Climate Ready Boston?

Identifying indicators to evaluate the City of Boston’s efforts to implement its climate change adaptation initiatives

Kara Runsten
National Adaptation Forum: April 25, 2019
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- IMPORTANCE OF THIS TOPIC
- QUICK INTRO ON M&E AND CHALLENGES FOR ADAPTATION
- APPROACH
- SUGGESTED INDICATORS AND METRICS FOR BOSTON
- REVIEW OF EXISTING ADAPTATION INDICATOR FRAMEWORKS
- KEY FINDINGS FOR BOSTON AND OTHER CITIES
IMPORTANCE

Why did I choose this topic?
- Relatively uncharted territory
- Timely for Boston

Why is it important?
- Help city government monitor own efforts
- Hold government accountable to public
- Bolster Boston’s adaptation leadership
INTRODUCTION TO M&E

Monitoring and evaluation

- **Indicators** (qualitative or quantitative variables that measure a particular attribute) and **metrics** (specific quantitative proxy measures used to operationalize indicators)
  - **Risk reduction (process) indicator** - indicator that monitors the progress in implementing resilience actions taken in anticipation of the worsening effects of climate-related hazards
  - **Risk management (outcome) indicator** - indicator that measures the effects of implementing resilience actions
- **Monitoring** - periodic measurement of process or outcome results over time
CHALLENGES FOR ADAPTATION INDICATORS

Challenges to climate change adaptation monitoring and evaluation

- Defining success
- Long time-horizons and shifting baselines
- Resource constraints
APPROACH

1. Reviewed vulnerability assessment and talked to City staff
2. Reviewed six indicator frameworks
3. Compiled list of indicators and organized them by Boston hazard
4. Explored existing data sets
5. Suggested indicators
SUGGESTED INDICATORS FOR BOSTON

- 20 indicators (with 7 starter indicators)
- Reasons for their selection
  - Included in multiple frameworks
  - Data exists or could be relatively easily obtained
  - Related to risks identified in the vulnerability assessment
  - Many are connected to current actions the City is prioritizing
SUGGESTED INDICATORS AND METRICS FOR BOSTON

Goal one: Updated climate projections
  ● Described qualitatively

Goal two: Prepared and connected communities
  ● Prevalence of heat-related illness
  ● Adequate health insurance coverage
  ● Reliable emergency response
  ● Access to critical services for vulnerable populations
  ● Community awareness of hazards and need for adaptation

Goal three: Protected shores
  ● Residents and businesses protected from flooding
  ● Amount of vulnerable coastline secured
  ● Qualitative description of use of zoning to address coastal flooding

Goal four: Resilient infrastructure
  ● Resilient electricity system
  ● Reliable public transit
  ● Increased tree canopy coverage
  ● Amount of green space
  ● Adequate stormwater system

Goal five: Adapted buildings
  ● Increased flood insurance coverage
  ● Resilience components incorporated into new development
  ● Economic losses due to flood events
  ● Prepared municipal facilities
  ● Climate risk considerations included in neighborhood planning processes

Context indicators: Current level of heat hazard, current level of stormwater flooding hazard, current level of coastal flooding hazard
## Suggested Indicators and Metrics for Boston

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Related hazard</th>
<th>Type</th>
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<th>Data source</th>
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<th>Data collection</th>
<th>Scales available</th>
<th>Impact sub-metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased tree canopy coverage</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Net number of new trees per year (plantings minus removals)</td>
<td>City Arborist data</td>
<td>Increase</td>
<td>Annually, data up-to-date</td>
<td>Citywide and potentially by neighborhood</td>
<td>Net number of new trees in tree deficient areas; net number of new trees in areas with large percentages of socially vulnerable groups</td>
</tr>
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</table>
## Suggested Indicators and Metrics for Boston

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<tbody>
<tr>
<td>Prevalence of heat-related illness</td>
<td>Extreme heat</td>
<td>Risk management indicator</td>
<td>Heat-related illness emergency department visits during warm weather months by year</td>
<td>MA Center for Health Information and Analysis and Boston Public Health Commission’s Health of Boston Report</td>
<td>Decrease</td>
<td>Collected annually by the Commonwealth, most recent data available from 2015</td>
<td>Citywide and by certain social vulnerability indicators</td>
<td>Emergency department visits by socially vulnerable group; emergency department visits by those in tree deficient areas vs. those with plentiful trees</td>
</tr>
</tbody>
</table>
REVIEW OF EXISTING ADAPTATION INDICATOR FRAMEWORKS

Top-down
- ND-GAIN Urban Adaptation Assessment
- 100RC/Arup City Resilience Index
- OneNYC Resiliency Section

