

Noxious algal blooms in lake Erie

Sentinel-3 OLCI FR acquired on **14 February 2017** at 16:00:43 UTC

Sentinel-3 OLCI FR acquired on **29 March 2017** at 15:45:45 UTC

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Author(s): Sentinel Vision team, VisioTerra, France - svp@visioterra.fr

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[3D Layerstack](#)

Fig. 1 - S3 OLCI (14.02.2017) - 10,6,4 colour composite - Lake Erie is the southernmost, least voluminous & warmest of USA great lakes. [3D view](#)



Fig. 2 - 29.03.2017 - 390km long, 90km large but only 64m deep, it is also shallowest of these lakes [3D view](#)



The 1st August 1969, the Time magazine printed: "Each day, Detroit, Cleveland and 120 other municipalities fill Erie with [5.7 million cubic metres] of inadequately treated wastes, including nitrates and phosphates". "These chemicals act as fertilizer for growths of algae that suck oxygen from the lower depths and rise to the surface as odoriferous green scum". "Commercial and game fish—blue pike, whitefish, sturgeon, northern pike—have nearly vanished, yielding the waters to trash fish that need less oxygen. Weeds proliferate, turning water frontage into swamp. In short, Lake Erie is in danger of dying by suffocation."

Michael Wines [published](#) an article released in the New-York Times the 14 March 2013: "Decades ago, some [29 thousand tons] of phosphorus flowed into Lake Erie each year from industrial and sewer outfalls, leaky septic tanks and runoff from fertilized lawns and farms. Relentless and unregulated dumping of sewage and industrial pollutants spawned algae blooms and earned Lake Erie the nickname 'North America's Dead Sea'."

Fig. 3 - 01.12.2017 - Lake Erie is the most hit by algal blooms, colouring it in green to blue colours.

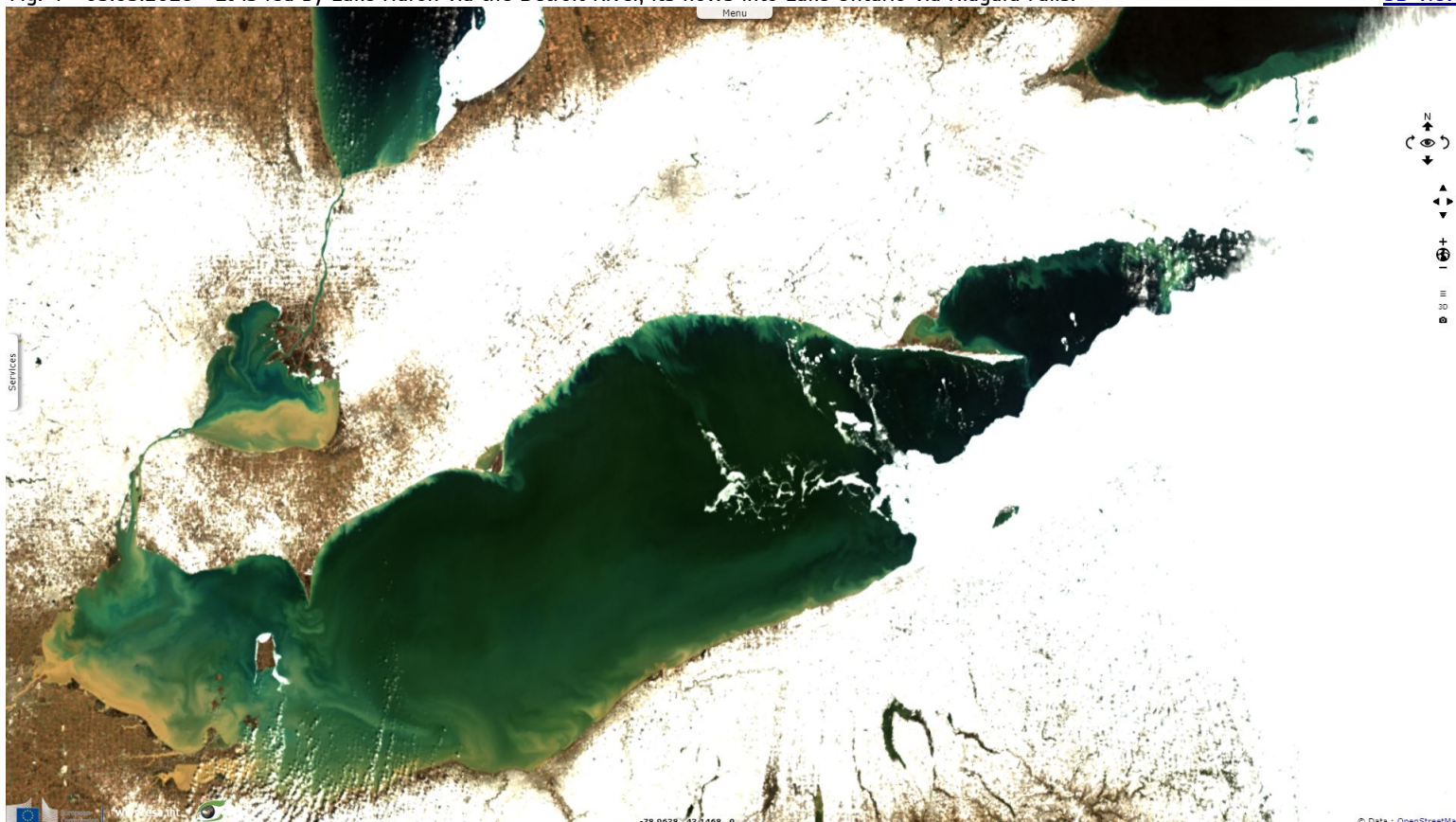
[3D view](#)



