Developing Climate Change Indicators: Lessons Learned from Two Estuary Programs

Susan Asam, ICF International

Restore America's Estuaries

November 16, 2010

Overview

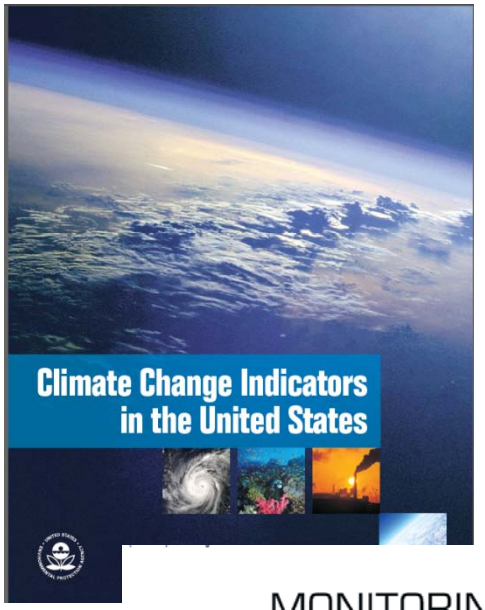
- Monitoring climate change impacts using indicators
- A general framework for selecting indicators
  - Examples from 2 estuaries
- Applying climate change indicators to inform adaptation efforts
- Summary and conclusions

Using indicators to monitor climate change impacts

- Coastal stakeholders and decision-makers are increasingly interested in knowing how they can identify and track climate change impacts locally
- Environmental indicators are commonly used to represent the state of environmental conditions in an estuary over a given area and period of time
- Because environmental indicators are already used to track trends in estuary conditions, stakeholders are considering how to develop indicators that can help track the impacts of climate change
- Despite recognized value, there is a lot of uncertainty about how development of climate change indicators may differ from the development of other indicators

Indicators of climate change

- NRC of the National Academies *Monitoring Climate Change Impacts* report presents 71 metrics at the intersection of human and earth systems. http://www.nationalacademies.org/morenews/20101008a.html
- EPA's *Climate Change Indicators in the United States* report presents 24 indicators, each describing trends related to the causes and effects of climate change. http://www.epa.gov/climatechange/indicators.html



