IMPROVING UNDERSTANDINGS OF CONSEQUENCES, VULNERABILITIES, AND ADAPTATION STRATEGIES TO CLIMATE CHANGE RELATED HAZARDS

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The context

- **MA coastal communities are vulnerable to many hazards**
  - Large populations and economically important.
  - Already stretched in dealing with hazards.
  - Climate change will exacerbate hazards.
  - Adaptation will often come from the community level.

- **Calls to develop planning tools and processes**
  - Facilitate local assessments
  - Integrate climate science and local knowledge about consequences, vulnerabilities, adaptation options, and priorities
The context

- **Hazard mitigation planning**
  - MA has been a leader when it comes to hazard mitigation and planning.
  - An opportunity to integrate climate change adaptation into local community planning.
  - HMPs revisions required every 5 years.

The context

- **Barriers to planning for hazards and climate adaptation**
  - Preliminary findings from two WPI student research projects.

  - Coastal communities engaged in hazard management, but not much climate change adaptation.
  - Informational, resource, and planning barriers.
    - Access to information, data, and expertise
    - Lack of coordination and communication
    - Insufficient staff time and resources
    - Limited funding for planning and implementation
    - Perceived importance and urgency
    - Unclear agency guidance and checklist mentality
What we are doing

• Demonstrating the feasibility and usefulness of a facilitated process to support local adaptation planning by engaging local officials
  • Provides an opportunity for group learning and dialogue.
    • About climate science
    • A framework for thinking
  • Can be integrated into routine planning activities.
  • Highlights multi-hazards approach, timing, and flexibility.

• Building on past project
  • Coastal planning and climate change in South Carolina and North Carolina (NOAA SARP funding)

We call it the

“Vulnerability and Consequences Adaptation Planning Scenarios” (VCAPS) Process
Elements of the process

- Help people think…
  - Integration of local knowledge with scientific information
  - Anchored in conceptual frameworks of hazards and vulnerability
  - Diagramming tool to articulate possible scenarios
    - AKA “influence diagrams” or “causal pathway diagrams”
    - Link local climate stressors, consequences, vulnerabilities, and management options

- Efficiently…
  - Reasonable (and flexible) demands on time and resources.

- To produce “useable knowledge.”
  - Results can be integrated into hazard mitigation plans.

The typical VCAPS process

- Review background materials.
  - Can supplement with interviews of key staff.
- 2-4 facilitated meetings.
  - 2-3 hours per meeting.
  - 6-10 people: Town staff, including Department heads, and Commission/Board members.
- Follow-up interviews with participants.
- A lessons learned document.
VCAPS diagramming sessions

- Collectively produce diagrams illustrating impacts of climate stressors on critical infrastructure, community resources, etc.
- AKA “influence diagrams” or “causal pathway diagrams”
- Link local climate stressors, consequences, vulnerabilities, and management options.
- Provide visual depiction of local concerns and knowledge.
- Structure discussions.

Conceptual framework: The causal structure of hazards

Figure 6: Flow Chart of Hazard Management (Source: Kasperson, Kates, and Hohenemser 1985)
**Vulnerability**

![Flow Chart of Hazard Management](Source: Kasperson, Kates, and Hohenemser 1985)

### VCAPS diagramming sessions

- **Session 1**
  - Introduction to project / meetings
  - Presentation about locally relevant climate stressors
  - How to create diagrams / scenarios
  - Choose management concern
    - (e.g., stormwater, wastewater, shoreline infrastructure)
  - Interactive diagramming time
  - In between meetings
    - “clean-up” diagrams
    - Identify gaps.
    - Identify additional information needs.

- **Session 2++**
  - Interactive diagramming time
  - Reflections and wrap-up
How to create a diagram / scenario

- Start simple; make the diagram more complex gradually.
- Begin with a management category and a climate stressor.
- Start with the outcome that follows most immediately from the climate stressor.
- Focus on outcomes and consequences that can be modified by management actions or individual actions.
Start with the management concern and the climate stressor

Add outcomes

- There are many outcomes associated with heavy precipitation
  - What happens to the socio-ecological system?
  - Ask, "Why does the town care about heavy precipitation?"
  - If we simply drew a diagram that went from precipitation to flooding, we’d be ignoring opportunities to manage causes of flooding or erosion (e.g., run-off).
• The more detailed the causal chain, the easier it will be to identify and envision possible management actions.

Continue by adding consequences

• Consequences are implications of the outcomes that affect things that people care about. They exert some sort of loss or cost to things that people value.
  - individuals, communities, institutions, or ecosystems.
• Sometimes the distinction between outcomes and consequences is fuzzy. That's OK!
Localize the diagram with contextual factors

- Start asking:
  - What about this place makes the town more or less vulnerable to these outcomes and consequences?
  - What makes this (climate stressor, outcome, or consequence) better, worse, stronger, larger...?
Complete the diagram by adding management and individual actions

- For each object in the diagram, ask:
  - What IS government doing to prevent or mitigate this? What COULD government do?
  - What ARE private individuals or organizations doing to prevent or mitigate this? What COULD individuals do?
  - What can be done upstream vs. downstream?
  - Actions can have consequences.

