CENTER FOR WATER POLICY

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The Great Lakes basin holds the world's largest supply of surface freshwater and is home to over 35 million people. Climate change is predicted to have major impacts on the natural resources of this system, which will exacerbate existing problems and create new challenges. This series of policy briefs explores several impacts of climate change and emphasizes the need for responsible stewardship of our vital water resources.

Climate Change Impacts on Nearshore Health and Non-Point Source Pollution in the Great Lakes Basin

The Great Lakes coastline is expansive. It includes 158 counties and covers more than 10,000 miles (NOAA 2014, Figure 1). Nearshore areas provide drinking water for surrounding communities, serve as a transportation system for raw materials and goods, provide habitats for fish and wildlife resources, and are used for recreation and tourism. Great Lakes nearshore areas are a vital component of the North American econo-my. Coastal counties account for over 40 percent of the economy in Great Lakes region (GLC 2007) and nearly 500,000 jobs (Vaccaro & Read 2009).

Nearshore areas often suffer from a host of interconnected problems. Deteriorating water quality is a significant problem and beach closures are common in the Great Lakes basin. In 2012, there were 3,437 total closings and advisory days. Of these, 82 per-cent were from unknown contamination sources, 14 percent from stormwater runoff, 3 percent from other contamination sources, and less than 1 percent from wildlife (Dorman & Haren 2013). In 2011, there was a 12 percent increase of pollutants being released into the Great Lakes basin, including nitrates and pesticides from agricultural practices and municipal wastewater treatment plants. In 2012, one in every 10 samples from the Great Lakes region contained contamination levels higher than EPA standards (Dorman & Haren 2013). Non-point sources of nearshore pollutants, such as runoff from agricultural and urban lands, contribute over 80 percent of nutrients to water bodies overall.

Figure 1. Nearshore waters of the Great Lakes. Source: Edsall & Charlton 1997.

The Impacts of Climate Change

The nearshore is particularly vulnerable to the effects of climate change due to the sensitivity and complexity of land-water interactions. In the coming decades, climate change is expected to alter precipitation patterns, reduce ice cover, alter lake levels, and cause more extreme weather events and variability in weather patterns (Kling *et al.* 2003, 2005). There is strong evidence that climate change is already affecting the Great Lakes region, and predictions of future climate scenarios indicate the rate of change will continue to accelerate, with acute effects on non-point source pollution and nearshore health (SWCS 2006).

Increased Erosion and Runoff

Climate change is expected to increase precipitation in the Great Lakes Basin by 2050 (Hall & Stuntz 2007, Figure 2). Predicted and observed changes in storm frequency and magnitude may increase runoff and erosion from agricultural lands by as much as 94 percent (SWCS 2003). In addition, the runoff and erosion risk increases dis-proportionately com-pared to precipitation amount or intensity, which means small changes in precipitation may have large runoff and erosion impacts (SWCS 2003). Less than 1 percent of the 38 million acres of agricultural land in the Great Lakes basin is brought under conservation practices each year, so the basin remains vulnerable to nutrient runoff and soil erosion (USGAO 2013). Despite greater annual precipitation, higher air temperatures due to climate change are expected to create extended droughts and dry soil conditions in the summer months, along with longer growing seasons (Kling *et al.* 2003, 2005). Drier soils and extended production seasons may make land more susceptible to erosion.

Lake Levels, Shipping, and Port Conditions

Increased lake temperatures resulting from climate change are already causing decreases in the annual spatial and temporal extent of ice cover, which may increase evaporation and lower lake levels by as much as 2.5 meters by 2090 (Lofgren et al. 2003). Any decreases in lake levels will directly impact the shipping industry, which transports an average of 163 million tons of cargo per year and sustains over 118,000 jobs in the Great Lakes region (Vaccaro & Read 2009). According to the U.S. Great Lakes Shipping Association, for every 2.5 centimeters lake levels decrease, a cargo ship must reduce its load by 99-127 tons (Hall

& Stuntz 2007). In some ports, capacity reduction may be even more significant. A 1-meter decrease in lake levels of Goderich Harbor in Lake Ontario would decrease the load capacity of a 30,000 ton cargo ship by an estimated 30 percent, or 9,000 tons (Schwartz et al. 2004). Dredging costs to restore shipping channels in the port would exceed $6 million.

Larger and More Frequent Algal Blooms

Increased water temperatures resulting from climate change can magnify the effects of nutrient loading, creating larger and more frequent algal blooms (USEPA 2014). Warmer water temperatures reduce lake mixing, allowing algae to grow more rapidly. Positive feedback occurs when algal mats absorb sunlight, which further increases surrounding water temperatures. In addition, higher carbon dioxide levels in air and water can lead to increased algal photosynthesis and production. Toxic blue-green algae prefer warmer temperatures, so this variety will likely become more dominant under warmer conditions. Climate change is projected to alter coastal upwelling due to increased variability in weather patterns. Changes in the timing and intensity of upwelling may result in greater periodic delivery of nutrients from sediments to surface waters, resulting in larger algal blooms.

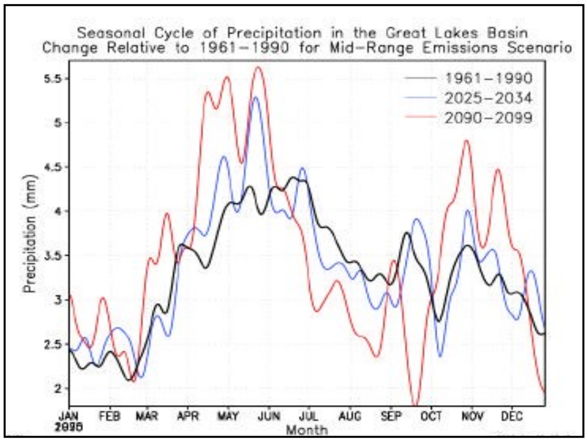

Figure 2. Seasonal cycle of precipitation in the Great Lakes basin. Source: NWF 2007.

Conclusion

Climate change effects, such as higher air temperatures and greater variability of precipitation, can have profound impacts on nearshore health and non-point source pollution in the Great Lakes basin. Changes in precipitation patterns will likely lead to an increase in erosion and runoff, while lower lake levels can decrease shipping loads and port capacities. Increased water temperatures and nutrient loading may promote larger and more frequent algal blooms. The environmental and economic consequences of these impacts make it essential that future policy regarding nearshore health and non-point source pollution effectively integrates climate change effects.

-Authored by Will Kort and Kim Kramer; Edited by Aaron Thiel; Supervised by Dr. Jenny Kehl; Updated 26 June 2014

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