Climate Ready Estuaries

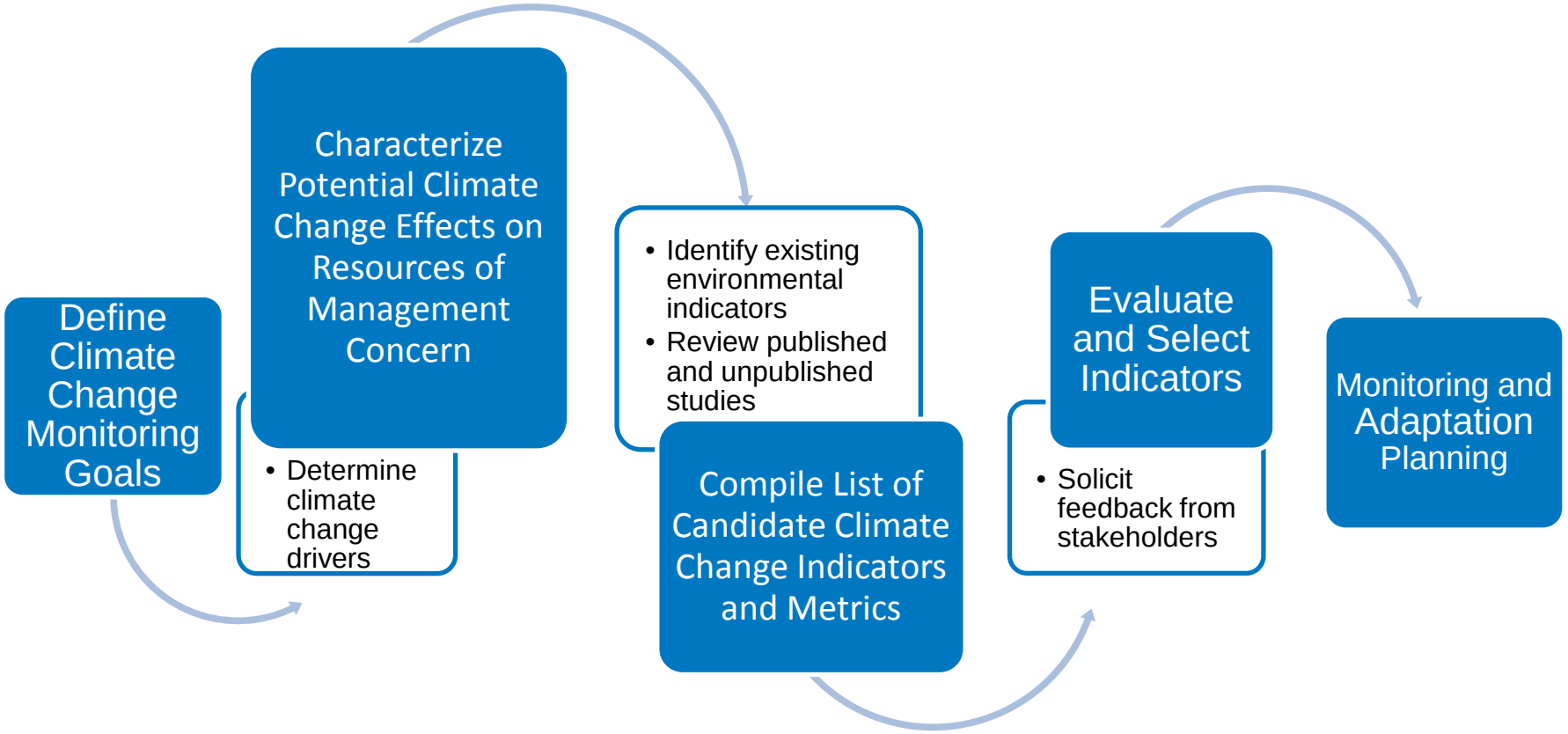
- Long Island Sound Study (LISS) and Charlotte Harbor National Estuary Program (CHNEP) received awards of direct technical assistance from the CRE program to develop climate change indicators
- ICF International has been working with LISS and CHNEP to identify, evaluate, and select appropriate climate change indicators
- Work began in 2009 and is ongoing at both estuaries
- Both estuaries are working to add monitoring of climate change indicators to their existing monitoring efforts

http://www.epa.gov/cre/

Climate Change indicator selection

- Indicator selection is critical to the use of indicators
- Indicators may be quantitative or qualitative measures or a combination of indicators making up an index
- At a minimum, climate change indicators must be:
  - sensitive to climate change impacts
  - effective at tracking changes in those impacts over time
- Estuaries are finding that identifying indicators that meet these and other criteria may not be as straightforward as it sounds
- The following framework presents a systematic approach for identifying and selecting indicators and provides a good structure for presenting the lessons learned to date

General Framework



Define climate change monitoring goals

- Selecting indicators is one part of developing a monitoring strategy
- Define monitoring goals upfront to ensure indicators selected will support them
  - What knowledge does the program ultimately hope to gain from the monitoring?
  - What will the program do with the knowledge gained through monitoring the selected indicators?
  - How will the monitoring results feed back in to management decisions?
- Link climate change monitoring goals to current management goals

