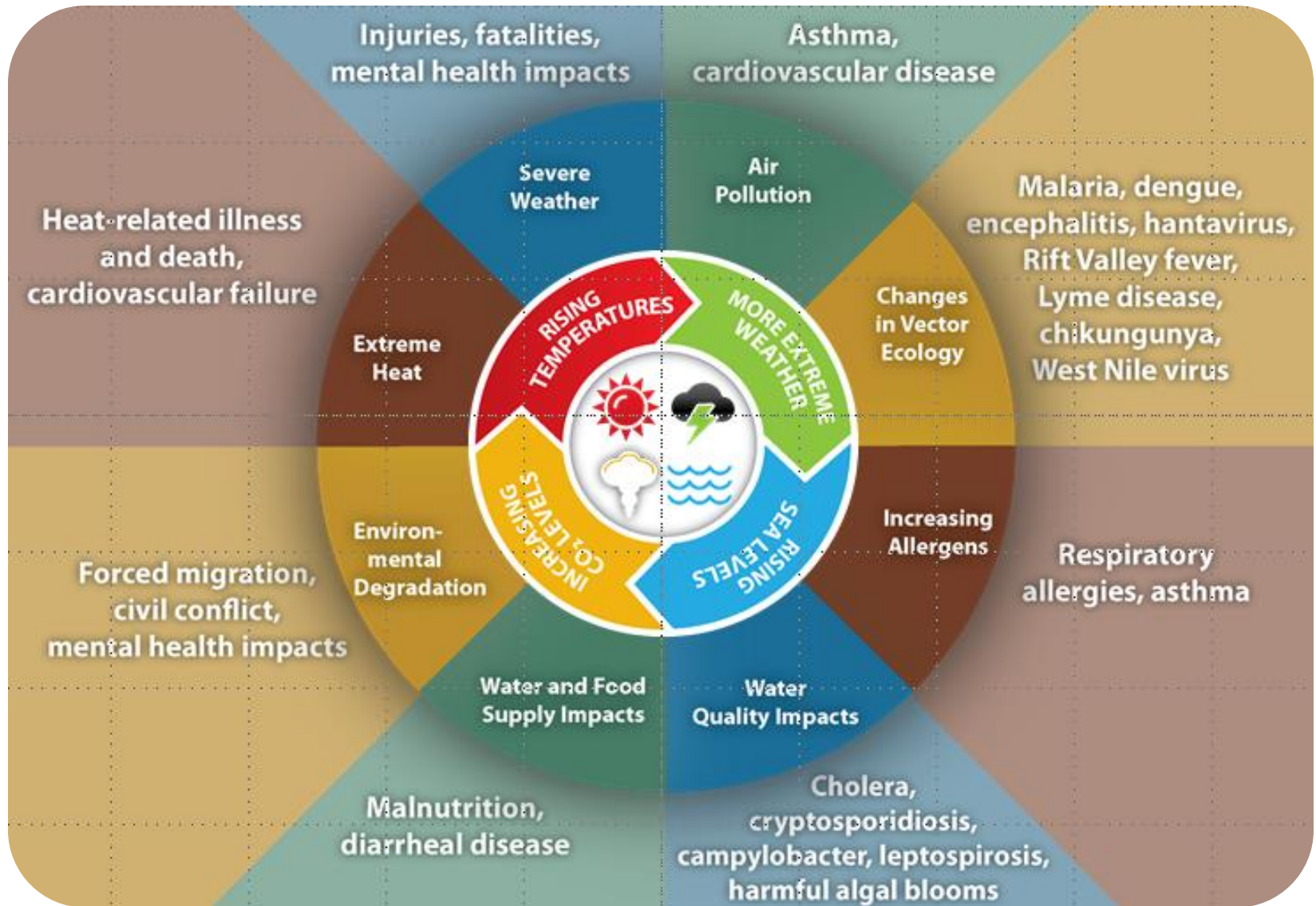
Published: 20 June 2014







# Climate-Related Impacts





# BRACE Framework



**PURPOSE:** Couple climate projections with health data to more effectively **anticipate, prepare, and respond** to climate sensitive health impacts.

- STEP 1: Use Climate Projections to Assess Vulnerabilities**
- STEP 2: Estimate Disease Burden from Climate Change**
- STEP 3: Assess Public Health Interventions**
- STEP 4: Develop & Implement Climate Adaptation Plan**
- STEP 5: Evaluate Impact and Improve Framework**



# BRACE Framework



**PURPOSE:** Couple climate projections with health data to more effectively anticipate, prepare, and respond to climate sensitive health impacts.

**STEP 1:** Use Climate Projections to Assess Vulnerabilities

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**STEP 4:** Develop & Implement Climate Adaptation Plan

**STEP 5:** Evaluate Impact and Improve Framework

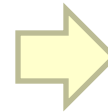
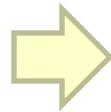