Michael Wines [added](#): "The United States and Canadian governments responded by capping household detergent phosphates, reining in factory pollutants and spending \$8 billion to upgrade lakeside sewage plants. Phosphorus levels plunged by two thirds, and the algae subsided."

Fig. 4 - 03.03.2018 - It is fed by Lake Huron via the Detroit River, its flows into Lake Ontario via Niagara Falls.

[3D view](#)



Michael Wines [proceeded](#): "Erie recovered then, thanks to a multibillion-dollar cleanup by the United States and Canada that became a legendary environmental success story. 'We've seen this lake go from the poster child for pollution problems to the best example in the world of ecosystem recovery. Now it's headed back again,' said Jeffrey M. Reutter, who directs the Sea Grant College Program at Ohio State University."

The 3 August 2014, Suzanne Goldenberg [wrote](#) in the Guardian: "The algal blooms came back to the Great Lakes in force in 2011 – forming a green scum that covered 5000 km² of water at its biggest extent – in the worst algal bloom in recorded history."

Fig. 5 - 30.04.2018 - Important rainfalls carry sediments, causing blooms that soon cover most of the lake's surface.

[3D view](#)



Suzanne Goldenberg [examined](#) the phenomenon: "The main cause for such algal blooms is an overload of phosphorus, which washes into lakes from commercial fertiliser used by farming operations as well as urban water-treatment centres".

The 28 April 2008, Sonja Puzic had already investigated some of the causes in an article [published](#) in the Windsor Star: "Stone lab director Jeff Reutter said scientists are also still struggling to figure out how to control Lake Erie's dead zone, an oxygen-deprived area devoid of life in the deepest parts of the lake's central basin, created when the oxygen supply is cut off by warmer layers of water near the surface. Pollutants that cling to lake sediment, the flow of contaminants such as phosphorus and the persistence of aquatic invasive species have wreaked havoc on some parts of Lake Erie, said Reutter, who often works and consults with University of Windsor's Great Lakes Institute."

There are also plumes of harmful algal blooms spreading across the southern shore of Lake Erie in Ohio during the warm summer months – caused by phosphorus dumped into the lake by industries, municipalities, tributaries and agriculture. Although that plume, coming from the largest source of polluted runoff flowing into Lake Erie -- the Maumee River -- tends to concentrate in northwest Ohio, it does not stay there. In fact, recent satellite images show the algae mass moving slowly toward Pelee Island. Ultimately, it could end up in Lake Erie's central basin, sinking to the bottom as the algae die off, Reutter said."