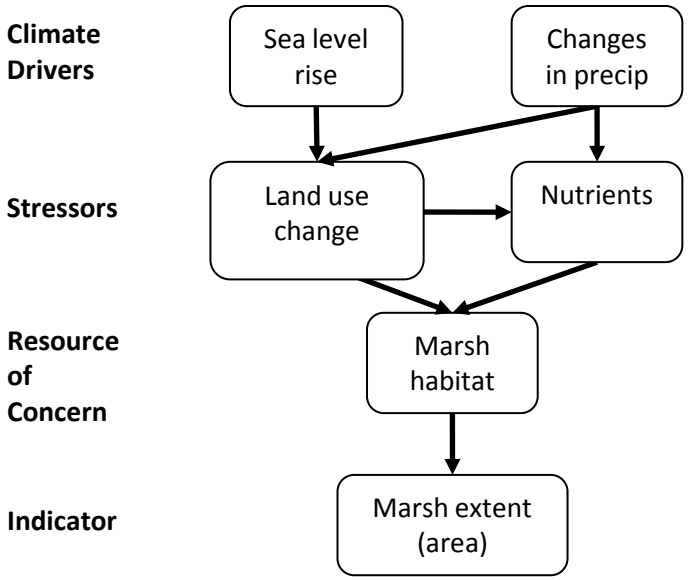
Determine climate change drivers

- Which climate change drivers are of most concern given the management and monitoring goals?
- Climate change drivers may be direct (e.g., changes in temperature, precipitation) or indirect (accelerated sea level rise)

- **LISS climate change drivers**
  - Changes in air temperature
  - Changes in wind
  - Changes in precip and storm climatology (changes in seasonal precip and changes in climatology of heavy precip events)
  - Changes in the ocean (including sea level rise, changes in ocean temperature, and ocean acidification)

Characterize climate change effects

- Does not need to involve detailed downscaling of climate change modeling outputs
- Example approaches include:
  - Review and synthesize information already compiled (e.g., in regional impact analyses, as part of a vulnerability assessment)
  - Develop local conceptual ecological models (CEMs) of climate change that characterize drivers, stressors, ecological effects, key attributes and measures



Characterize climate change effects (cont.)

CHNEP

- Vulnerability assessment conducted in 2009
- Efforts underway now to develop a conceptual ecological model that will:
  - assist in the identification of natural systems climate change vulnerabilities
  - identify potential natural systems indicators of climate change

LISS

- *Synthesis of Climate Change Drivers and Responses in Long Island Sound*
  - qualitatively characterized key predicted changes in climate to LIS and summarized how those changes may interact with non-climate stressors

Identify candidate indicators

- Sources of potential climate change indicators:
  - indicators that are already monitored
  - indicators taken from published or unpublished studies
  - indicators suggested by local experts
  - indicators based on a consensus among estuary stakeholders

Examples from LISS list of candidate indicators

Indicators	Sources
Air temperature	LISS, 2009a, 2009c; PDE, 2008; ESIP, 2009
Alewife, abundance of	LISS, 2008
American lobster, abundance of	LISS, 2009c
Atlantic salmon, abundance of	LISS, 2008
Atmospheric pressure*	LISS, 2009a, 2009c
Bacteria (*Enterococci*, Fecal Coliform)	U.S. EPA, 2007
Beach closure days	LISS, 2008; U.S. EPA 2007; PSP, 2009
Benthic index (Virginia Province Benthic Index)	LISS, 2009b
Benthic macroinvertebrate abundance/diversity	LISS, 2009a
Benthic marine algae, abundance	LISS, 2009a
Biochemical Oxygen Demand	U.S. EPA, 2007
Bioturbation pattern/rates	LISS, 2009a
Blue crabs, abundance of	LISS, 2009c; PDE, 2008
Bluefish, abundance of	LISS, 2008
Bottom water, temperature of	LISS, 2008, 2009c
Brackish marsh, extent of	Rozsa, 2009; PDE, 2008
Chemical contaminants in bivalve mollusks, concentrations of	LISS, 2009b
Chlorophyll-a	LISS, 2009a, 2009c; ESIP, 2009
Coastal Erosion	LISS, 2009a

