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Why Hydropower is Not Clean Energy

9 Jan, 2007 02:53 pm

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Hydropower is generally presented as “clean energy,” at least from the perspective of global warming. Of course, hydro impacts, such as displacing human populations, flooding terrestrial ecosystems and radically altering aquatic ones. Until recently, the significant additional impact of many dams, especially in the tropics. The hydropower industry has reacted strongly to the results makes this resistance harder and harder to justify.

“It’s baloney!” was the initial response of the industry, as voiced by a spokesperson for the U.S. Hydropower Association. My calculation that Brazil’s Balbina Dam was worse than fossil fuels in terms of greenhouse-gas emissions (Fearnside, 2002) and that northern reservoirs can release greenhouse gases (Rudd et al., 1993). This was only the beginning of the long debate. The fact that methane released by passing through the turbines of tropical dams have been confirmed by direct measurements of methane release in the Amazon (April et al., 2005) and the Balbina Dam in Brazil (Kemenes et al., 2006).

In 2002, I published a paper in the journal *Water, Air and Soil Pollution* calculating that in 1990, Brazil’s Tucuruí Dam (turbines) emitted more greenhouse gases than the city of São Paulo (Fearnside, 2002). Once again, shock waves were set off. The head of ELETROBRÁS (Brazilian electric utility) claimed that the study showed that those who say that dams have high emissions (that is to say, me) are subject to “greenhouse gas lobbies.” (Rosa et al., 2004; See reply: Fearnside, 2004). In a follow-up attack (Rosa et al., 2006; see reply: Fearnside, 2006), he argued that bubbles in a leisurely consumed bottle of guaraná (a Brazilian soft drink) would reveal the error in my use of Coca Cola’s principle that gases have higher solubility under increased pressure (see Giles, 2006; McCully, 2006). I had used the bottle to explain why so much methane (CH₄) is released when water from the bottom of a reservoir emerges from the surface. Whether the gas bubbles all emerge immediately or whether the process continues for half an hour or more (as with a bottle of beer) the bottom of a reservoir is under high pressure and contains a high concentration of dissolved methane. When the pressure is released at the turbines, most of this methane is released.

Methane accumulates in the water near the bottom of the reservoir because the water column is thermally stratified (geothermal) such that the colder deep water does not mix with the warmer surface water. Since the deep water (hypolimnion) has very low oxygen levels, organic matter undergoing decomposition comes both from what was originally present in the vegetation and from that which enters the reservoir each year, one example being from the soft vegetation that grows on the mudflats that are exposed to be flooded again when the reservoir is refilled. Unlike a natural lake where an outlet stream draws water from near the surface, one pulls the plug at the bottom—outflow is through turbines and spillways that are located at depths where the water is coldest and the greatest in the first years after a reservoir is filled, the annual flooding of the drawdown zone can sustain an appreciable amount of methane. One ton of methane is equivalent to 21 tons of CO₂ in terms of impact on global warming, according to the conversions given by Fearnside (2002). This gives hydroelectric dams a significant contribution to the greenhouse effect.

Omissions of methane from the turbines and spillways is the main reason why my estimates of greenhouse-gas emissions from hydroelectric dams are 10 to 20 times higher than the official estimates Brazil submitted to the Climate Convention in its national inventory (Brazil, MCT, 2002). The official responsible for Brazil’s national inventory confessed in a singularly public way that ELETROBRÁS had been involved in the omission of hydroelectric emissions specifically because the agency would produce a politically convenient result that would avoid the inclusion of methane (Brazil, MCT, 2002; see Fearnside, 2004).

The dispute over greenhouse gases from hydroelectric dams, as in many scientific disputes, is likely to cause people to lie somewhere between the two sides, presumably at the midpoint. Unfortunately, while the central-limit theorem is a good one of the same type, such as a series of measurements of gas concentrations in the water at a given place and time, the theorem does not apply to omissions of important components of a problem, in this case the principal sources of methane release: the turbines and spillways. See the “Amazonian Controversies” section at <http://philip.inpa.gov.br>.