Bottom-up
- EPA METRO

Guiding
- USGBC/STAR Rating System
- USDN Developing Urban Climate Adaptation Indicators
#1 Reviewing existing frameworks is helpful but can only take you so far
Overcoming resistance to indicator adoption is possible
#3 Data is a key limitation, for now
KEY FINDINGS

#4 Finding ways to analyze adaptation actions’ impact (including on socially vulnerable groups) is critical
#5 Progress should be easy to understand
### KEY FINDINGS

**Vision 4: Buildings**

<table>
<thead>
<tr>
<th>4.2.1</th>
<th>Number of flood insurance policies across the city</th>
<th>55,000 (2018)</th>
<th>55,700 (2017)</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.2</td>
<td>Square footage of buildings upgraded against flood risk</td>
<td>21,534,000 (2018)</td>
<td>7,692,000 (2017)</td>
<td>Increase</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Number of elevated homes in the Build It Back program (cumulative)</td>
<td>1,315 (2018)</td>
<td>957 (2017)</td>
<td>Increase</td>
</tr>
</tbody>
</table>

Legend:
- **Green**: Performance Improving or Stable
- **Yellow**: Performance Declining (< or = 10%)
- **Red**: Performance Declining (> or = 10 or Zero Tolerance*)
- **Gray**: New Indicator or No Data Available This Year
#6 Progress should be easily accessible
Imagine Boston 2030 Dashboard

Imagine Boston 2030 Goal:

**IMPROVE THE WALKABILITY OF EACH NEIGHBORHOOD**

Boston Commits to:

*Increase Walk Score® rankings by neighborhood, including reducing the number of households classified as car dependent by half*

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**BASELINE METRICS**

- **81**
  - Boston's Walk Score® ranking

- **99**
  - The North End's ranking - "a walker's paradise"

- **Hyde Park**
  - Boston's most car dependent neighborhood
Qualitative indicators are important too
#8 Connecting evaluation to action will be a vital next step
Quadrant plot of Boston indicators inspired by the EPA METRO tool
THANK YOU!


kara@kimlundgrenassociates.com
Supplemental Slides
SUGGESTED INDICATORS AND METRICS FOR BOSTON

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<tr>
<td>Goal one: Updated climate projections</td>
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<tr>
<td>This goal should be evaluated qualitatively and include a description of the number of years since City hazard projections and maps have been updated. The goal from the CRB report is to update them every five years.</td>
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## SUGGESTED INDICATORS AND METRICS FOR BOSTON

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<th>Goal two: Prepared and connected communities</th>
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<tr>
<td><strong>Indicator</strong></td>
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<td>Adequate health insurance coverage</td>
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## Suggested Indicators and Metrics for Boston

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<tr>
<td>Reliable emergency response</td>
<td>Extreme heat and flooding</td>
<td>Risk management indicator</td>
<td>Average annual Emergency Medical Service (EMS) response time- EMS priority 1 responses triggered by 911 calls related to life-threatening illness or injury</td>
<td>Boston CityScore</td>
<td>&lt; 6 minutes</td>
<td>Daily, data up-to-date</td>
<td>Citywide</td>
<td>Average response time during/after extreme events; average response time in areas with large percentages of socially vulnerable groups; average response time for areas in 100-year flood plain</td>
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<td>Access to critical services for vulnerable populations</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Number of facilities and community organizations serving vulnerable populations with continuity of operations plans</td>
<td>BPHC’s effort to develop continuity of operations plans for these facilities and community organizations</td>
<td>Increase</td>
<td>Data not currently collected systematically because program has not started; ability to work with BPHC to implement appropriate data tracking</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Number of facilities and groups with continuity of operations plans in areas particularly vulnerable to extreme heat or flooding</td>
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<tr>
<td>Community awareness of hazards and need for adaptation</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Number of Climate Ready Boston Leaders trained and number of people reached by these Leaders</td>
<td>Boston Environment Department Data on the Climate Ready Boston Leaders program</td>
<td>Increase</td>
<td>Annually, data up-to-date</td>
<td>Citywide and by neighborhood</td>
<td>Number of people reached in areas with high percentages of socially vulnerable groups; number of people reached in areas particularly vulnerable to heat or flooding</td>
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<tr>
<td>Residents and businesses protected from flooding</td>
<td>Flooding</td>
<td>Risk reduction indicator</td>
<td>Number of residents and businesses expected to be protected due to new coastal defense measures</td>
<td>Boston Environment Department neighborhood level resilience studies</td>
<td>Increase</td>
<td>Data not currently collected systematically, could be collected annually with limited additional effort</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Number of residents and businesses expected to be protected in areas with high percentages of socially vulnerable groups; number of residents and businesses expected to be protected under various sea level rise scenarios</td>
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<tr>
<td>Amount of vulnerable coastline secured</td>
<td>Flooding</td>
<td>Risk reduction indicator</td>
<td>Feet of coastal defenses completed</td>
<td>Massachusetts Department of Conservation and Recreation 2007 study and other City department data on flood protection measures installed since 2007</td>
<td>Increase</td>
<td>Data not currently collected systematically, would require additional data collection efforts and processing</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Feet of coastal defenses in areas with little defense/low elevation; feet installed in areas with high percentages of socially vulnerable groups; feet of coastal protection in critical flood pathways</td>
</tr>
</tbody>
</table>
Goal three: Protected shores

