Deliberate drownings of Brazil's rainforests are worsening climate change

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It isn't just Bolsonaro and the fires. Hydroelectric dams in the Amazon are submerging millions of trees, transforming huge carbon sinks into sources of planet-warming gases.

In Balbina, a small town in the heart of the Brazilian Amazon, the shoreline of a vast reservoir sparkles blue and a mild wind ruffles the water, lifting small whitecaps. Within a few months, fire will devastate vaste swathes of the forest, some not far from here, but the story I've come to investigate lies just below the water's surface, where millions of trees have been drowned by a hydroelectric dam blocking the Uatumã river. The submerged jungle is no longer sucking carbon dioxide out of the atmosphere. Instead, the rotting corpses of once-magnificent trees are belching out yet more greenhouse gases.

No wonder the Balbina dam is known by experts as "the worst hydroelectric power plant in the world". And yet its environmental impact is worse than previously thought, as I discovered when I visited the region earlier this year to spend time with climate researchers. Their findings suggest that any dam built in tropical lowlands could be exacerbating the climate crisis, which is particularly alarming now that Brazil's president Jair Bolsonaro has promised to extract more of the Amazon's resources, including hydroelectric power.

Completed in 1989, the Balbina dam was controversial from the start. Its construction ensured that an area substantially larger than Greater London was flooded, engulfing territory that belonged to indigenous groups previously decimated by disease and violent confrontations with settlers. The Brazilian government claimed the project would modernise the Amazon. But the dam never achieved its advertised capacity, and over the past decade whatever green credentials it had have been discredited.

Hydroelectric power is widely considered a good way to reduce greenhouse gas emissions while satisfying our ever-increasing demand for power. The most recent study produced for the Intergovernmental Panel on Climate Change (IPCC) on this topic, released in 2012, reported that, taking into account construction and operation, hydroelectric power produces only half a per cent to three per cent of the warming of fossil-fuel power plants that burn coal, oil or natural gas.

That is true for some dams, such as those built in relatively cool, dry places with relatively little vegetation, which rots and turns into greenhouse gases. But the IPCC report ignored dams built in lowland tropical forests, where luxuriant jungle produces an unusually large amount of emissions.

One of the first people I met when I travelled to Brazil was Philip Fearnside, a biologist at the National Institute of Amazon Research, known as INPA, in Manaus. He has spent the past 25 years arguing that hydroelectric dams in tropical lowlands are a climate disaster.

He cites two reasons. First, tropical lowland forests are highly productive and so contain more carbon than other areas, which means they release more when they die. Second, in hotter climates microbes that digest organic matter grow better and so produce more greenhouse gases. There are two types of microbes that digest the dead trees: one group operates in the oxygen-free conditions at the bottom of the reservoir and produces methane while the other, which lives in oxygen-rich water close to the surface, produces CO_2. In both cases, growth is promoted by higher temperatures.

Fearnside says that the increased methane created in tropical dams is especially problematic. Although it is relatively short lived in air, methane warms the atmosphere much more than CO_2. According to the IPCC, over 20 years, each gram of methane has the same heating effect as 86 grams of CO_2.

So why did the IPCC reports give tropical dams a clean bill of health? “A lot of the authors were from big hydroelectric companies,” Fearnside says. William Moomaw at Tufts University in Massachusetts, lead author of the methodology study on which the 2012 IPCC report was based, says the body did “drop the ball,” by lumping tropical dams with all dams as if there is no distinction. But he insists that was due to inattention, not nefarious motives. “The IPCC is dominated by people from the temperate world,” says Moomaw.

In any case, a clear-eyed assessment of tropical dams is now more critical than ever. Most of the hydroelectric plants being planned are in the tropics, primarily in lowland forests. Nearly 150 large dams are slated in the Amazon basin alone, with another 72 planned in Laos and 50 in Cambodia. We aren’t going to restrain global warming if we build these dams based on false assumptions, says Fearnside.

One of those assumptions was that the methane generated in the reservoir is forever trapped, held down by the mass of water above. But Fearnside and his colleagues weren’t convinced. In the early 2000s Bruce Forsberg, also at INPA, and Alexandre Kemenes, then a graduate student of Forsberg’s, put this to the test. They realised the turbine water intake at Balbina is several metres below the surface, right where most of the methane is held. They thought the gas could be released into the air where the water disgorged and the pressure dropped. “Like opening a bottle of Coca-Cola,” says Forsberg.

Sure enough, when Kemenes invented a novel way to sample the water exiting the turbines for methane, the researchers detected significant amounts of the stuff. Extrapolating, they were able to show that the reservoir at the Balbina dam is releasing 39,000 tonnes of methane every year. This more than doubles the amount attributable to the dam compared with previous estimates. The research shows that if you include methane and CO_2, Balbina is nearly 10 times as bad for the environment as a coal-fired power station producing the same amount of electricity.

The news got even worse earlier this year when another research team reported that the dam is creating even more CO_2 and methane downstream of the floodgates. To see for myself, I joined Jochen Schöngart, another INPA biologist, in a fishing boat.

Halfway between Balbina and the point where the Uatumã river joins the Amazon river, Schöngart stared gloomily across the gunwale. Our pilot cut the engine and we glided silently through a dead forest, skeletal branches poking above the water. This eerie graveyard was once a stand of rare shoreline trees, known as an Igapó forest. Its trees are adapted to sporadic flooding, the result of rains changing the water level each year.

But the construction of the dam disrupted the river's natural rhythms. Balbina's technicians deal with the annual three-month pulse of high water by adjusting outflow to store this extra water for release during the rest of the year, smoothing out the amount of electricity produced. In years gone by, the water level of the river fluctuated a lot more between wet and dry seasons than it does now. Where Schöngart has brought me, the average difference in water level between these seasons has been significantly reduced. During the dry season the water is on average 1 metre higher than before the dam was built.

Schöngart thinks this higher water prevented tree roots from ever drying out, killing the forest. To confirm it, he and his team looked at growth rings inside 17 dead trees to see when the forest started failing. The results showed that the first trees began dying a year or so after Balbina started raising the river's dry season level. Every tree at the lowest elevation along the previous shoreline has since died.

Schöngart and his team also used satellite radar images to estimate the scale of tree mortality. They found that the dam has killed hundreds of thousands of Igapó trees, which had previously locked up roughly 130,000 tonnes of carbon. It isn't yet clear how quickly the carbon from this dead and rotting forest will be released, but it only adds to the case that the Balbina dam is even more environmentally damaging than anyone thought.

The problem is, demand for energy is growing. Hydroelectric dams provide 80 per cent of Brazil's electricity, and president Bolsonaro has promised to build more. That will be "disastrous for the environment and for local people", says Fearnside.

Even insiders from Brazil's hydroelectric industry agree that the Balbina dam produces too much greenhouse gas. Luiz Pinguelli Rosa, former president of Electrobras, Brazil's largest electricity company, admits that "Balbina is very bad". But he insists that it is an outlier.

Forsberg begs to differ. More than a decade ago, he and Kemenes demonstrated that three other dams in the Amazon also give off two to four times as much CO_2 as an equivalent coal-fired power plant. "Almost all of these lowland tropical dams emit more greenhouse gases per megawatt than a thermoelectric plant burning dirty coal," he says.

As Bolsonaro plots to further exploit the Amazon to fuel Brazil's economic development, one thing is abundantly clear. "The solution is to not build more dams," says Fearnside.