# Climate-Related Impacts





# Risk of Climate Effects



## HAZARD

Magnitude of  
Impact

## EXPOSURE

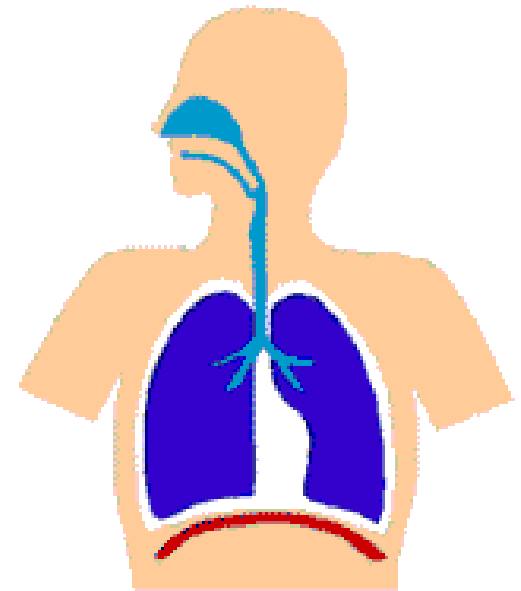
Susceptibility to  
Impact

## RISK

Estimate of  
Damage



# Climate-Related Health Impacts

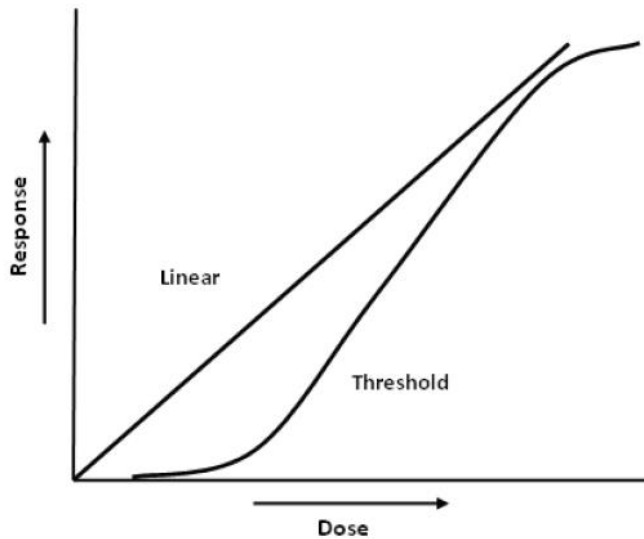




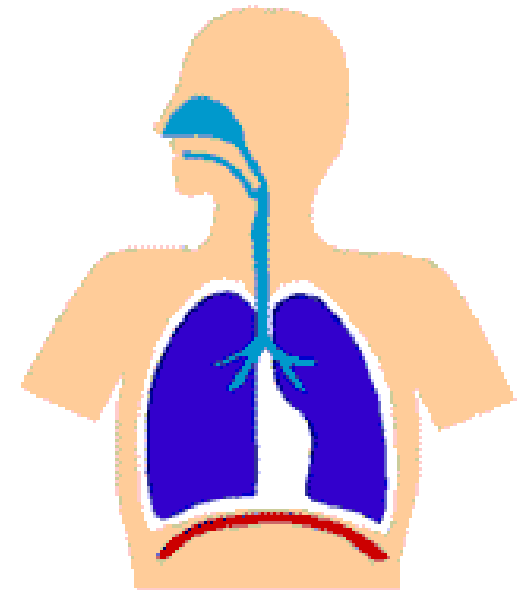
# Climate-Related Health Impacts



*X amount of exposure = Y effect*



**Dose-Response  
Assessment**



**HAZARD**



# Public Health Risk Assessment



Public health **risks** are a function of the type of **hazard** and our **exposure** to them

STEP 1 - Determine level that presents a health **hazard**

(e.g., less than 2 grams)

STEP 2 - Determine level that people are **exposed**

(e.g., consumed .5 grams)

STEP 3- Estimate **risk** based on margin between 2

(**EXP** ÷ **HAZ** = **RISK**)

$$.5 \div 2 = 0.25$$

*Using this “margin of exposure” approach, no **risk** when value less than 1.0*





# Climate Risk Assessment



**Risks** are directly related to the specific climate **hazard** and our **exposure** to them.

- Known dose-response of climate-related **hazards**
- Estimate **exposure**
- Estimate **risk** based on:

**RISK = function of HAZARD & EXPOSURE**

Using this framework allows us to manage public health **risks** of climate change are similar to how we manage other health risks (e.g., microbes, chemicals, radiation).



# Public Health Risk Management



Manage public health **risks** by preventing the **hazard** or preventing our **exposure** to them.



# Public Health Risk Management



Manage public health **risks** by preventing the **hazard** or preventing our **exposure** to them.



**HAZARD**



# Public Health Risk Management



Manage public health **risks** by preventing the **hazard** or preventing our **exposure** to them.



**HAZARD**



**EXPOSURE  
REDUCTION**



# Public Health Risk Management



Manage public health **risks** by preventing the **hazard** or preventing our **exposure** to them.



**HAZARD**



**HAZARD  
REDUCTION**



**EXPOSURE  
REDUCTION**



# Public Health Risk Management



Manage public health **risks** by preventing the **hazard** or preventing our **exposure** to them.



**HAZARD**



**HAZARD  
REDUCTION**



**EXPOSURE  
REDUCTION**



# Sea Level Rise



## CLIMATE HAZARD

Increasing Sea Level and  
Storm Surge Height



## EXPOSURE

People Living at Low  
Elevation Near Coastlines



## RISK

Evacuation, Property  
Loss, Stress



## VULNERABILITY

Elderly Living Alone  
Young Children  
Low Income  
Low English Proficiency

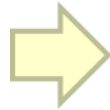


# Sea Level Rise



## CLIMATE HAZARD

Increasing Sea Level and Storm Surge Height



## EXPOSURE

People Living at Low Elevation Near Coastlines



## RISK

Evacuation, Property Loss, Stress



## INTERVENTIONS and ADAPTATIONS:

- Resilient Building
- Zoning Changes
- Evacuation Planning
- Floodwater and Surge Control
- Infrastructure Assessment