To address this goal, the City is also studying how it could use zoning law to address coastal flooding (initiative 5.1 in the CRB report). While not amenable to quantitative tracking, the City should include qualitative updates related to this point in each CAP update.
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<tr>
<td>Goal four: Resilient infrastructure</td>
<td></td>
<td></td>
<td>1) Average number of months between interruptions 2) System average time in minutes to restore service to customers</td>
<td>Eversource yearly sustainability report</td>
<td>1) Increase 2) Decrease</td>
<td>Annually, most recent data available from 2017</td>
<td>Regional, includes Eversource coverage area in MA, CT, and NH</td>
<td>Average number of months between outages and average time to restore service in areas with high percentages of socially vulnerable groups; average time to restore service after extreme events</td>
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<td>Reliable public transit</td>
<td>Extreme heat and flooding</td>
<td>Risk management indicator</td>
<td>Reliability of buses, subway, and commuter rail</td>
<td>Massachusetts Bay Transportation Authority (MBTA)</td>
<td>MBTA targets: Bus: 75% reliability Subway: 90% reliability Commuter rail: 90% reliability</td>
<td>Daily, data up-to-date</td>
<td>Citywide</td>
<td>Reliability of transit during/after extreme events; reliability for routes that service high percentages of socially vulnerable groups</td>
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<tr>
<td>Amount of green space</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Park land as a percentage of city area</td>
<td>The Trust for Public Land ParkScore®</td>
<td>Increase</td>
<td>Annually, most recent data available from 2017</td>
<td>Citywide and by neighborhood</td>
<td>Percentage of new park land in green space deficient areas; percentage of new park land in areas particularly vulnerable to heat or flooding; percentage of new park land in areas with high percentages of socially vulnerable groups</td>
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<td><strong>Goal four: Resilient infrastructure</strong></td>
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<tr>
<td>Adequate stormwater system</td>
<td>Flooding</td>
<td>Risk management indicator</td>
<td>Volume of sanitary sewer overflows</td>
<td>Boston Water and Sewer Commission (BWSC)</td>
<td>Decrease</td>
<td>SSO events updated as they occur</td>
<td>Citywide and by neighborhood</td>
<td>Volume of SSOs in areas with high percentages of socially vulnerable groups; volume of SSOs in areas particularly vulnerable to heat or flooding; volume of SSOs in areas with large percentages of trees or green space</td>
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<tr>
<td>Increased flood insurance coverage</td>
<td>Flooding</td>
<td>Risk reduction indicator</td>
<td>Number of flood insurance policies across the city</td>
<td>Federal Emergency Management Agency (FEMA) and Boston’s Hazard Mitigation Plan (HMP)</td>
<td>Increase every five years through the HMP, possibility that FEMA may track and share more regularly</td>
<td>Citywide</td>
<td></td>
<td>Difference in flood insurance coverage for those in the 100-year floodplain by income and other social characteristics; percentage of people in most vulnerable areas with flood insurance</td>
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<tbody>
<tr>
<td>Goal five: Adapted buildings</td>
<td></td>
<td></td>
<td>Number of buildings incorporating resilience measures from Article 80 Climate Resiliency Checklist</td>
<td>Boston Planning and Development Agency</td>
<td>Increase</td>
<td>Data not currently collected systematically, could be collected annually with limited additional effort</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Number of buildings incorporating resilience measures in areas with high percentages of socially vulnerable groups; number of buildings incorporating resilience measures in areas that are particularly vulnerable to flooding</td>
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## Suggested Indicators and Metrics for Boston

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<tr>
<td>Economic losses due to flooding events</td>
<td>Flooding</td>
<td>Risk management indicator</td>
<td>FEMA dollars spent on repetitive loss properties</td>
<td>Federal Emergency Management Agency (FEMA) and Boston’s Hazard Mitigation Plan (HMP)</td>
<td>Decrease</td>
<td>Every five years through the HMP, possibility that FEMA may track and share more regularly</td>
<td>Citywide</td>
<td>FEMA dollars spent in areas with high percentages of socially vulnerable groups; FEMA dollars spent in locations with less trees/green space/development with resilience measures</td>
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<tr>
<td>Prepared municipal facilities</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Budgeted investments in resilience projects through the capital planning process</td>
<td>Office of Budget Management</td>
<td>Increase</td>
<td>Data not currently collected systematically, could be collected annually with limited additional effort</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Investments in resilience projects in areas particularly vulnerable to heat or flooding; investments in areas with high percentages of socially vulnerable groups; investments in high development areas that could motivate the private sector</td>
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</tbody>
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# Suggested Indicators and Metrics for Boston