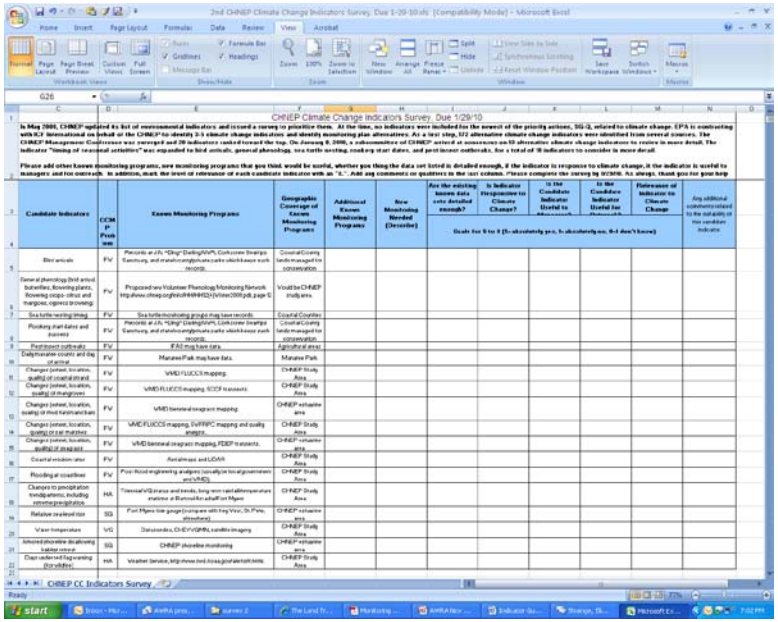
Evaluate and select indicators

LISS criteria

- Relevant to resources of management concern?
- Sensitive to climate change driver(s)?
- Shows climate change effects?
- Measurable?
- Measurable at multiple sites?
- Available data?
- Representative of regional ecosystems, biological communities, and/or processes?
- Feasible?

- Specific criteria should reflect local priorities
- The list presented here has applied in multiple locations
- Criteria can be applied to the candidate indicators to select the best indicators to monitor

