Methane emissions from dammed rivers higher than expected

Investigations carried out on the River Saar suggest that significant amounts of the greenhouse gas methane are emitted not only from large tropical reservoirs but also from countless smaller reservoirs along temperate rivers. Methane is emitted especially from reaches where organic-rich sediments are deposited – and such emissions are likely to increase in the future. *Text: Andres Jordi*

Manfred Vollmer / imagetrust

Fig. 1: Dammed sections of temperate rivers – as here at the Serrig hydropower plant on the Saar – are hot spots for methane emissions.

Three years ago, Eawag scientists demonstrated that substantial amounts of methane – a greenhouse gas 25 times more potent than carbon dioxide – are released from Lake Wohlen, near Bern. This finding was widely reported in the media. Now, a study conducted by Tonya Del Sontro of the Surface Waters department in collaboration with German and Danish researchers shows that, in temperate regions, Lake Wohlen is by no means unique in this respect. As Del Sontro says, "Considering the innumerable small reservoirs along rivers, methane emissions from inland waters worldwide could well be up to 7 per cent higher than was

previously thought." This is suggested by the results of measurements carried out by the researchers on the Saar in Germany. To date, it has been assumed that rivers and lakes account for around 18 per cent of global methane emissions.

Ebullition rates influenced by sedimentation

Methane released from freshwaters is a product of microbial degradation, mainly originating from anoxic sediments. It arises when organic carbon is fermented by bacteria under anoxic conditions, rather than being degraded aerobically to form carbon dioxide. Anoxic zones of this kind are found where large amounts of organic matter are deposited – for example, in run-of-the-river reservoirs close to the dams. High levels of methane production lead to enrichment of the water with the greenhouse gas and the formation of bubbles which are released into the atmosphere (Fig. 2).

Fig. 2: Gas bubbles form when large amounts of methane are produced in sediments.

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In their study, Del Sontro and her colleagues quantified methane emissions from five dam reservoirs and from the reaches lying between the dams along a roughly 100-kilometre stretch of the river. Using sensor and echo sounder measurements, they determined the amounts of methane diffusing to the atmosphere from the surface, released via ebullition from sediments or degassed as a result of turbulence at dam outflows. Methane emissions from the reservoir sites are between 75 and 620 milligrams per square meter per day, compared to only around 4 milligrams for the river-type reaches. The emissions are mainly attributable to ebullition from reservoir sediments and degassing from methane-enriched water at dam outflows; surface diffusion plays a minimal role (see Fig. 3). Methane emissions vary from season to season and are much higher in warmer water – this explains why tropical reservoirs are considered to be significant sources of methane emissions, while alpine storage lakes, for example, are not.

