



Development of Climate Change Indicators and Metrics for the Chesapeake Bay: Workgroup Update: October 16, 2017

Workshop Objectives

The workgroup session on climate change indicators will use a combination of discussion and scoring activities to elicit input from workgroup members on specific candidate indicators as well as the best methods for valuing candidate indicators and combining them into a suite for implementation.

Workshop Agenda and Key Discussion Questions

0. Before the meeting

- a. Review the background material on pp. 2–5 of this handout.
- b. Review the matrix of indicator topics. To prepare for the discussion in agenda topics 2 and 3 (below), note any important strengths, limitations, or additional data sources we may have missed for these topics, as well as any suggestions you have for how best to construct an indicator from the available data.
- c. Start to think about what criteria you would suggest for assessing the value that each proposed indicator would add to the overall suite, to prepare for the discussion in agenda topic 5.

1. Introduction and overview of progress to date (Zoe Johnson [NCBO] and Chris Lamie [ERG])

2. Review of indicator/topic matrix

- a. What is your overall impression of the breadth of topics and sources covered here?
- b. Are you aware of any notable strengths or limitations to specific data sources that we should note?
- c. Are you aware of additional data sources for these topics that we may have missed?

3. Suggestions for constructing indicators

- a. What approaches would you suggest to construct indicators from specific data sources, beyond the suggestions already captured in the matrix?
- b. What principles should be applied when combining multiple data sources into a single indicator?
- c. What are some examples of topics from the matrix that might work well as hybrid indicators? How do you envision that the resulting indicators would look?

4. Review of data quality criteria scoring

- a. What is your impression of the way in which we have assessed data quality and related considerations?
- b. What suggestions would you make, if any, to improve this step of the indicator assessment process?

5. Assessing “value added” and a vision for the final suite

- a. In your opinion, what should be the stated purpose(s) of this suite of indicators?
- b. What characteristics should we use to assess each candidate indicator with regard to “value added”?
- c. What additional considerations do you feel are important when selecting the final suite of indicators—for example, number of indicators and qualities that make for a cohesive “whole.”
- d. What is the relative importance of each of the considerations identified in response to the previous questions? For example, how important is “desired data quality” versus “value added”?
- e. As time allows, we will conduct a “value added” scoring exercise to apply the suggested criteria.

6. Next steps and wrap-up

Overall Project Goals

Eastern Research Group (ERG) is working with the Chesapeake Bay Program to develop a suite of climate-related indicators that can be used to track and analyze trends, impacts, and progress towards advancing “climate resiliency.” The chief aim of this project is to track progress toward the climate resiliency goal in the 2014 Watershed Agreement:

Goal: Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure, and communities, to withstand adverse impacts from changing environmental and climate conditions.

While the 2014 Watershed Agreement has many goals, this project’s scope includes only the *climate resiliency* goal. However, this work will undoubtedly relate to existing indicators for other goals.

Project Framework and Criteria

We will seek a balance of indicators across three categories:

- Indicators of **physical climate trends** based on measurements of physical or chemical attributes of the environment.
- Indicators of **ecological and societal impact** that measure a) attributes of ecological systems, particularly attributes that may be influenced by physical climate trends, or b) impacts on society, such as health or economic outcomes.
- Indicators of **programmatic progress toward resilience** that quantify resilience or show evidence of learning or adaptation over time. Responses include management actions such as designating land for protection, as well as physical actions such as constructing systems to reduce combined sewer overflows into the Bay.

We will also look for connections across categories, such as causal relationships. Candidate indicators will be prioritized based on a set of 20 criteria that consider factors such as relevance, value added, data availability, and data quality. These criteria are designed to focus our efforts on indicators that will be useful and relevant to technical users, such as scientists and policy analysts involved in management and oversight. Where possible, we will prioritize indicators that are also relevant to a public audience.

Workflow

Step	Timeframe
Establish framework (categories, definitions, criteria)	May 2017
Compile lists of potential indicators and data sources	May–June 2017
Evaluate candidate indicators against the criteria	June–Oct 2017
Gather feedback and prioritize candidate indicators	Oct–Nov 2017
Develop implementation plan	Dec 2017–Jan 2018
Develop the top three to six indicators	Mar–April 2018
Compile final results	May–July 2018

existing datasets. The implementation plan may propose indicators that require more substantial data collection and analysis for future consideration.