## VULNERABILITY

- Elderly Living Alone
- Young Children
- Low Income
- Low English Proficiency





# Heat and Air Quality



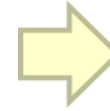
## CLIMATE HAZARD

More days with high heat and high ozone levels



## EXPOSURE

Being outdoors or breathing outdoor air



## RISK

Heat-Related Illness and Mortality



## VULNERABILITY

Outdoor workers  
People > age 65 or < age 5  
Residents of Cities  
Cardiovascular disease,  
kidney disease, asthma  
Loss of Electricity/No AC





# Heat and Air Quality



## CLIMATE HAZARD

More days with high heat and high ozone levels



## EXPOSURE

Being outdoors or breathing outdoor air



## RISK

Heat-Related Illness and Mortality



Reducing Emissions  
Eliminating "Heat Islands"



Community Cooling Centers



**INTERVENTIONS and ADAPTATIONS:**  
Heat and Air Quality Warnings  
Community Cooling Centers (with backup generators)  
Eliminating "Heat Islands"  
Reducing Emissions  
Improving Health and Fitness



## VULNERABILITY

Outdoor workers  
People > age 65 or < age 5  
Heat and Air Quality Warnings  
Improving Health and Fitness  
kidney disease, asthma  
Loss of Electricity/No AC





# Risk of Vector-borne Disease



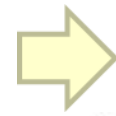
## CLIMATE HAZARD

Increased Habitat for Infected Mosquitoes



## EXPOSURE

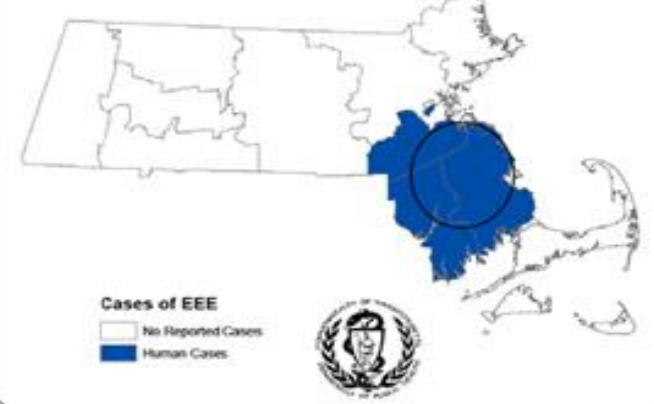
People living, working near mosquito breeding habitats



## RISK

Arbovirus Infections

Eastern Equine Encephalitis Human Cases by County 2004 - 2007

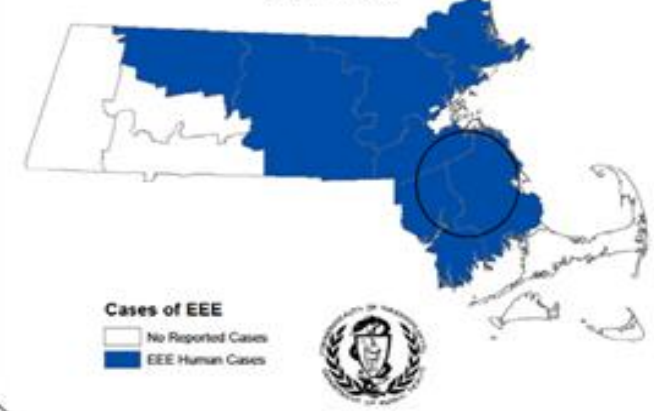


## VULNERABILITY

Outdoor workers  
Outdoor recreation  
People over age 50  
People under age 15



Eastern Equine Encephalitis Human Cases by County 2011 - 2013





# Vectorborne Disease



## CLIMATE HAZARD

Increased Habitat for Infected Mosquitoes



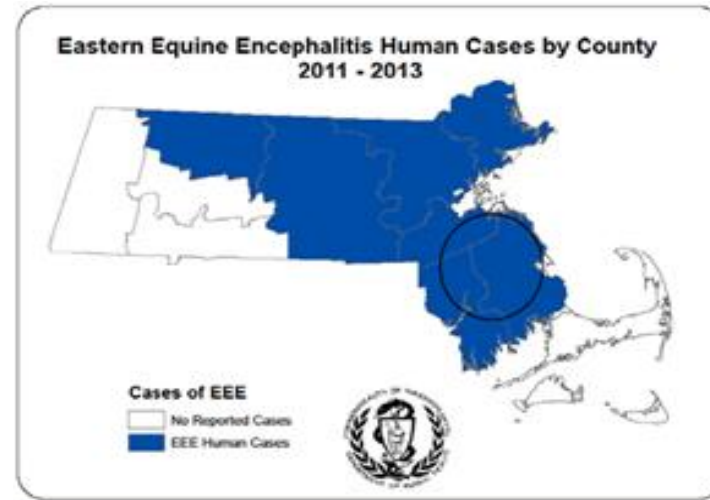
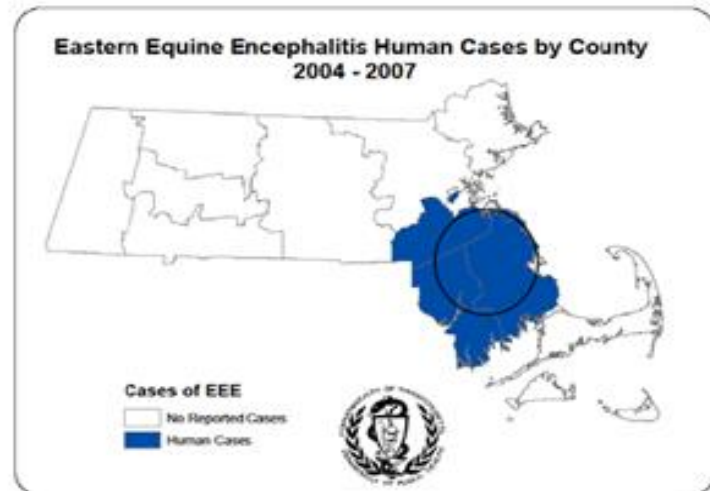
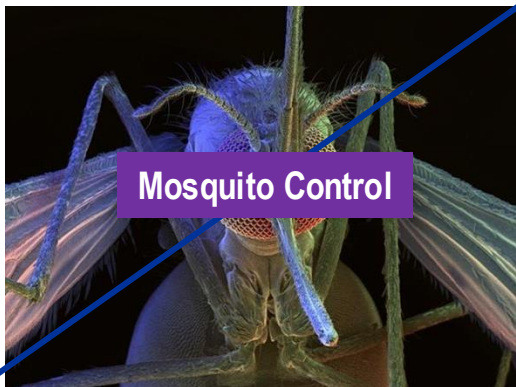
## EXPOSURE

