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# What the Northeast Climate Impacts Assessment Means to Public Works

**There is a lot of discussion about climate change in the popular and technical press. Much of what is written with respect to the solutions to Climate Change emphasizes mitigation strategies which attempt to reduce the impacts of climate change by reducing greenhouse gas emissions. The focus of this article is Climate Change adaptation strategies, which are more of a priority for public works planners and managers.**

Adaptation strategies acknowledge that even if society is successful at reducing greenhouse gas emissions in the decades ahead, some climate change will still occur and public infrastructure will be negatively impacted. In fact, we are already experiencing some of the negative impacts of Climate Change. Looking ahead, researchers are telling us that even under the more optimistic emissions scenarios, these negative impacts are going to get worse. Utility managers and engineers who are responsible for the long term financial and technical maintenance of public works infrastructure need to consider these changes in climate as part of their planning and design of new infrastructure.

The Northeast Climate Impacts Assessment (NECIA) was published in two parts, the first in October 2005, and the second in spring 2007. It is a peer-reviewed scientific study by over 40 independent climatologists and the Union of Concerned Scientists. In contrast to Global Climate Models (GCM) which model the planet as whole, the NECIA endeavored to focus on a smaller, regional area, from Maine to Pennsylvania. They scaled down the GCM data to a higher resolution grid, added historical rain gauge data, and modeled two dozen different climatological factors under two different emissions scenarios. With this approach, they were able to do a regionally focused analysis of

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Climate Change impacts specifically for this part of the world. The biggest unknown factor in predicting how much the climate will change in the decades ahead is greenhouse gas emissions. We do not know how successful society will be at reducing carbon emissions into the atmosphere. Therefore, the NECIA modeled two scenarios: an optimistic lower emissions scenario, and a pessimistic higher emissions scenario. The higher emission scenario assumes a continuation of the 2% to 3% annual increase in greenhouse gasses which we have been averaging over the most recent decades. The optimistic scenario has emission amounts leveling by mid-century then declining by the end of the century to levels slightly below where we were in 2000. Their analysis also broke the 21st century into three parts: 2000-2039; 2040-2069; and 2070-2100. This enabled them to model how climate will likely vary in the beginning, middle, and end of this century in each scenario.

NECIA detailed climate impacts on coastal areas, marine life, forests, water, agriculture, winter recreation, and human health. It did not specifically detail impacts on public works infrastructure. The purpose of this article is to extrapolate the impacts to our infrastructure. By examining the many observations and predictions in the NECIA, it becomes relatively straightforward to assess the ways in which infrastructure is going to be impacted, and then explore the tactics and management strategies available to plan and adapt more effectively.

*Freeport, Maine road and culvert damage due to insufficient stormwater conveyance capacity at Desert Road*

Researchers are telling us we have a real world problem to solve with Climate Change.

**The specific changes to climate that NECIA predicts include:**

- Hotter summers, wetter winters, increased evaporation rates, and reduced soil moisture
- Increased number of short-term droughts by end-of-century
- Increased frequency of heavy rain events
- The heavy rain events will be more intense
- Ocean levels will rise more in the next century than in the past century
- The pH of sea water will continue to change, becoming more acidic

Over the past century, New England tide gauges have documented over 6.5" of sea level rise. The Intergovernmental Panel on Climate Change's (IPCC) conservative* predictions for the next century's sea level rise is for somewhere between two and three times more than that amount. Again, the largest unknown variable in predicting such things is that climatologists don't know which emissions scenario is going to be operative in the century ahead. (*The IPCC did not include land-based ice melt from Greenland or Antarctica in their estimates as there was arguably no reliable way to model that yet.)

The projected climate changes will have a significant impact on public infrastructure. Most obviously, stormwater infrastructure will be impacted. The majority of the stormwater infrastructure was designed to accommodate design storms, like the 50 or 100-year storm event. Engineers relied on published rainfall intensity data from the National Weather Service compiled for the various design storm scenarios. This data was derived by performing statistical analysis of historical data. While this data was a good representation of what happened in the past, it is by all accounts not a good indicator of what we should expect moving forward and, therefore, is not a sufficiently conservative approach of sizing new stormwater infrastructure for the future.

With respect to new stormwater systems, a modified approach to sizing them is in order. Some statistical analysis has been started[1] to use the NECIA model output data to re-compute the 100-Year values for one location within the study area. Preliminary results reflected the 24 hour, 100-Year storm for the end of this century (2100) as being 66% higher than the historical 100-Year storm for that location (Boston MA) in the low emissions scenario. The high emissions scenario came out higher by a factor of 2.5. More research needs to be done in this area. Ideally, engineers would like to have new 24 hour precipitation contours for the beginning, middle, and end of this century in order to plan and design various infrastructure which have different planned life spans. In any event, with respect to existing stormwater infrastructures, you will find many existing systems will not have sufficient capacity for future rainfall events. Flooding problems and infrastructure damage will become more common.

