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What Extreme Weather Events do to Lake Superior

Hi. I'm Jesse Schomberg and you're listening to the Sea Grant Files. If you lived near western Lake Superior over the past decade, you've likely become aware of the extreme weather events affecting the lake's coastal communities and the lake itself.

Starting with the 2012 solstice flood that wreaked havoc in Duluth and surrounding areas, we can add the 2016 Saxon Harbor storm that swamped Wisconsin's Northwoods and killed three people including an assistant fire chief who was checking up on campers. In 2018, roads and bridges collapsed and another person died due to a mega-storm over Ashland and Michigan's Upper Peninsula.

Tales of the Gales of November are part of regional lore but the epic storms I just mentioned hit in June and July, and they seemed to catch us by surprise. The damage to infrastructure and lives they caused is visible and costly. The way the storms affected Lake Superior was evident in large muddy sediment plumes visible by satellites and atypical algae blooms. There's more to the Lake Superior story, however, and today, Ellen Cooney, a PhD Candidate in Water Resources Science at the University of Minnesota, is here to talk about it.

Welcome to The Sea Grant Files, Ellen.

Ellen: Thanks for inviting me here …or some such thing.

Jesse: Ellen studies how intense storms can change the biogeochemistry of Lake Superior's water beyond just making a muddy scene. Before we start talking about your research, Ellen, can you explain what a biogeochemist does?

Ellen: Biogeochemists study how chemical elements flow through living systems and their physical environments. …or some such thing.

A Biogeochemist studies cycles of crucial elements, such as carbon and nitrogen, and their interactions with other substances and organisms as they move through Earth's atmosphere, water cycle, food chain, and rock cycle. We focus especially on the chemical cycles that are either driven by or have an impact on biological activity, like carbon, nitrogen, sulfur, and phosphorus.

Jesse: In a recent issue of the Journal of Geophysical Research: Biogeosciences, you were lead author on an article about how the 2012 and 2016 storms locally altered the biogeochemistry of Lake Superior … but altered it in different ways. How were the consequences of the storms different?

Ellen: Talk about the storms and what you found out about them. Similar in precipitation but difference in lake level rise and plumes. Phosphorus 2012, 27 days' worth in 1 event; Carbon

2016, 20 days' worth in one event. Please mention that Minnesota Sea Grant funded 2012 data collection.

While the storms were similar in precipitation the watersheds in which the majority of the events differed. The 2012 event's rain fell mostly on the St. Louis River watershed, while the 2016 event fell mostly on the Wisconsin shoreline. These watersheds are very different in their land use and soil type. the St. Louis watershed having a higher stream order, more wetlands and rich organic matter, where the Wisconsin shoreline have smaller watershed, which indicates that they will deliver different material to the lake system. In 2012 thanks to Minnesota Sea Grant funding we observed that there was a significant input of Total Phosphorus, Total Nitrogen and color dissolved organic matter.We calculated that this one storm delivered 27 days worth of Phosphorus. For the 2016 event we observed that there was a significant input of Carbon Cycling parameters(acidity, total inorganic carbon, and dissolved organic carbon) and ammonia levels were elevated within the plume, and it was determined that 20 days worth of Total Organic carbon was delivered in one event. These differences are consistent with trends predicted by the soil types, stream orders, and land use in the different watersheds affected by the rain events.

Jesse: Can you talk about what all this additional phosphorus and carbon means for Lake Superior's aquatic food web?

Ellen: A previous study of the 2012 plume data indicates that light availability limited phytoplankton growth and that by the time the suspended solids and CDOM were dissipated sufficiently to relieve the light limitation, the plume-delivered increase in nutrients was no longer present in the water column. During both of our extreme rain event studies we did not observe a significant increase in chlorophyll a, which is a proxy for the amount of phytoplankton in the plume compared to non-plume impacted areas.

It is possible that Chlorophyll a could have a delayed response to the flux of TP into the system (especially as we see warmer surface water temperatures). This delayed response could occur as phosphorus adsorbed to sediments and nutrients within dissolved organic matter are later released into the environment by photochemical processes and as light limitation is relieved due to sedimentation of suspended solids. These intricate interactions highlights the need for studying the evolution of plume water quality and the resulting effects on primary and secondary production over the entire timescale of the event.

Jesse: Weather events add up to make a climate. Scientists have shown that the climate in this area and around the world is changing. Given that 195 nations are meeting this week in Poland to further define plans and goals for dealing with our planet's changing climate, it seems appropriate that I ask you, Ellen, what sort of climate might Lake Superior residents be facing in the next decade?

Ellen: Maybe talk about what "500 year floods" mean…and that the two you studied happened within 5 years….warming….water levels...floods and fire… Maybe mention the Fourth National Climate Assessment https://www.globalchange.gov/nca4 that was recently released by the U.S. Global Change Research Program -- see chapters on water and the midwest. comment on the UN climate change conference: https://www.reuters.com/article/us-climate-change-accord/political-divisions-cloud-poland-climate-talks-idUSKCN1NW13E; http://sdg.iisd.org/events/unfccc-cop-24/ …or some such thing.

As climate change becomes a more pressing issue, it is necessary to understand the relationship between lakes and their watersheds to predict the quality of freshwater systems. The frequency and Intensity of Extreme Rain events are increasing. The average U.S. Precipitation has increased by 5% since 1990 while the Midwest has experienced a 10% increase. Extreme events, defined as the heaviest 1% of all daily events have also been experiencing an upward trend, especially in the Southeast, Northeast and Great Lakes areas within the last 30 years. The Midwest has experienced an increase of 37% above average in these extreme events for the past 30 years. Here in the Western Lake Superior Area we have experienced 2, 500 year flood events within the past 6 years. A 500 year flood event means that there is a 0.2% chance of a rainstorm delivering that much rain every year. It is anticipated that these changes in climate could lead to increasing damage to infrastructure, increase soil erosion, and input of organic matter, as well as carry contaminants into the lake systems.

Jesse: Well, that's all we have time for today. I've been talking to Ellen Cooney, who is working on a doctoral degree at the University of Minnesota Duluth. Thanks for joining us, Ellen.

Ellen: Thanks for inviting me …or some such thing.

In addition to helping to fund research like Ellen conducted on storm-induced changes in water chemistry, Minnesota Sea Grant helps coastal communities grapple with extreme weather events. For more information, contact Minnesota Sea Grant by email at seagr@d-dot-umn-dot-edu or by phone at (218) 726-8106 … ask for Tom Beery, Minnesota Sea Grant's resilience specialist.

This episode of the Sea Grant Files was produced by Sharon Moen, Chris Harwood, KUMD and, me, Jesse Schomberg. To listen to other episodes of the Sea Grant Files, visit Minnesota Sea Grant at w-w-w-dot-sea-grant-dot-u-m-n-dot-e-d-u. Thanks for listening!