## Goal Five: Adapted Buildings

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<tbody>
<tr>
<td>Climate risk considerations included in neighborhood planning processes</td>
<td>Extreme heat and flooding</td>
<td>Risk reduction indicator</td>
<td>Percentage of neighborhood plans released annually that consider climate resilience</td>
<td>Boston Planning and Development Agency</td>
<td>Increase</td>
<td>Data not currently collected systematically, could be collected annually with limited additional effort</td>
<td>Could be collected citywide and by neighborhood</td>
<td>Percentage of neighborhood plans incorporating resilience in areas with high percentages of socially vulnerable groups; percentage of neighborhood plans incorporating resilience in areas particularly vulnerable to heat or flooding</td>
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<tr>
<td>Current level of heat hazard</td>
<td>Extreme heat</td>
<td>Hazard indicator</td>
<td>Average summer daily maximum temperature--May through September</td>
<td>National Oceanic and Atmospheric Administration (NOAA)’s NOWdata</td>
<td>N/A</td>
<td>Daily, data up-to-date</td>
<td>Citywide</td>
<td>Level of heat hazard in areas with high percentages of socially vulnerable groups</td>
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<tr>
<td>Current level of stormwater flooding hazard</td>
<td>Flooding</td>
<td>Hazard indicator</td>
<td>Annual mean precipitation (inches)</td>
<td>BWSC</td>
<td>N/A</td>
<td>Daily, data up-to-date</td>
<td>Citywide and by neighborhood</td>
<td>Level of stormwater flooding hazard in areas with high percentages of socially vulnerable groups</td>
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<td>Current level of coastal flooding hazard</td>
<td>Flooding</td>
<td>Hazard indicator</td>
<td>Number of days per year in which coastal waters rose above the local threshold for minor flooding</td>
<td>NOAA’s Center for Operational Oceanographic Products and Services (CO-OPS)</td>
<td>N/A</td>
<td>Daily, data up-to-date but would require processing</td>
<td>Citywide</td>
<td>Level of coastal flooding hazard in areas with high percentages of socially vulnerable groups</td>
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</tbody>
</table>
Current efforts to evaluate municipal climate adaptation initiatives

Figure 1: Motives for developing indicators

- Ranking relative performance of cities: Implies variables must be comparable across cities, specific, measurable, quantifiable, normalised, and associated with a relative weighting.
- Influencing or driving change in performance: Implies variables must be relevant and tailored to a city, must be specific and measurable and must enable objective assessment over time.
- Understanding and diagnosing performance: Implies variables can incorporate quantitative and qualitative aspects, but need to be standardised for application across different cities.
THE BOSTON CONTEXT

Imagine Boston 2030

- Climate Action Plan
- Climate Ready Boston

Programs & Policies:
- Climate Ready South Boston
- Climate Ready Boston Leaders
- Climate Ready Charles Town
- Climate Ready East Boston
- Ongoing coordination

Frameworks:
- Boston's Resilience Strategy

Citywide Master Plan:
- Zero Waste Boston
- Go Boston 2030
- Housing a Changing City
- Open Space and Recreation Plan 2015-2021
- 10+ other plans
THE BOSTON CONTEXT
THE BOSTON CONTEXT

2.32 Establish preparedness indicators
Develop a set of indicators to provide quantitative measures of the preparedness of the Boston community, set goals in terms of these indicators, and report on them annually.

OVERVIEW OF BOSTON’S VULNERABILITY ASSESSMENT

Hazard 1: Extreme Heat
- People
  - Heat-related mortality or illness and injury
  - Air pollution and related health problems
  - Vector-borne diseases
- Infrastructure
  - Road buckling
  - Derailments
  - Power failure
  - Health of green infrastructure/natural systems
  - Availability of and access to emergency shelters

Hazard 2: Stormwater Flooding
- People
  - Indoor air quality
  - Mold growth/respiratory problems
  - Inability to get to work and school
  - Social isolation
- Buildings
  - Access to buildings
  - Damage to yards/exterior of buildings
- Infrastructure
  - Access to transportation (often emergency routes)
  - Flooding due to over-capacity of stormwater system
- Economy
  - Business closures, job loss
  - Less spending

Hazard 3: Coastal and Riverine Flooding
- People
  - Displacement
  - School closures
  - Mortality/injury
- Buildings
  - Damage to buildings
  - Property value
- Infrastructure
  - Damage/access to transportation/emergency routes
  - Damage/access to critical/essential/public facilities and transportation/evacuation routes
  - Power failure
  - Telecommunications failure
- Economy
  - Business interruption or closure
  - Less spending