Many New England communities are already experiencing this. For example, in Alstead, New Hampshire in October 2005, two persons were killed and another missing when their vehicles drove off a washed out section of Route 123A into the flood waters of the Cold River[2]. Seven months later, the 2006 Mother's Day storm event caused 579 roads and bridges to be closed due to flooding and wash outs in New Hampshire, according to that state's DOT[3]; there were hundreds more in other surrounding states. Eleven months after that, the 2007 Patriots Day storm caused damage in many of the same municipalities who had just finished repairs from the Mother's Day storm. In the spring of 2008, Fort Kent, Maine experienced "a greater than 100 year event" according to the USGS, the same month that Iowa experienced a 500-Year flood event. So, this is not just a New England phenomenon.

*Damaged water main at Desert Road*

This flooding and these washouts happen because the existing stormwater conveyance systems did not have sufficient capacity. These photographs show a damaged water main and road washout in Freeport, Maine after a more recent intense rain event in August 2008. The remains of the 8-foot diameter culvert ended up 100 feet downstream. Here again, this was not an isolated incident in just one location; infrastructure damage was reported in dozens of communities in southern Maine and New Hampshire from that storm last summer. With the hilly terrain and numerous streams in New England, many of our roadways are at risk of washouts due to Climate Change.

Looking ahead, communities should develop a hydraulic capacity analysis of critical stormwater elements to identify undersized elements and to develop a prioritized upgrade plan to prevent future flooding and property damage. While one strategy could be to just wait for components to fail, then replace them with larger systems, this approach can be very costly. It often costs twice as much, or more, to replace failed infrastructure than it does to have planned upgrade programs. There are many more strategies to engage beyond simply making culverts and other stormwater conveyance systems larger. There are a host of creative strategies which can be used to reduce runoff. All of these tactics are going to become more important in the future.

Wastewater collection and treatment systems will also be impacted by Climate Change. With the more intense rainfall patterns, infiltration and inflow problems are apt to worsen, tying up more capacity with clean water. Communities with combined sewers could find their overflow problems worsening and more CSO control measures may become required. Homeowners may experience more seasonal basement flooding, which often translates to more sewer system inflow.

Wastewater treatment plant discharge standards could also be impacted by Climate Change. As summertime low flow conditions get lower, water quality based discharge standards are apt to become more stringent. Coastal treatment facilities and pumping stations could also be adversely impacted by the sea level rise. Plant hydraulics could be negatively impacted and the risk of flooding will increase.

Water supply systems will also be impacted by Climate Change. Longer drought conditions may reduce the safe yield of many water supplies, requiring water utilities to plan for supplemental water sources. Drier summertime conditions are apt to increase water demand as consumers use more water for irrigation. Looking forward, desalination facilities will be considered in locations never envisioned in the past.

Sea level rise will lead to increases in erosion from ocean storms, and many of the roadways and buildings which are at risk now will be more at risk. Municipalities are heavily dependant upon the higher tax revenues from coastal property owners. If coastal properties become less valuable due to an increased exposure to damaging storms, then the tax burden will gradually shift from the more expensive coastal property owners to others. FEMA flood insurance rates and re-build policies will be likely to change. As some properties become uninsurable, it will obviously impact coastal development.

**The bottom line is — Climate Change is causing growing impacts to our infrastructure systems. Moving forward, it will be important to consider the climate conditions of the future when planning new infrastructure. It will be particularly important to consider the expected life of any new infrastructure and the likely climate change over that period. It will also be very important to take stock of the weaknesses of existing infrastructure systems as it relates to Climate Change and factor this into long-term asset management strategies. Maintaining reliable public works services for the future will require proactive strategies to stay ahead of the impacts of climate change.**

Following is a list of a few informative resources that have been produced on the subject of adaptive climate change solutions and the impact on infrastructure.

**Information Resources:**

Northeast Climate Impacts Assessment, full texts available at: www.climatechoices.org

"Stationarity is Dead - Whither Water Management?" Science Volume 319, February 2008

State of Knowledge on Climate Change: http://epa.gov/climatechange/science/stateofknowledge.html

EPA National Water Program Strategy - Response to Climate Change, September 2008 — www.epa.gov/ow/climatechange/

Implications of Climate Change - Design Standards for US Transportation Infrastructure
http://onlinepubs.trb.org/onlinepubs/sr/sr290Meyer.pdf

To view a video of the washout at Desert Road, Freeport, ME, go to: http://www.youtube.com/watch?v=p_uqPR4Ir5o

**References**

[1] Ellen Douglas, PE, PG, PhD, Asst. Prof. Hydrology, UMass Boston
[2] Associated Press, October 10, 2005
[3] Concord Monitor, May 15, 2006