- Increase taxes to rebuild reserves

**Stress on the town reserves**

- Increase financial strain for residents

**Run-off**

- Modify impervious surface regulations
- Adapt landscape & install cisterns on public lands
- Provide homeowner incentives

- Install rain barrels
- Increase vegetated ground cover
- Decrease impervious surfaces

**Organic waste enters the waterways**

- Treatment of run-off before discharge

**Concentration of organic waste in stormwater**

- Regulate waste collection and disposal
- Proper waste disposal

**Stormwater**

- Install rain barrels
- Increase vegetated ground cover
- Decrease impervious surfaces

**Run-off**

- Increase financial strain for residents

- Increase taxes to rebuild reserves

**Waste in run-off exceeds regulatory standards**

- Stress on the town reserves

- Decrease in town’s ability to cover future costs

- Decrease in town’s financial condition

**Town is fined for run-off noncompliance**

- Amount of fine in relation to town’s reserves

**Heavy precipitation**

- Frequency, intensity of storms and hurricanes

- Increase precipitation infiltration & plant of vegetation
- Ground saturation
- New developments
Implementing VCAPS in MA coastal communities

- 3 communities
  - Plymouth, MA
  - Boston, MA
  - New Bedford, MA

- All are revising hazard mitigation plans.

- No planning specifically for climate change impacts, but express interest in doing so.

- A departure from prior work:
  - Size of community
  - Specific planning context

Plymouth, MA

- Completed two meetings in Nov + Dec
  - 7 participants
- Focused on a) stormwater management and b) coastal erosion
- Provided town with results (diagrams, report with tables)
- Town currently writing HMP
- Initial feedback was that process influencing actions and priorities in HMP
- Awaiting more detailed feedback
Boston, MA

- Multiple meetings with City and Regional Planning Council
- Focused on stormwater and rising sea levels/tides
- Conducted initial meeting with “champions” (end of January)
  - 7 participants
- Need to schedule subsequent meetings
SLR and high tides

Backflow pushes against check valves

Combined sewer system

Backflow rises GW elevation

Clay soils temporary storage for water raises local GW levels

More tailwater in pipes pumping capacity of MWRA

Electrocution of people

Dam failure Back Bay inundated

Subway floods

Seawater pushed up outfall pipes

Greater head pressure needed

Sewage pushed back up system pipes

Stormwater pushed back up system pipes

Tidal height longer emergency response times

Grant program conflict from FEMA and backwater funds ended backflow funding

Check valves work

Check valves fail

Backflow pushes through cracks

Flowback through storm drains

Ponding in roads and depressions

Sewage in harbor

CSO overflows

Blackouts

Fire

Contact with district heating steam pipes

Explosion

Non-functioning septic/drainage

Public complaints

Lawsuits against commission

Education outreach on mold and air (via bills)

Legal costs for commission

Higher fees

People exposed to sewage

Wet wall board carpets, floors

Chronic public health threat

Acute public health threat

Elevation and drainage inundation water moves along pipes and utility conduits

Electrical conduits or transformers inundated

Condition of conduits

Re-route traffic

Traffic blocked

Flowback into basements

Check value installation

Homeowner maintenance

Sump pump installation

Education via building permit process

Seawater pushed up Charles River

Seawater circumvents Charles River dam

New toxic contamination

Clean up pollutants

Avoid GW movement in plumes

GW moves pollutants

Preexisting pollutants

Public health

Land value

Ecological harm

New capital improvement projects

Sandbag transformers

Number of bathrooms

Inspect check valves

New Bedford, MA

• Initial planning meeting in December
• Follow-up meeting planned later this month
• Focus will be on issues related to Harbor (produce annex for city HMP)
• Planning to do work in spring
Additional activities

- Investigation of factors that facilitate and discourage integration of climate change into HMPs
  - 3 communities: Salisbury, Westport, Marblehead
  - Interviews with regional planners

- Assess past consideration of climate change in HMPs
  - 31 plans reviewed
  - Types of hazards, changes, and consequences considered
  - Types of hazard mitigation and adaptation strategies proposed
  - Types of data utilized

Past feedback: Participants’ comments on VCAPS

- “VCAPS provides the structure that allows for a focused discussion.”
- “This is good because you pull global issues into a local context.”
- “Laundry lists are useless.”
- “Helps show how the problems we have now might get worse.”
- “Surprising how much agreement we found.”
- “For 4 hours, this is a respectable amount of work, another 4 hours and we’d have a finished action plan.”
- “I am enthralled with the idea of doing another session.”
Our insights about VCAPS

- A conceptual framework structured thinking and discussions.
  - causal model of hazards
  - vulnerability
- Real-time diagramming supported understanding and sharing of information.
- Challenging to find a balance between forcing a focus (efficiency) vs. jumping around (letting people share)
- Self-generated scenarios were more credible.
- Local planners were interested in working with consultants.
- Local planners hungry for climate science relevant to local scale.
- Need better integration into "routine" decision processes.

Benefits of the process

- Gathers and summarizes information, knowledge, and experience that exists within a community.
- Stimulates thinking and conversation about how to manage consequences.
  - Highlights multi-hazards approach, timing, and flexibility.
- Identifies issues or data needs that people may want to explore further.
This person said it all:

“Even though we did not focus the discussion on climate change, we ended up addressing all the key issues that are relevant to planning for it”

Project webpage

www.seri-us.org/MA-Coastal-Hazard-Mitigation-Planning