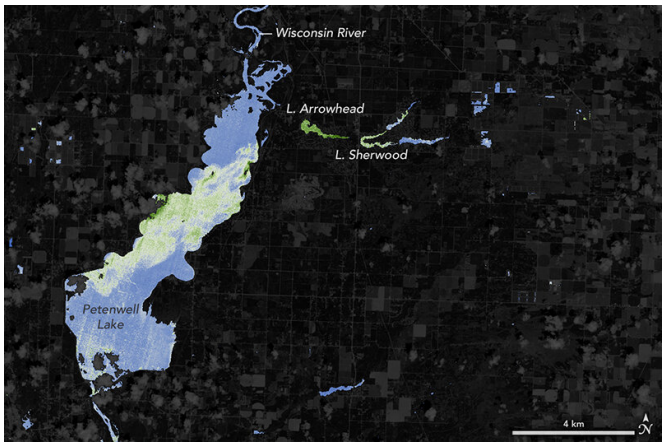
NASA helps warn of harmful algal blooms in lakes, reservoirs

21 June 2019



Data from Landsat 8 can be used to detect high concentrations of chlorophyll-a (shown in pale green in this enhanced image of Wisconsin), which can warn water managers of potential harmful algal blooms. Credit: NASA Earth Observatory/Joshua Stevens

Harmful algal blooms can cause big problems in coastal areas and lakes across the United States. When toxin-containing aquatic organisms multiply and form a bloom, it can sicken people and pets, contaminate drinking water, and force closures at boating and swimming sites.

With limited resources to monitor these often-unpredictable blooms, water managers are turning to new technologies from NASA and its partners to detect and keep track of potential hazards. This is particularly critical in lakes and reservoirs that people use for both recreation and water supply.

A new app for Android mobile devices, from the U.S. Environmental Protection Agency (EPA) and now available on Google play, will alert officials and members of the public when a harmful algal bloom could be forming, depending on specific changes in the color of the water observed by satellites. The app is a product of the multi-agency Cyanobacteria Assessment Network, or CyAN.

"The interest is to use remote sensing as an eye-in-the-sky, early warning system to get a picture of harmful cyanobacteria in U.S. inland lakes," said Jeremy Werdell, the NASA Goddard Space Flight Center lead for CyAN, which also includes the EPA, the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA).

"Resources are limited, and it's not possible for everyone on the ground to be monitoring all inland water bodies all of the time," he said. "Satellites are providing a tool to help inform how and when to expend resources to go and collect water samples."

NASA has been studying water quality from space for decades, beginning in 1978 with the Coastal Zone Color Scanner instrument that used the color of the ocean to study phytoplankton populations. With later instruments, like the Moderate Resolution Imaging Spectroradiometer on NASA's Terra and Aqua satellites, the resolution was fine enough to distinguish larger inland lakes and reservoirs, and scientists began to use the data to detect the signatures of cyanobacteria in fresh water.

Cyanobacteria occur naturally in many bodies of water, from the Great Lakes to small neighborhood ponds. In small numbers, these algae are not a problem. But under the right conditions—warm water, sunlight, plus nutrients that often wash off agricultural fields—cyanobacteria can multiply and form potentially toxic blooms.

Even though the individual algae are microscopic, blooms can be seen from space. In massive numbers, cyanobacteria blooms can appear as large green swaths and patches due to their main photosynthetic pigment. Their presence can also be detected using fluorescence, which algal blooms emit in response to exposure to sunlight. Using the bloom's unique characteristics, instruments on the

NASA/USGS Landsat satellites, the European Space Agency's Copernicus Senteinel-2 and Copernicus Sentinel-3 satellites, as well as several others, are able to pinpoint the presence of algae.

With computer programs developed to crunch those satellite observations from Sentinel-3, NASA supercomputers produce weekly reports on the color—and other water quality information—of more than 2,000 lakes across the United States as part of the CyAN project, said Bridget Seegers, a research scientist at Goddard in Greenbelt, Maryland.

