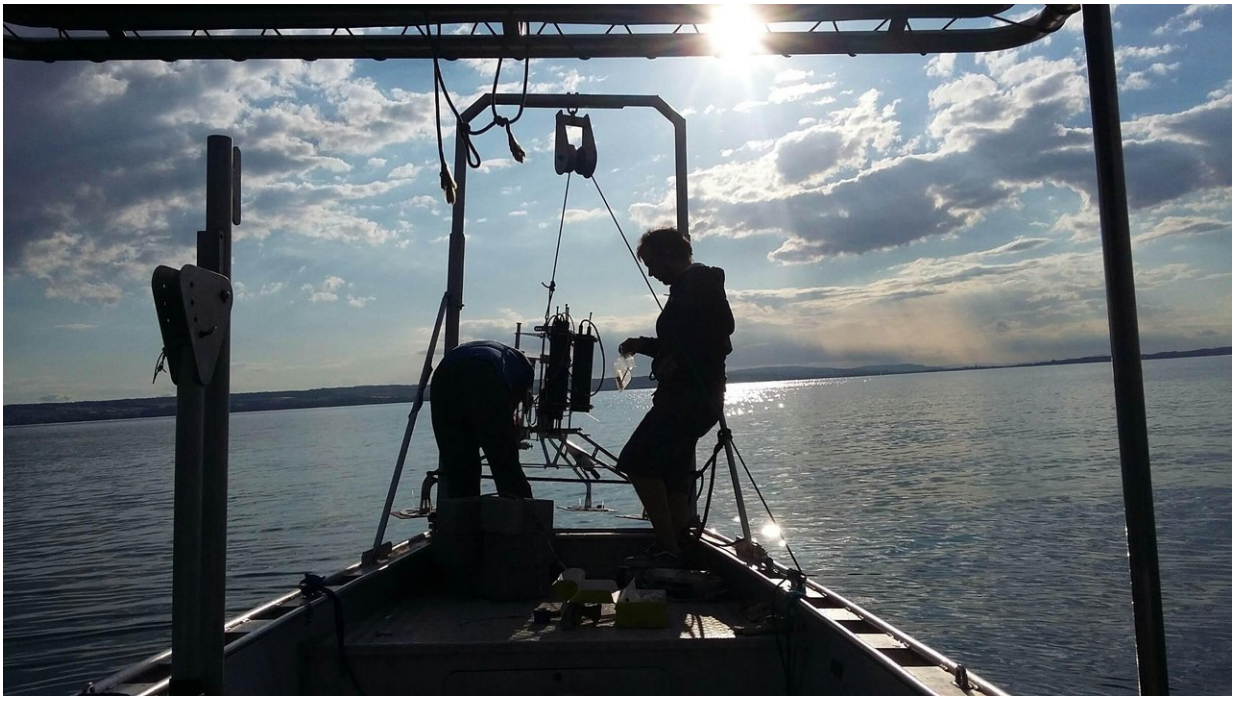
Are our lakes on the brink of suffocation?

November 24 2017



Credit: © 2017 EPFL Physics of Aquatic Systems Laboratory

In order to gain insight into how lakes breathe, EPFL scientists have studied oxygen depletion in the depths of Lake Geneva – the first time such research has been carried out. By collecting key data, they were able to enhance their understanding of the lake's ecosystem and how it is likely to evolve over time.