~~People living outdoors~~  
Screened Outdoor Structures  
Mosquito Repellents  
breeding habitats



## RISK

Arbovirus Infections



## INTERVENTIONS and ADAPTATIONS:

Mosquito Control  
Screened Outdoor Structures  
Mosquito Repellents  
Behavioral Changes (e.g. changing outdoor hours)



## VULNERABILITY

~~Outdoor workers~~  
Behavioral Changes  
People over age 50  
People under age 15





# Predicting Climate Effects



## 1. Identify Climate Risks


Determine relationship between climate hazard and exposed population *now*.

## 2. Identify Vulnerable Populations

Based on climate risks, identify populations vulnerable to those risks *now*.

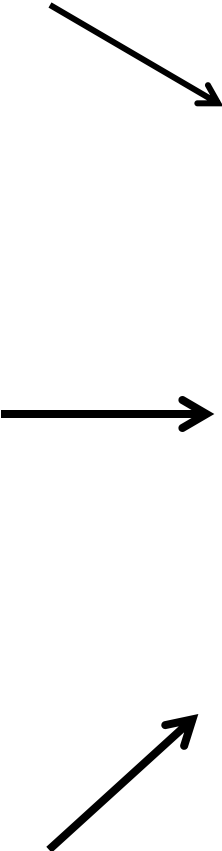
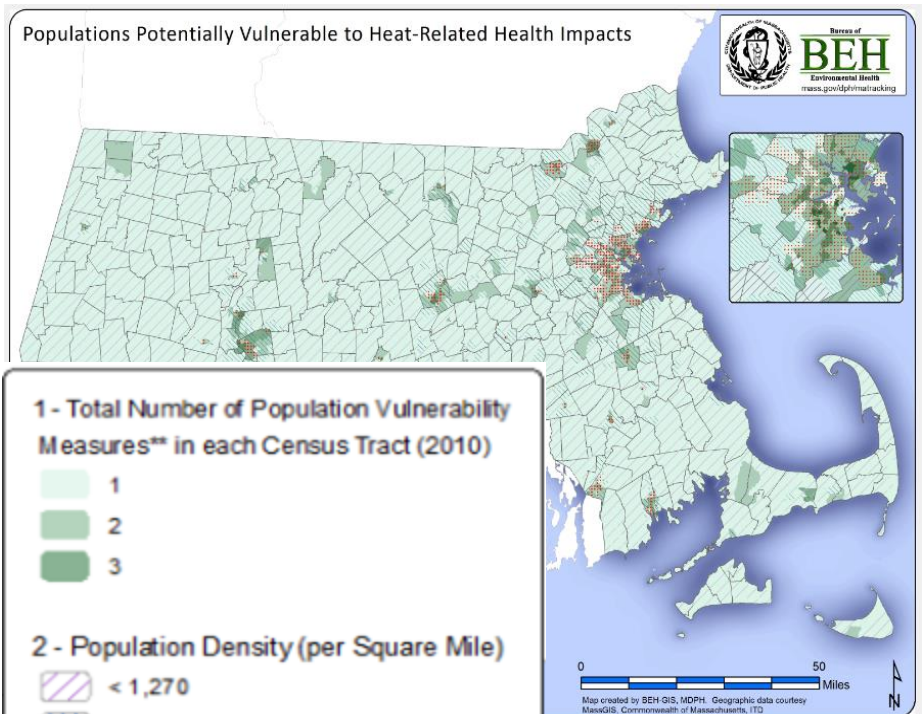
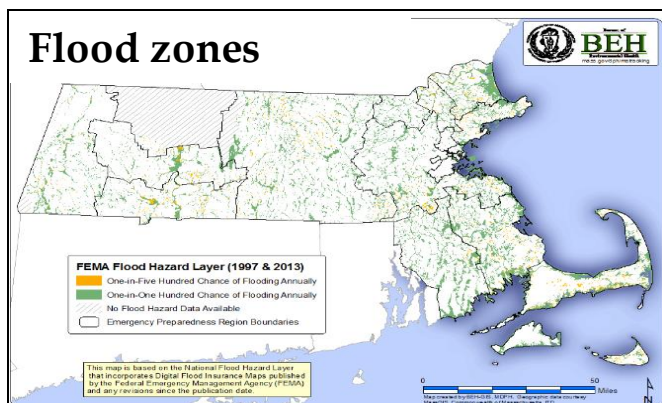
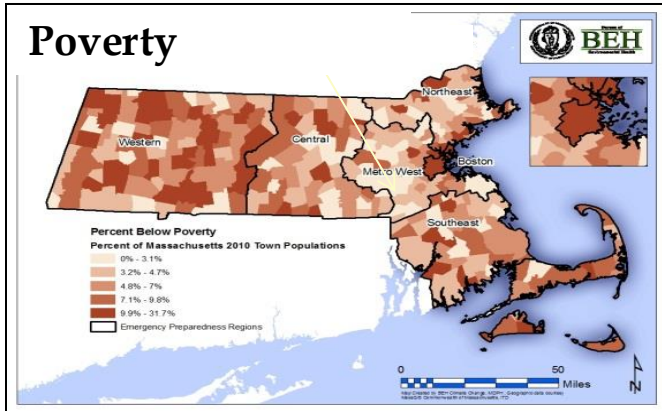
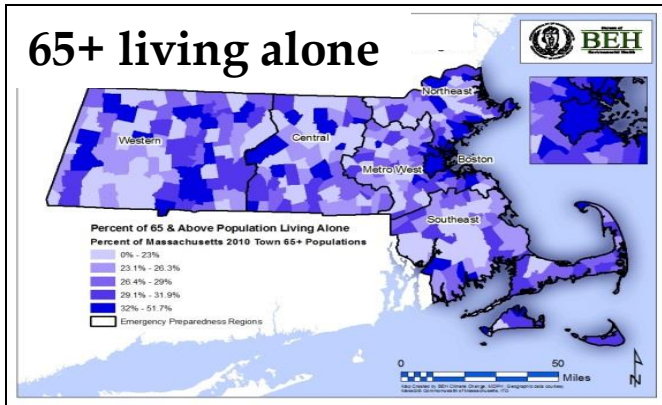
## 3. Future Burden