Users of the new CyAN app will be able to mark a particular lake with a pin—which will appear as green if the lake appears bloom free, yellow if algae are present but below a certain threshold of concern, or red, indicating that a bloom is likely present. It's designed not only for water quality managers, Seegers said, but for people putting a canoe on their car and debating where to go, or an outfitter directing people to the best lake for kayaking.

CyAN started in 2015, and has worked with state and local agencies to identify potentially harmful blooms, said Blake Schaeffer, a research ecologist with the EPA and that agency's lead for the program.

Water quality managers with EPA Regions and Office of Water teamed up with CyAN to test and evaluate the app and satellite data, he said, furthermore, citizen scientist groups, tribal groups and the public have shown interest in the data as well.

"We're putting the power of the satellite information directly into the hands of the people," Schaeffer said. "They don't have to mine for data; they can opt to have the data pushed to them."

The program does have limitations, however. The satellites can't see through clouds, and because of the resolution of Sentinel-3A, lakes would need to be a bit more than half a mile (900 meters) wide to track with the highest-quality data.

To peer at even smaller lakes and reservoirs, Schaeffer and others are turning to Landsat. Because of issues with clouds (and a less frequent revisit), Landsat satellites, scientists get about one clear measurement of a given site every month. But with Landsat's higher spatial resolution, they can track water quality information from more than 60% of the U.S. lakes and reservoirs, or more than 170,000 waterbodies.

Landsat and Sentinel-3 are complementary; Landsat has greater spatial resolution whereas Sentinel-3 gathers data over individual sites more frequently and detects wavelengths more appropriate for cyanobacteria. In addition, Landsat satellites have thermal sensors that can be used to monitor surface temperature of lakes, which is useful, since warmer temperatures promote bloom growth. Schaeffer is investigating how to add that additional factor into the monitoring program.

Ultimately, the goal is to create a water quality monitoring system that leverages data from many sources—Sentinel-2, Landsat, and other satellites, as well as information gathered on the water, said Nima Pahlevan, a researcher at Goddard and member of the Landsat science team.

He and his team are working on how to best use Landsat and Sentinel data to identify lakes, rivers, reservoirs and other water bodies with excessive algae present. The Landsat mission has been operating since the late 1970s, so researchers and water managers can track the history of a given lake to determine if each lake—or potentially even an individual pixel within an image of a lake—has changed, and if it indicates a bloom.

"We're hoping that with these images, produced in near-real time—within as little as 3 to 4 hours—we can build a system to issue warnings that are specific to each lake or reservoir," Pahlevan said.

One challenge the group is facing is that there aren't many water measurements being taken across the different lakes to compare with, and verify, what the satellite is reporting. With support from the Landsat Project Science Office, Pahlevan and collaborators have placed three instruments in Green Bay, Wisconsin, Lake Okeechobee, Florida, and Grizzly Bay, California, to take measurements

of the water for comparison with Landsat and other satellite measurements.

With those data from the field, and work this summer which includes tracking a handful of lakes using Landsat and Sentinel-2, Pahlevan hopes to build up the program and expand it to an operational system with more locations by summer 2020.

For people like Donalea Dinsmore, who works for the Wisconsin Department of Natural Resources (DNR), more satellite monitoring tools would be a welcome addition to the suite of methods the state uses to keep a handle on where harmful algal blooms occur. Each summer, the department receives questions about whether the green muck floating on lakes is harmful, or reports of dogs sickened after swimming in or drinking from a lake, she said. Wisconsin's DNR has staff who monitor many of the thousands of lakes in the state, but they can't reach everywhere.

"With 15,000 lakes, can you visit them all? And depending on when you visit, you might just miss a bloom," Dinsmore said. "It can be a really complicated and expensive monitoring program if you go in blind."

Provided by NASA's Goddard Space Flight Center