Michael Wines [completed](#): "Dead algae sink to the lake bed, where bacteria that decompose the algae consume most of the oxygen. In central Lake Erie, a dead zone now covers up to a third of the entire lake bottom in bad years."

Fig. 6 - 08.05.2018 - Shades of blue and green show the poisonous presence of *Microcystis cyanobacteria*.

[3D view](#)



[According to](#) Suzanne Goldenberg: "Scientists attribute the comeback in large part to changes in farming practices, including larger farms and different fertiliser practices, which send heavier loads of phosphorus into the lakes. Lake Erie has also grown more susceptible to the algal blooms because of invasive species and climate change."

Of these foreign species "one is the zebra mussel, a foreign invader that has dominated Erie since its discovery in 1988. Millions of mussels feast on nontoxic green algae, removing competitors to the toxic *Microcystis* algae and decimating the base of the food chain that supports Erie's fish. Then in a vicious cycle, mussels excrete the algae's phosphorus, providing the *Microcystis* a ready-made meal", [wrote](#) Michael Wines.

Suzanne Goldenberg [confirmed](#): "The other is climate change. Only heavy rains wash fertilizer off farmland, and since 1940, Mr. Richards said, heavy spring rainstorms have increased by 13 percent. Heavy rains in spring and early summer – a critical time for algal bloom formation – cause more phosphorus to enter the lake through agricultural runoff. Hotter temperatures then cause the blooms to spread." Sonja Puzic [concluded](#): "As the water level in Lake Erie decreases, the lake becomes warmer, causing concerns about the dead zone's expansion."

Fig. 7 - 15.06.2018 - Sun glint reveals linear forms on the lake's surface.

[3D view](#)



These algae do not only negatively affect wildlife, they are also dangerous to health as [reported](#) Michael Wines: "2011 was the wettest spring on record. That summer's algae bloom, mostly poisonous blue-green algae called *Microcystis*, sprawled nearly 190 kilometres, from Toledo to past Cleveland. It produced lake-water concentrations of microcystin, a liver toxin, that were 1200 times World Health Organization limits, tainting the drinking water for 2.8 million consumers."

Suzanne Goldenberg [showed](#) an example of consequences that happened in Toledo in 2014: "The toxins that contaminated the water supply of the city of Toledo – leaving 400,000 people without access to safe drinking water for two days – were produced by a massive algae boom. But this is not a natural disaster. Water problems in the Great Lakes – the world's largest freshwater system – have spiked in the last three years, largely because of agricultural pollution. Toledo draws its drinking water from Lake Erie.

Residents were warned not to drink the water on Saturday, after inspectors at the city's water treatment plant detected the toxin known as microcystin. The toxin is produced by *microcystis*, a harmful blue-green algae; it causes skin rashes and may result in vomiting and liver damage if ingested. It has been known to kill dogs and other animals and boiling the water does not fix the problem; it only concentrates the toxin."



A sample glass of Lake Erie water is extracted near the City of Toledo water intake crib on 03.08.2014 - Source: Haraz N Ghanbari for Associated Press.

Fig. 8 - 30.04.2018 - 18,11,8 colour composite - The blooms show less reflectance in red edge & near infrared than in green. [3D view](#) [3D animation](#)



As [written](#) by Associated Press, authorities monitor Lake Erie using remote sensing for several years, it is likely the use of Copernicus data now completes NASA / USGS program and aerial views as sources of data: "NASA Glenn Research Center got involved in algae monitoring in 2000, funding a study that revealed algae's specific "spectral signature" when seen in satellite images. Every plant, animal or nonliving object reflects and absorbs light differently, and has a unique spectral signature. But satellites pass over Lake Erie only every eight days. Researchers need more frequent images, said John Lekki, an optical systems research engineer at NASA Glenn. So NASA engineers last summer teamed up with the Great Lakes Environmental Research Laboratory to record the spectral images from the side door of an airplane."

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