Use predictive model to estimate future burden using *projections* of item 1 and item 2 in future year.

Examples of Vulnerable Populations	
	- People over the age of 65 and living alone
	- Children under 5 years old
	- Adults with less than high school education
	- Poverty
	- Living in a flood zone
	- People living in areas lacking green space



# Vulnerable Mapping Tool

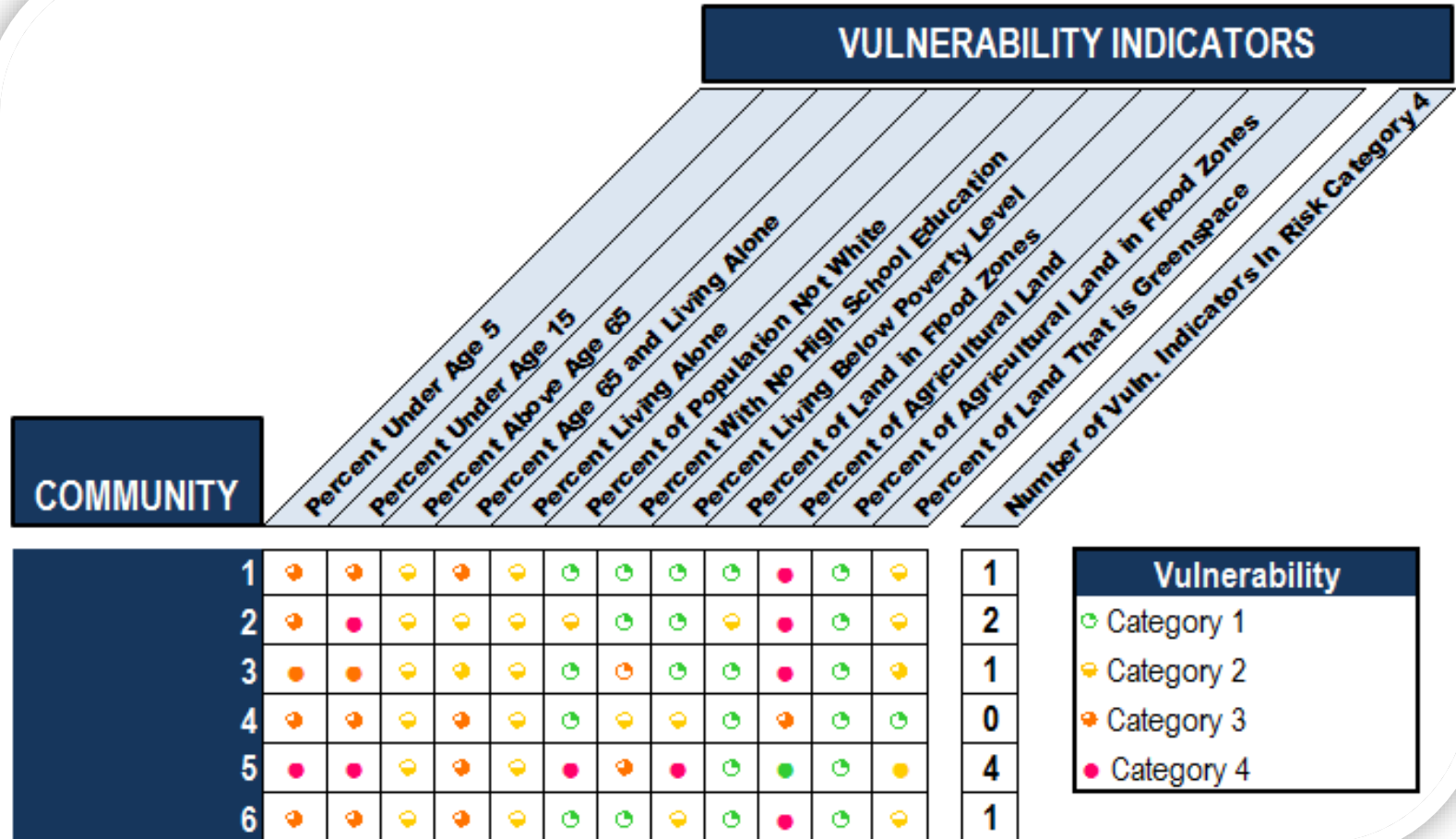




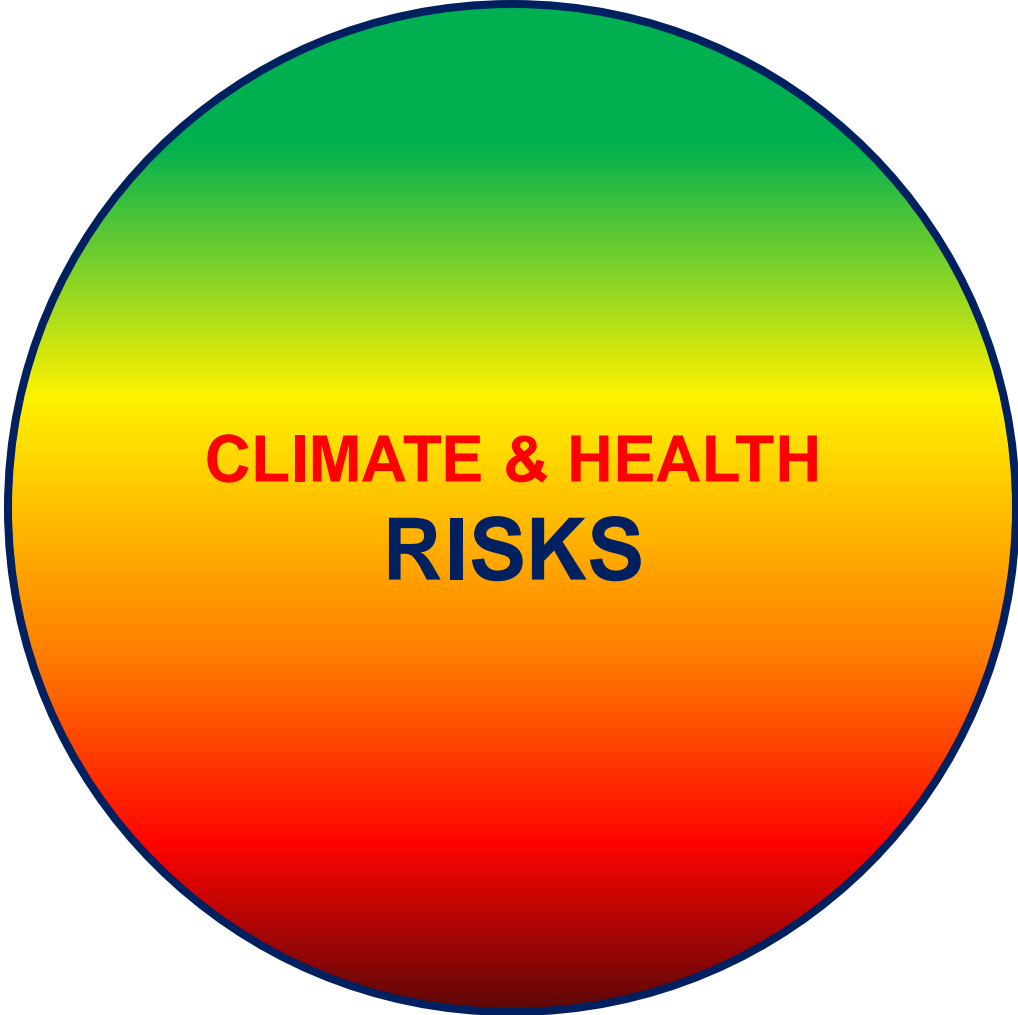
# Vulnerability Metric



## Cumulative Number Of Vulnerable Indicators

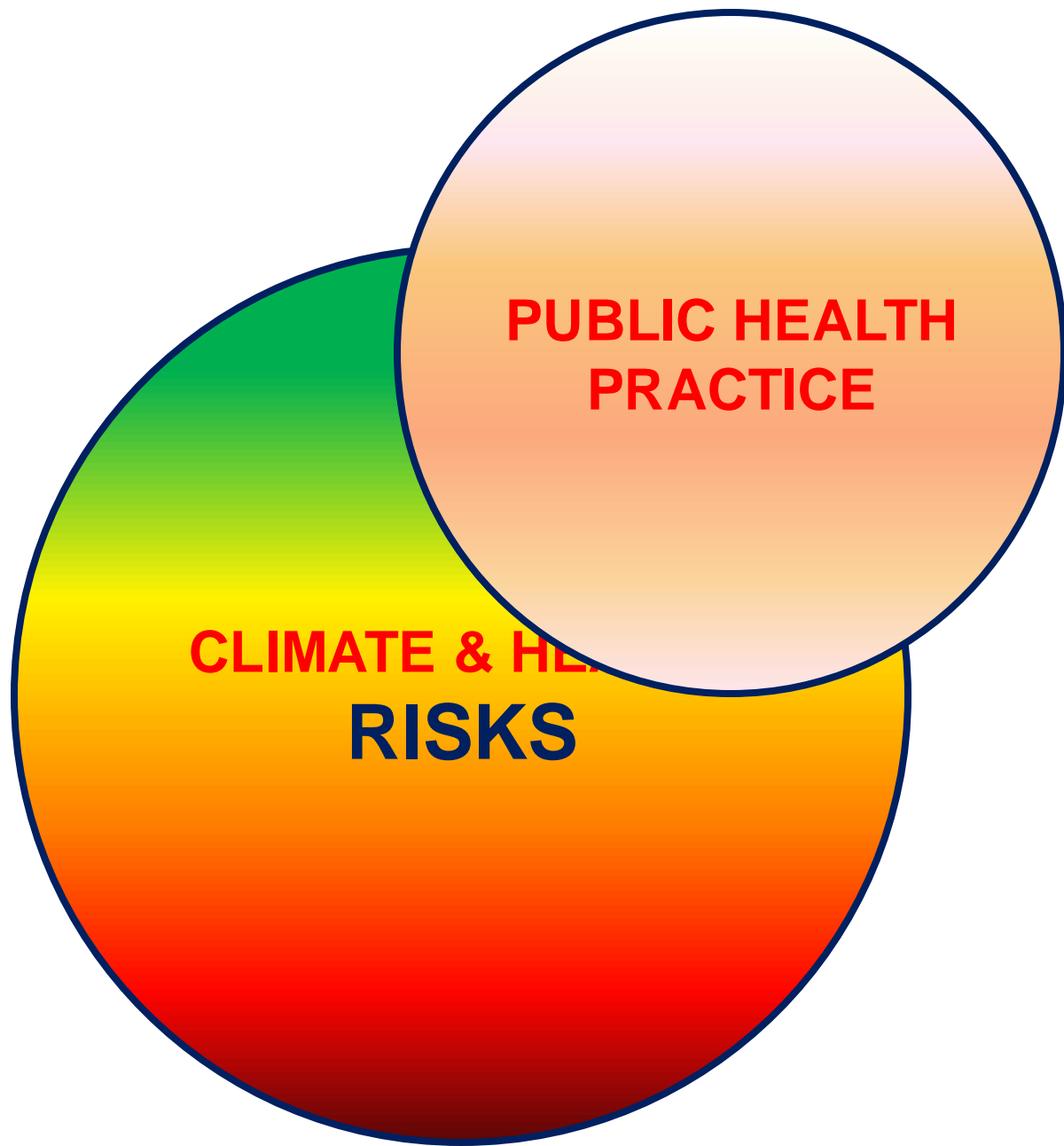


Vulnerability	
Category 1	
Category 2	
Category 3	
Category 4	



**CLIMATE & HEALTH  
RISKS**





**EMERGENCY  
RESPONSE**

**PUBLIC HEALTH  
PRACTICE**

**CLIMATE & HEALTH  
RISKS**

**EMERGENCY  
RESPONSE**

**PUBLIC HEALTH  
PRACTICE**

**DISASTER  
PREPAREDNESS**

**CLIMATE & HEALTH  
RISKS**

## Exploring the Health Impacts of Climate Change Using Dynamic Web-based Technology

Margaret Round, Edward Considine, Stacy-Michelle Reid,  
