CLIMATE CHANGE
Vulnerability Assessment

Analysis of Vulnerabilities is a Key Tool for Climate Change Planning

Overview
Water utilities have always faced uncertainty in future planning. Traditional methods were based on the assumption that future hydrological conditions would be similar to the past. However, current scientific information on climate change indicates that future conditions will be significantly different. This highly uncertain future adds a layer of complexity to the already substantial challenges facing water utility managers.

To adapt to climate change, water utilities generally must complete a four-step process (Means et al. 2010). This Overview focuses on step 2.

1. **Understand.** Learn about climate science and climate model projections.
2. **Assess.** Complete a vulnerability assessment that evaluates the water system’s vulnerability to potential climate changes.
3. **Plan.** Incorporate climate change into water utility planning.
4. **Implement.** Carry out adaptation strategies.

Water utility managers generally conduct one or more system vulnerability assessments. These pinpoint where the utility is most vulnerable and lay the groundwork to evaluate adaptation options and costs. While an

Quick Facts
- Current science indicates that future climate and hydrologic conditions will be significantly different from the past
- Many water utilities are incorporating climate change information into their infrastructure, operations and management
- Vulnerability analysis helps resource managers make informed judgments about planning for climate change

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Fact Sheet

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While incorporating climate change uncertainty into long-range planning is new for most utilities, the increasing availability of new data and tools makes analysis more accessible. The assessment does not provide all the information necessary to make a decision, it is an important step in the process.

Key attributes reviewed in vulnerability assessments include: the watershed’s location and predominant characteristics, sources of customer demand, diversity of water supply sources, current flood management operations, assets and conditions, how regional water sources are shared, and water quality impacts.

Vulnerability Assessments: Top-Down and Bottom-Up

Vulnerability assessments generally adopt one of two broad approaches. The top-down approach is based on global climate change models, which generally do not forecast impacts at a scale small enough to be relevant to an individual utility. With the bottom-up approach, utilities identify cause-and-effect pathways where climate change would be expected to impact their assets or operations. It allows for evaluating water resource management activities in a reasonable 20–50 year planning horizon. The two approaches can be used together to improve adaptation decision-making.

The following are the four most common assessment types used by water utilities, as adapted from Climate Change Vulnerability Assessments: A Review of Water Utility Practices (Vogel and Smith 2010).

**Top-down: Scenario Analysis**
The scenario approach generally begins by defining two or three plausible greenhouse gas emission futures that merit consideration by a water utility. Next, general circulation model results are downscaled. Finally, for each scenario the vulnerability of the water system is investigated in terms of specific hydrology, demand, operational and/or management models.

**Top-down: Sensitivity Analysis**
A sensitivity analysis incorporates the use of incremental changes in climate—such as annual temperature increases—combined with annual changes in precipitation. This type of analysis does not require the time- and resource-intensive greenhouse gas emissions projections, climate model projections, or downscaling climate model output of scenario analysis.

**Impact and Adaptation Options**

Source: Miller and Yates, 2006

**Figure 1. Bottom-up and top-down approaches to climate change assessment**
**Top-down: Paleoclimate or Historic Analysis**
This approach incorporates paleoclimate (past climates) studies or historic climate observations. Temperature and precipitation patterns are defined for water system planning purposes. This method often presents a worst-case scenario, such as three consecutive years of the drought of record. It can also look back beyond observed variability to the long-ago paleorecord to examine the water system effect of droughts.

**Bottom-up: Threshold Analysis**
The bottom-up approach to climate change vulnerability assessments is grounded in the knowledge of a utility’s own water system. It begins with a qualitative system assessment to determine which components are vulnerable to change. The results can be used to focus further study on specific impacts of concern.

**Climate Information And Vulnerability Assessment Tools**
Increasingly available data and tools make climate change vulnerability analysis more accessible to water utilities and their long-term planning. Data include climate change projections that offer temperature and precipitation estimates in daily, weekly or monthly time frames. These data are input into hydrology, demand, and operations models that are specific to utilities, helping managers assess the effects of different climate conditions on water supply.

Vulnerability assessment tools and methodologies developed by various organizations, including WRF, can help utilities understand their vulnerabilities and potential impacts, and evaluate long-term planning options.

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<td><strong>Tool</strong></td>
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<td>High-resolution simulations (NARCCAP 2007)</td>
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<td>Climate Resilience Evaluation and Awareness Tool (EPA 2016)</td>
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<td>A Framework for Assessing Climate Change Vulnerability and Defining Robust Risk Management Strategies for Water Utilities (Groves et al. 2014)</td>
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References