Key Definitions for This Project

Resilience is the ability to anticipate, prepare for, and adapt to changing conditions and to withstand, respond to, and recover rapidly from disruptions.

Our working definition of resilience is intentionally broad. We will seek further input and define the term operationally over the course of the project.

An **indicator** is a numerical value derived from actual measurements of a state or ambient condition, ecological or societal response, or programmatic action, whose trends over time represent or draw attention to underlying trends in the condition of the environment or measure progress towards a desirable state or condition.

Our goal is to develop a few indicators as resources allow, while providing a detailed plan for how a larger set of indicators can be developed. The indicators in the implementation plan will be selected based on several rounds of review and scoring, including input from numerous stakeholders. While feasibility is one consideration, candidate indicators will not be restricted to

Stepwise Process for Narrowing and Prioritizing Candidate Indicators

Step 1	Assemble initial topic list	Complete
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ERG reviewed several existing sets of indicators, reviewed additional variables measured by some of the key Bay and watershed monitoring programs, brainstormed with our in-house subject matter experts and CBP staff, and elicited input from multiple workgroups. This step resulted in a list of approximately 210 topics.

Step 2	Narrow the topic list based on crude “value” scoring	Complete
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In spring and summer 2017, ERG and CBP ran a series of exercises with workgroups, goal team leads, and other stakeholders, asking each individual to choose their top 10 candidate indicator topics within each of the three categories. The criteria for selection were left vague, which admittedly raised some very valid concerns, but the purpose of this initial screening step was mainly to aggregate “gut-level” reactions from a wide diversity of knowledgeable individuals to arrive at a shorter list that would be more conducive to detailed investigation and scoring in subsequent steps.

ERG aggregated the vote totals, combined a few overlapping or similar topics, and worked with CBP to establish an objective threshold (a minimum vote count) for topics to be included in the subsequent narrowed list. This process also allowed us to grant a “waiver” to keep a few topics alive that were added or clarified late in the voting. The resulting list contained approximately 70 discrete topics: 15 to 20 in each of the three categories. **This list of topics is the basis for the matrix we are sharing with the Climate Resiliency Workgroup (CRWG) now.**

Step 3	Review and document data (subdivide matrix as needed)	Mostly complete, with additional input to be provided by the CRWG
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Next, ERG conducted web and literature research, reached out to data providers and program managers at key agencies and organizations, and conducted interviews to gather information about existing data sources and ongoing data collection and indicator development efforts. We used our detailed matrix to record basic information about each data source and each existing indicator—that is, an existing effort to transform the data into a numerical value that is easy to digest, visualize, and track over time.

The detailed matrix captures basic information about data sources, data collection methods, spatial and temporal attributes of the data, initial thoughts about strengths and weaknesses in the data, and initial thoughts on what additional data collection and analysis might need to take place to transform the data into an indicator. As part of this step, we divided some topics into multiple rows to allow us to accommodate metadata and scoring for multiple data sources. For example, the section on sea level (topic ID#1 from the original list) has additional rows numbered 1.1 and 1.2 to capture information about satellite altimetry and long-term tide gauges, respectively.

This matrix is not intended to provide an exhaustive review of every data source; rather, it records basic information that can help to support subsequent scoring steps. **The “condensed” matrix we are providing to the workgroup offers more of an executive summary-level view, whereas additional fields can be found in the “detailed” worksheet.**

Step 4	Assess conformance to required data quality criteria	Mostly complete
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During the early stages of this project, ERG and CBP established a set of 11 criteria that all indicators must meet. **These criteria are listed and described in the “required criteria” worksheet in the master Excel file.** These criteria can be thought of as the minimum standards for quality that every indicator will ultimately need to meet, so as to ensure that the indicators are credible and usable. They are derived from similar criteria used for several EPA indicator compilation efforts, including EPA’s national suite of climate change indicators. Each criterion is assessed on a yes/no basis.

During Step 4, ERG gave each row of the indicator/data matrix a yes/no score with regard to each of the 11 criteria, with the following exceptions:

- The criteria for objectivity (#7) and transparency and reproducibility (#9) apply to the way an indicator has been assembled, communicated, and documented—not really for scoring the underlying data sources. These criteria will be applied later, as standards against which any final indicators developed during or after this project will be judged.
- The peer-review criterion (#11) is relevant to physical measurements and data transformations, but arguably not applicable to certain administrative metrics, such as counting the number of teachers who participate in training or the number of municipalities that undertake a particular management action.