Elizabeth C. Homan and Marc A. Nascarella

Massachusetts Environmental Educator Society Meeting

March 9, 2016



### A TEACHER'S GUIDE

## Exploring the Health Impacts of Climate Change Using Dynamic Web-based Technology

Massachusetts Environmental Educator Society Meeting

March 9, 2016

Margaret Round  
Chief of Air Toxics, Environmental Toxicology Program  
Massachusetts Department of Public Health

Edward Considine  
Digital Learning Specialist  
Boston Public Schools

Stacy-Michelle Reid  
AP Environmental Science, East Boston High School  
Boston Public Schools

Elizabeth C. Homan  
Administrator of Educational Technology Integration  
Waltham Public Schools

Marc A. Nascarella  
Director, Environmental Toxicology Program  
Massachusetts Department of Public Health

# Using EPHT to Develop Climate Change Curricula

- Engage students through “real” (empirical) data at the community level
- Lessons designed to make comparisons across communities.
- Evidence-based framework for considering health impacts of climate change and informing adaptation planning
- Health outcome data displayed by rates and across time
- Social determinants of health by community and census tract
- Mapping functionality can be integrated into a lesson plan that can be tailored for different age groups



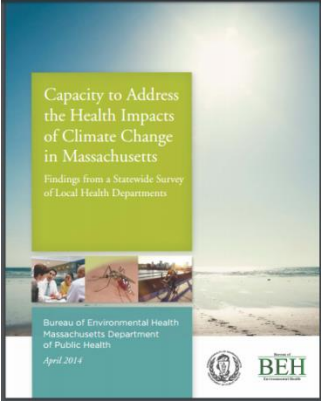
- Instructor provides:
  - Background on climate impacts (hazards) for heat-related events
  - Information on vulnerable populations
  - Near- and long-term strategies to reduce health
  - How to identify community that students lives/works in
- Students (or teams) will query the EPHT portal to identify:
  - Prevalence of pediatric asthma in their community
  - Identify vulnerability indicators/populations
- Class will discuss:
  - Identify short-term and long-term strategy to reduce impacts
  - Community approach to implementation