CHNEP evaluation and selection of indicators

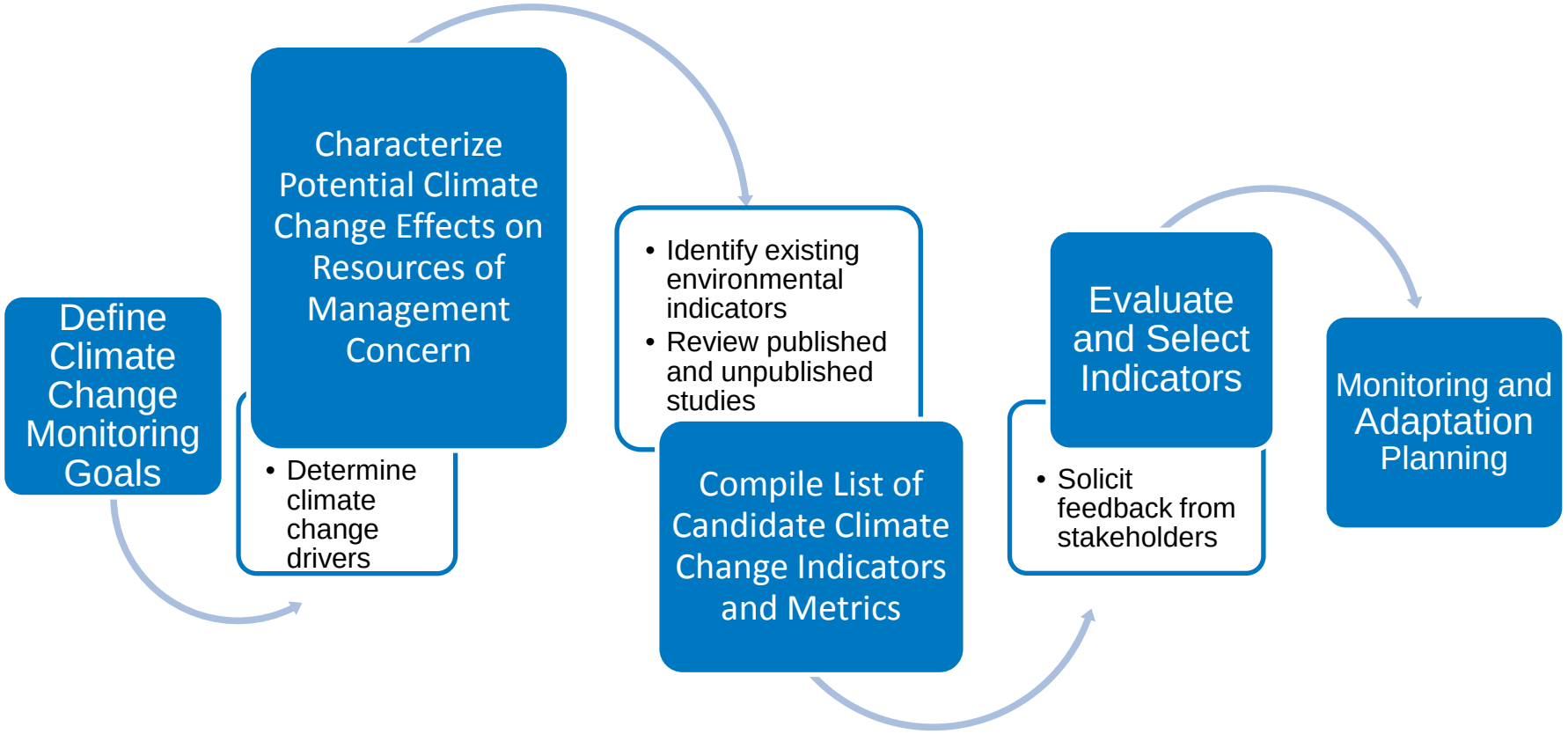


- 1st survey solicited feedback on the relevance of 172 candidate indicators to climate change
- 2nd survey (shown left) asked workgroup to evaluate a narrowed list of 18 indicators against these criteria:
  - Are the existing known data sets detailed enough?
  - Is indicator responsive to climate change?
  - Is the candidate indicator useful to managers?
  - Is the candidate indicator useful for outreach?
  - Relevance of indicator to climate change

CHNEP climate change indicators

- CHNEP Management Committee approved 5 Indicators in Fall 2010:
  - changes to precipitation trend/patterns, including extreme precipitation
  - sea level rise
  - water temperature
  - phenology
  - habitat migration
- Short summaries prepared for 5 selected indicators, describing:
  - the indicator
  - the available data products
  - data gaps
  - targets

General Framework (revisited)



Moving forward

CHNEP:

- incorporated the selected climate change indicators into an addendum to their environmental indicators report
- is now working on developing conceptual ecological models

LISS:

- is now working with technical committees in Connecticut and New York to prioritize the list of indicators, test pilot indicators, and, in the longer term, establish a Long Island Sound wide monitoring network

Using indicators for monitoring and adaptation

- Monitoring selected indicators can help managers assess the vulnerability of key resources to climate change and the performance of adaptation measures.
- As with monitoring for status and trends, indicators can fulfill this function when other more complex data are not available.
- Climate change indicators can also help track the performance of adaptation actions
    - Indicators can help managers identify the need for “mid-course corrections” – i.e., adaptive management

Summary and conclusions

- To reduce the harmful impacts of climate change, we need to identify coastal resources that are vulnerable to climate change, determine how to monitor these resources, and develop adaptation options based on the best available information.
- Climate change indicators facilitate these activities.
- Selection of indicators is a key step! Selection requires a systematic process that starts with consideration of the characteristics of vulnerable resources and management goals.

For more information

Susan Asam

Senior Manager

Climate Change Impacts & Adaptation

ICF International

sasam@icfi.com

202-448-8976

www.icfi.com

Providing climate change strategy services to governments, businesses, and international development institutions world-wide