ERG applied these criteria to the data *as they currently exist*. We calculated a total score, which should equal 9 if all applicable criteria are presently met. Rows with a score of 9 are noted with a “yes” in the condensed matrix.

Step 5	Consider the potential to conform to the required criteria in the future	Mostly complete
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Some data sources or proposed indicators are not mature yet, but *could* meet all the required criteria in the future. For example, a topic without a dedicated ongoing data collection program would not meet criterion #10 (feasibility) at present, but if this topic scores highly and merits development, our implementation plan might strongly recommend that a data collection program be established. In short, we do not want to eliminate a candidate indicator from contention just because it does not have data that meet all the required criteria already.

ERG calculated a new total for each row that incorporated the potential to meet the required criteria in the future. Rows with a score of 9 are noted with a “yes” in the condensed matrix.

Step 6	Eliminate topics and sources that cannot meet the required criteria	Mostly complete
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This step aims to narrow the list further and focus subsequent efforts by eliminating any topics that we feel are unlikely to be able to meet the required indicator criteria, even at some point in the future. In practice, this step eliminates few rows, as we are trying to keep an open mind to the potential for future data collection and development. The few topics or sources eliminated at this stage are those that appear to be impractical to develop into indicators, therefore we feel they do not meet the minimum bar for further consideration.

Step 7	Assess desirable data quality criteria	Mostly complete
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During the early stages of this project, ERG and CBP established an additional set of 10 criteria that indicators should ideally meet. The purpose of these criteria is to help CBP select the highest quality candidate indicators for development—particularly when all other scores are equal and a tiebreaker is needed. In practice, we anticipate that the most useful application of the desirable data quality criteria will be to select the best data source for an indicator on a given topic, if more than one source is available.

Each criterion can be assessed on a high/moderate/low basis. **These criteria are listed in the “desirable criteria” worksheet in the master Excel file, along with descriptions of what earns a high, moderate, or low score.** We set up these descriptions to allow us to assess each criterion as objectively as possible. The matrix will capture total scores. For simplicity, each “high” score is worth two points, “moderate” worth one point, and “low” worth zero points.

Step 8	Select the best data source(s) for each topic	Not started yet
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This step only pertains to those topics with multiple potential data sources. It involves narrowing the list further so only one row (one source) remains for each topic. The most straightforward way to do so is by selecting the row with the highest total desirable criteria score. However, this step also presents an opportunity to consider hybrid indicators that incorporate multiple data sets into a single graph or map. **We will ask the CRWG for input on hybrid approaches.**

Step 9	Assess value added	Not started yet
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We want to help CBP develop indicators that are most useful for the desired purpose(s)—in other words, the indicators that add the most value to the final product. The data quality criteria in Steps 4 and 7 only scratch the surface of “value added,” and the preliminary voting in Step 2 only offered a crude sense of value, without much context. Thus, we feel it is necessary to develop and apply additional criteria that can help to differentiate among candidate indicators on the basis of how much they have to offer. Such criteria might include, but are not limited to:

- Climate relevance (e.g., extent to which the indicator is driven by climate, not non-climatic factors)
- Connection to the CB Agreement Climate Resiliency Goal and Outcomes (i.e., monitoring/assessing trends and impacts; adaptation).
- The extent to which the indicator can be influenced by the Climate Resiliency Workgroup’s management approach or key actions.
- Connection to larger set of CB Agreement goals and outcomes.

During the October 16th workshop, we will ask the CRWG to suggest criteria that can be used to assess “value added.” We will start with a discussion to reach a shared understanding of the desired purpose of these indicators.

Step 10	Combine scores to develop a prioritized list	Not started yet
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Ultimately, we want to select a manageable suite of indicators to include in the implementation plan that constitutes the major deliverable for this project. Part of the selection will involve an objective approach that combines desired data quality criteria scores and value scores—tentatively with value scores weighted significantly more heavily than data quality scores, based on feedback we have received from the CRWG and others to date. However, the exact formula is to be determined, and we want to incorporate the CRWG’s input in designing this process. We also expect that the selection process will also need a more subjective component, applying judgment to make sure we create a strong *suite* of indicators—not just a collection of strong *individual indicators*. In other words, the whole should be worth more than the sum of the parts. **During the October 16th workshop, we will seek the CRWG’s input on several aspects of this approach.**