# Resources for Local Health Response to Climate Change



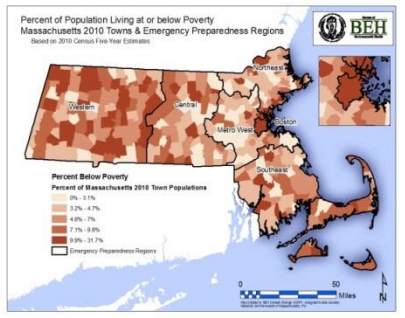
## Collaborating Across Jurisdictions, Programs, and Organizations Focused on Climate Change



## Climate Health Assessment Profiles for Local Health Planning Efforts

**EXTREME WEATHER**  
CLIMATE HAZARD SUMMARY GUIDE 2016

**HEAT AND AIR QUALITY**  
CLIMATE HAZARD SUMMARY 2016



## Trainings for Local Health and Municipal Officials



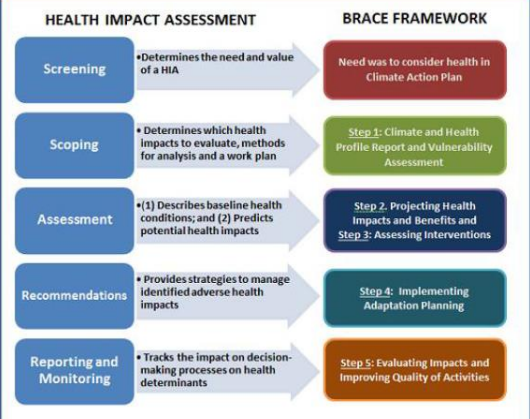
**Building Resilience to Climate Impacts in Massachusetts: A Public Health Symposium**

Friday, April 22, 2016  
Endicott House  
Dedham, Massachusetts

Time	Agenda Item
8:00 AM	Breakfast and Registration
9:00 AM	<p>Welcomes</p> <p>Monica Bharat, MD, MPH Commissioner Massachusetts Department of Public Health</p> <p>Impact of Climate Change on Public Health: A Global Perspective Ezzah A. B. Elzohbi, professor and Associate Department head Department of Civil and Environmental Engineering, Massachusetts Institute of Technology</p>
9:20 AM	Break
10:00 AM	<p>Evaluating Climate and Health Impacts in Massachusetts</p> <p>Maria A. Nascarella, Director, Environmental Toxicology Program Bureau of Environmental Health, Massachusetts Department of Public Health</p> <p>Mosquito Surveillance as a Tool to Assess Current Risk from Long-term Temporal Changes in West Nile Virus and Eastern Equine Encephalitis in Massachusetts Catherine M. Brown, State Public Health Veterinarian Bureau of Infectious Disease and Laboratory Science, Massachusetts Department of Public Health</p> <p>Preparing for Climate Effects at the Municipal Level: Implementing the Building Resilience Against Climate Change Framework Margaret Rowland, Chief of Air Toxics, Environmental Toxicology Program Bureau of Environmental Health, Massachusetts Department of Public Health</p>
11:00 AM	<p>Keynote and Demonstration of the Environmental Public Health Tracking Website</p> <p>Roundtable Discussion: Best Practices to Inform Climate Change Adaptation Planning at the Municipal Level in Massachusetts</p> <p>Chaired by: Michael Cetano, Chief of Water Toxics, Environmental Toxicology Program, Bureau of Environmental Health, Massachusetts Department of Public Health</p> <p>Panel:            Bill Ruggiero, Director, Massachusetts Office of Technical Assistance            Barry Edwards, Director, Public Health Department, Metropolitan Area Planning Council            Leo Sacco, Director, Division of Prevention and Wellness, Bureau of Community Health and Prevention, MAHVE            Deanne Jollyway, Director, City of West Springfield Health Department</p>
11:40 AM	
12:00 PM	
1:00 PM	

## Promote the Use of Health Impact Assessments (HIA) of Climate Action Plans

Figure 1: Integration of CDC BRACE Framework into HIA Process



### Assessing the Health Impacts and Benefits of Regional Climate Action Plan Strategies in Western Massachusetts

A COLLABORATIVE ASSESSMENT BY THE MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH, THE PIONEER VALLEY PLANNING COMMISSION, AND THE MUNICIPALITIES OF SPRINGFIELD AND WILLIAMSBURG

March 1, 2016

## Short-term Recommendations

- Develop a comprehensive heat wave plan
- Develop and improve on heat wave alert telephone tree and media outreach
- Work with community organizations and places of worship to improve heat alert system
- Advertise cooling centers and provide transportation to service locations.
- Conduct an analysis of vulnerable populations and the location of cooling centers

## Long-term Recommendations

- Building infrastructure assessment
- Promote reduction of heat island effects: cool roofs, green roofs, green spaces
- Weatherization in conjunction with ventilation improvements
- Built environment planning and modifications that encourages use of reflective paints and alternate cooling practices (e.g., ceiling fans, urban open space and green areas)
- Greenspace and planting of hypoallergenic trees in communities with high rates of asthma and lung dysfunction





# Thank You



## Questions?

Marc A. Nascarella, PhD  
Director, Environmental Toxicology Program

Bureau of Environmental Health | **Massachusetts Department of Public Health**  
617-624-5757 | [marc.nascarella@state.ma.us](mailto:marc.nascarella@state.ma.us)



Funding for this work was made possible (in part) by the Centers for Disease Control and Prevention. The views expressed in written conference materials or publications and by speakers and moderators do not necessarily reflect the official policies of the Massachusetts Department of Public Health, or the US Department of Health and Human Services. The mention of trade names, commercial practices, or organizations does not imply endorsement by the Commonwealth of Massachusetts or the U.S. Government.