Water temperatures set to drop after the Mühleberg nuclear plant closes

Mühleberg is the first Swiss nuclear power plant slated for decommissioning in 2019. EPFL researchers have shown that its shutdown will lower water temperatures in the Aar River and Lake Biel, and could affect waterways as far away as Germany.

The Mühleberg plant sits on the Aar River in the canton of Bern. © BKW FMB Energie AG

When the Mühleberg nuclear power station goes offline in 2019, the waters of the Aar River and Lake Biel will cool down. And since the Aar feeds into the Rhine, the effects could be felt as far away as southern Germany. Should we be worried? It's hard to say. The drop in temperature, which EPFL researchers estimate at 0.3°C, should slow the local impact of global warming. But it can also be an advantage for nearby companies that draw water from the Aar and the Rhine to cool their machinery.

The EPFL study, which was published in *Water Resources Research*, showed for the first time the impact that closing a nuclear power plant in Switzerland will have on the physics of its surrounding rivers and lakes. The researchers' methodology could be applied to the country's other nuclear plants.

Taking local measurements

"Nuclear power plants have a major impact on the surrounding environment," says Love Råman Vinnå, the study's lead author and a PhD student at EPFL's Physics of Aquatic Systems Laboratory (APHYS). "Around 70% of the heat produced by the Mühleberg plant ends up in the Aar. The remaining 30% is turned into electricity. The plant will stop generating heat in 2019, and it's crucial to both gauge and prepare for the effect that will have on water temperature and stratification. We know, for example, that an abrupt temperature change at the local level is a stress factor for fish, and can change the composition of plankton."

Measurements at three sites

Vinnå points in particular to the importance of taking upfront measurements at multiple sites in order to better anticipate the consequences of shutting down a nuclear plant. His study draws on two years and four months of fieldwork on Lake Biel – from May 2013 to September 2015. His team of researchers attached sensors to ropes and submerged them deep into the lake at three different spots. They took continuous measurements of several variables such as water temperature at different depths and the speed of water currents. They also obtained data on air temperature, wind and rain from MeteoSwiss, along with key information from BKW – the company that runs the Mühleberg plant – including the amount of heat given off by the plant (around 700 megawatts) and data specific to its regular summer shutdown.

1D and 3D models

Vinnå then took 1D and 3D theoretical models that resolve temporal changes in lake hydrodynamics – in other words, how lake temperatures and currents evolve over time – and adapted them to the Mühleberg plant. "We started out by comparing our measurements from the lake with the figures predicted by our 1D model," says Vinnå. "This model is useful because it's fast and cheap, but it's less accurate than the 3D model, whose output did indeed correspond closely to our field measurements. The 3D model makes more sense for complex case studies or when more accurate results are needed."

He then used the models to come up with precise forecasts of how the decommissioning of the Mühleberg plant will affect Lake Biel. This plant was relatively simple to model in this way since the lake's water is completely replaced every two months, which made the results of the 1D and 3D models fairly close to each other. The researchers predict an average 0.3°C drop in temperature throughout the lake starting in 2019 – although the 3D model's extremes suggest that certain spots will experience a drop by up to 4°C in the winter. It also turns out that temperature differences may be noticeable as far away as southern Germany, since around 150 megawatts of heat are carried 350 kilometers away from Lake Biel.

Modeling for a utility company

Vinnå's thesis is being backed by Biel's utility company, Energieservice Biel/Bienne, which supplies water, gas, and electricity to residents of the city and the surrounding Seeland region. Planning to upgrade its infrastructure, the company wanted to know which parts of the lake would be cleanest and coldest after 2019. The EPFL researchers used the 1D and 3D models to present the company with a series of recommendations, visualized in the form of a map.

Vinnå continues to work on his thesis and is already preparing another article that will be of use to Energieservice Biel/Bienne. These days, he is looking at the local consequences of climate change on Lake Biel after the Mühleberg nuclear plant closes down. One thing seems certain: by cooling the waters of the lake, shutting down the power plant should postpone the local effects of climate change – at least for a while.

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Reference
Love Råman Vinnå, Alfred Wüest, Damien Bouffard, *Physical effects of thermal pollution in lakes*, Water Resources Research, 16 May 2017

Link
Physics of Aquatic Systems Laboratory (APHYS)

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