Researchers examine how drought and water volume affect nutrients in Apalachicola river

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The Apalachicola River in Florida as seen looking downstream from Ocheesee Landing on September 3, 2024. Credit: Scott Holstein/FAMU-FSU College of Engineering

Near the Florida-Georgia border, the Chattahoochee and Flint rivers

meet and become the Apalachicola River, which carries freshwater and nutrients downstream to the Apalachicola Bay.

New research led by FAMU-FSU College of Engineering Assistant Professor Ebrahim Ahmadisharaf examined how drought and water volume in the Lower Apalachicola River watershed affect nitrogen and phosphorous, crucial nutrients for a healthy aquatic ecosystem. The study was published in *Water Research*.

"In watershed systems like this, that are subject to regulations upstream, knowing how the ecosystem reacts to changes helps us manage it effectively," said Ahmadisharaf, who is also a researcher at the Resilient Infrastructure & Disaster Response Center, or RIDER. "We can regulate the system to avoid negative consequences, including some that have the potential to be long-lasting."

The research team examined 20 years of nutrient data collected by the Apalachicola National Estuarine Research Reserve, a nationally protected natural organization funded by the National Oceanographic and Atmospheric Administration and managed by the Florida Department of Environmental Protection.

The researchers also analyzed streamflow data from a U.S. Geological Survey gauge to characterize drought and river flow conditions, which they compared to records of nutrients in the water using statistical analyses. That allowed them to investigate the impact of droughts and river flow patterns on nutrients in different phases of droughts and in short- and long-term periods after droughts ended.

Phosphorous levels

One of the nutrients researchers examined was dissolved inorganic phosphorus. When droughts first begin, phosphorus levels tend to

increase slightly, and the range of these levels usually narrows. As droughts continue and get worse, the variability in phosphorus levels increases and the average level goes down. After droughts, when water flow increased, phosphorus levels in streams bounced back quickly because of the "flushing" effect, in which nutrients washed into the streams from the land. Three back-to-back streamflow droughts within the 20 years posed long-term consequences for the export of phosphorus. For example, phosphorus level increased in high flows by 35% from 2003 to 2021, which threatened the downstream estuary with excessive nutrient levels, increased microorganism growth and lower levels of dissolved oxygen.

Nitrogen levels

Researchers also examined changes in dissolved inorganic nitrogen. The impact of drought on nitrogen levels varied more, with the changes more linked to the severity of the drought, and its timing in wet or dry seasons. Nitrogen levels bounced back after droughts finished, but their dynamics within the stream flow patterns changed. For example, nitrogen levels in low flows became higher than those in high flows. Before and during droughts, researchers saw the opposite pattern.

In an ecosystem, as in medicine, the right dose makes all the difference. Nitrogen and phosphorous are essential nutrients for the growth of plants and animals. But too much of those nutrients causes problems such as harmful algae blooms, which deplete dissolved oxygen and produce toxins.

The rapid increase in phosphorous after droughts could lead to a temporary excess in the downstream ecosystem that would cause algae blooms, fish kills, and lead to problems with human health, Ahmadisharaf said.

Their findings give researchers a more detailed understanding of the Apalachicola River and its watershed. The impacts of drought can be specific to a place, so examining the river in detail is key.

"These findings give us a better understanding of how to manage nutrient levels carefully, especially during and after droughts, to avoid ecological problems," Ahmadisharaf said. "Because climate change affects timing, severity and duration of droughts, this study is important for addressing climate resilience from the coastal water quality perspective."

More information: Sumon Hossain Rabby et al, Dynamic disparities in inorganic nitrogen and phosphorus fluxes into estuarine systems under different flow regimes and streamflow droughts, *Water Research* (2024). DOI: 10.1016/j.watres.2024.122238

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