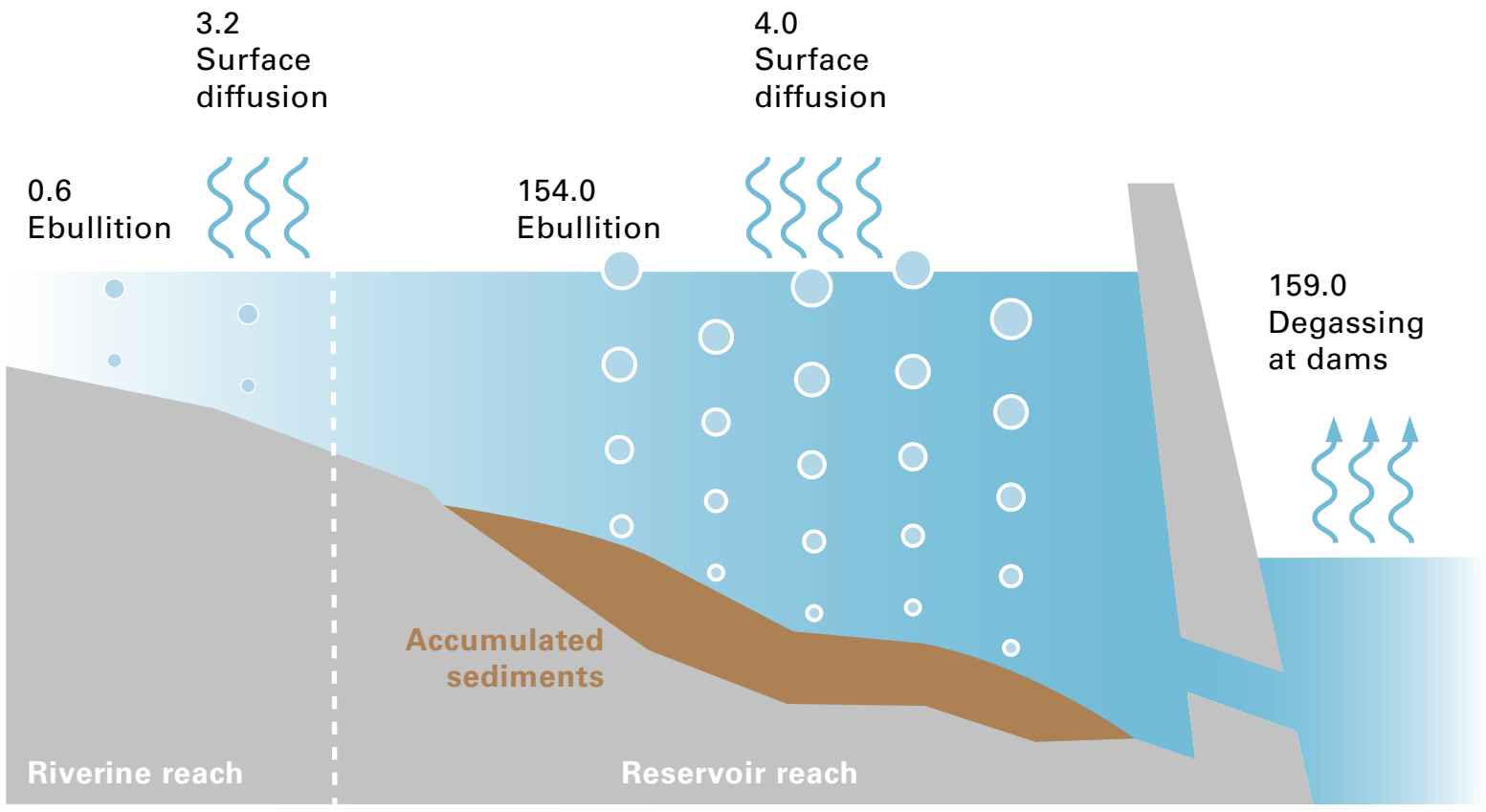

Fig. 3: Mean emissions of methane (in milligrams per square metre per day) from reservoirs on the Saar and from adjacent river reaches. The greenhouse gas is mainly released via ebullition from accumulated sediments in reservoirs and degassing at dam outflows.

The researchers also found that ebullition rates depend on sedimentation: the higher the rate of sediment accumulation, the more methane gas bubbles are produced. In the Saar, over 90 per cent of methane emissions are due to sedimentation processes. Del Sontro explains: "The particles transported by a river are mainly deposited in reservoirs in front of the dams, so a lot more methane is released to the atmosphere from these reaches than from riverine reaches." Sediment accumulation, she concludes, would be an excellent proxy for estimating methane emissions from small reservoirs. In fact, the correlation between sediment accumulation and methane emission found in the Saar study worked quite well with Lake Wohlen data, too.

Inclusion in global emission assessments

The Saar reservoirs, with a total surface area of one square kilometre, emit about 120 tonnes of methane per year, which is roughly equivalent to the CO_2 emissions from 20 million car kilometres. The emission rates are similar to those observed for tropical reservoirs, on which the attention of climate researchers has previously been focused. According to the research team's estimates, total methane emissions for comparable temperate reservoirs could be up to 7 million tonnes per year. "This means that they account for a significant proportion of emissions and should be given greater consideration in global assessments," says Del Sontro. She believes that methane emissions are likely to be further increased as a result of the construction of new dams, ongoing sediment accumulation in existing reservoirs, and rising temperatures. However, as she emphasizes, there is a need to retain a sense of proportion: the impact of inland waters on the climate is relatively small compared, for example, to fossil fuel-based energy production.

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>>Reservoirs: a neglected source of methane emissions?