In the autumn, lakes undergo their annual water exchange as high winds,

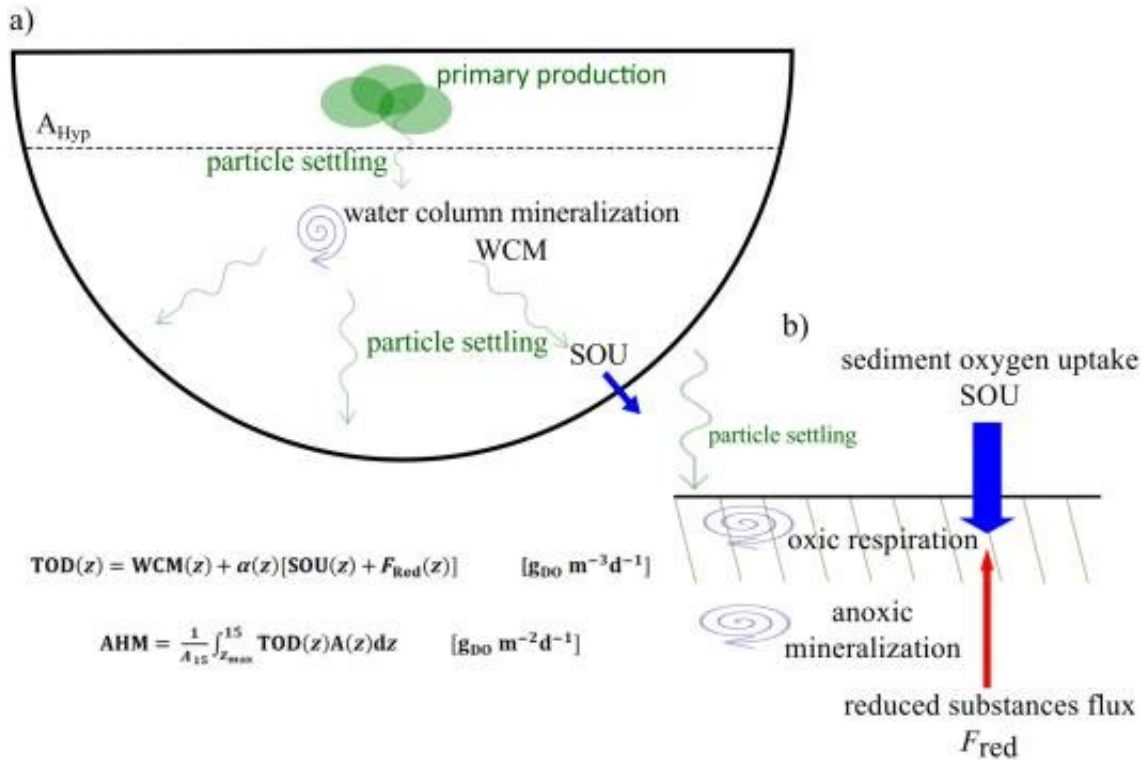
inflows from rivers and variations in water temperature mix up the water. During these colder months, the surface water, which is rich in oxygen, cools, sinks and mixes with the deeper layers, which brings fresh oxygen into the lakes' depths. But because Lake Geneva is so deep – going down 310 meters – the water exchange is only partial. The lake gets fully re-oxygenated only every eight years or so. A long-term shortage of oxygen could destroy the flora and fauna living in the lake's depths.

To better understand how lakes breathe, Robert Schwefel from EPFL's Physics of Aquatic Systems Laboratory probed the depths of Lake Geneva in order to measure oxygen levels there. He took samples at different depths using a robot capable of descending several hundred meters. Thanks to the robot's microprobes, he was able to measure oxygen concentrations micrometer by micrometer, in both the water and the sediment. Samples were taken at seven locations, and the results were quite telling: "We were able to collect data that is essential for estimating oxygen depletion in the sediment – something that had never before been measured out in the field."

175 natural lakes in Switzerland and as many reasons to be concerned

Since the middle of the last century, anthropogenic – or human – activity has caused water temperatures to rise and has led to eutrophication, whereby nutrients build up in water and cause algae to proliferate. That has destabilized lakes' entire ecosystems. In the past, toxic chemicals and other waste used to be disposed of through drainage systems that ran straight into our lakes, as it was thought that the lakes could clean themselves. However, it became apparent that this was not the case, and measures began to be put in place starting in the 1960s: water treatment facilities were improved, and a ban was placed on phosphates in washing

powders in 1985. As a result, Switzerland's lakes have become much cleaner. Yet, despite all these efforts, they still don't have enough oxygen.



Credit: Ecole Polytechnique Federale de Lausanne

With all the algae that have accumulated over the last 50 years, there is an immense amount of organic matter in deep-water sediment, and the bacteria that break down this matter consume a lot of oxygen. "Just because we've reduced the amount of phosphates coming from farming and industry doesn't mean that everything is as it should be. It'll take time before our lakes can breathe properly again," says Damien Bouffard, who was involved in the research.

By precisely measuring the oxygen concentration throughout entire water

columns and the sediment below, the researchers were able to explain how the oxygen is being depleted, with the sediment accounting for 30% of total oxygen depletion. The researchers were also able to create a model showing how oxygen depletion varies with depth, and they demonstrated how lake morphometry and decreasing organic matter mineralization in the water column largely affect oxygen depletion.

Using these micrometric data, the researchers created a large-scale model of oxygen dynamics in the lake and drew on their knowledge of water flows to predict what may happen going forward. Although the researchers hope that oxygen depletion in the sediment will gradually decrease, climate change will continue to have an impact on water exchanges. Further studies are therefore needed.

The findings were published in *Limnology and Oceanography*.

More information: Robert Schwefel et al. Using small-scale measurements to estimate hypolimnetic oxygen depletion in a deep lake, *Limnology and Oceanography* (2017). DOI: 10.1002/lno.10723

Provided by Ecole Polytechnique Federale de Lausanne