Drought in the Amazon basin leaves boats – and dam reservoirs – high and dry. Photo: © Rodrigo Baleia/ Greenpeace

Wrong Climate for Big Dams

DESTROYING RIVERS WILL WORSEN CLIMATE CRISIS

Proponents of large dams, hoping to capitalize on concern for climate change, are promoting a major expansion of large dams in developing countries. Yet large dams are highly vulnerable to climate change, which is changing rivers in ways we cannot predict. At the same time, healthy rivers are critical for helping us adapt to a changing climate. We need a water and energy revolution that dramatically cuts climate pollution and preserves the planet's lifelines.

Reducing climate pollution and eradicating poverty are two of the biggest challenges facing the world today. Large dams are the wrong response to both of these pressing problems for the following reasons:

- **River flows are increasingly unpredictable.** Large dams have always been based on the assumption that future stream-flow patterns will mirror those of the past, but this is no longer true. Climate change has begun to significantly and unpredictably change precipitation patterns. On the one hand, more frequent droughts will make many hydropower projects uneconomic, while on the other, more extreme rainfall will increase siltation of dams (reducing their useful lifetimes) and increase the risk of dam failures and catastrophic flood releases.

- **Dam reservoirs emit greenhouse gases.** In the tropics, dam reservoirs are a globally significant source of one of the most potent gases, methane. Even outside of the tropics, some dams can be significant sources of methane. Meanwhile, free-flowing rivers play a crucial role in helping trap carbon.

- **Healthy rivers are critical for supporting life on Earth.** Big dams reduce water quality and quantity, dry up forests and wetlands, flood productive land, and destroy fisheries. These

changes make it harder for people and ecosystems to adapt to a changing climate.

Due to widespread damming, healthy rivers are becoming an endangered species – just when we need them the most. Yet hundreds of new large dams are being proposed for key rivers, particularly in the Global South. A global dam boom poses huge risks to the natural support systems that we all depend on, and will make it harder for all life on Earth to adapt to a warming world. Instead of damming the world's rivers, it is both possible and practical to develop climate-safe energy and water supply systems that improve lives, share the development wealth, and help us weather the coming storm.

DAMS ARE DESTRUCTIVE AND DIRTY

More than 50,000 large dams choke at least 60% of the world's rivers. The consequences of this massive engineering program have been devastating. Large dams have wiped out species; flooded huge areas of wetlands, forests and farmlands; displaced tens of millions of people, and affected close to half a billion people living downstream.

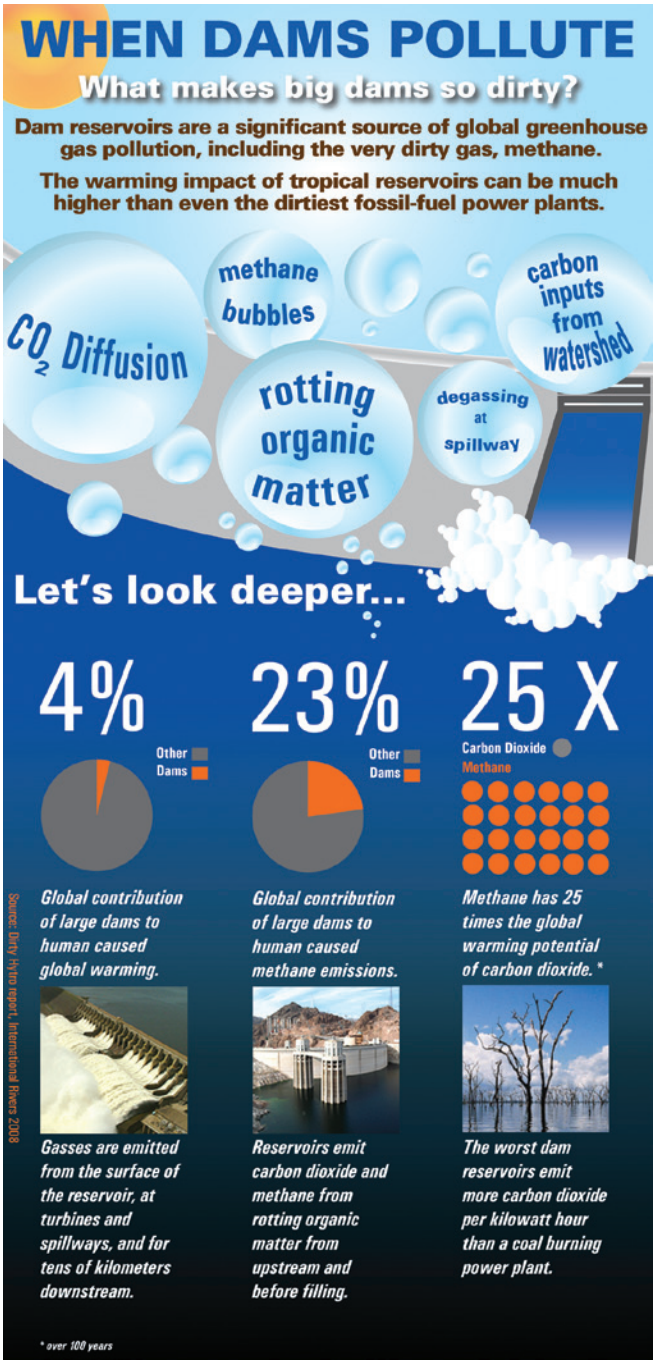
In addition to these serious impacts, large dams are a major source of emissions, particularly in the tropics (a hotspot for damming). Brazilian researchers have estimated that dams and reservoirs are responsible for almost a quarter of all human-caused methane emissions. These 104 million tonnes of methane are responsible for at least 4% of all human-caused warming.

Reservoirs emit greenhouse gases due to rotting organic matter from the vegetation and soils flooded when the reservoir is created; the plants that grow in the reservoir, and the detritus that flows into the reservoir. Gases are also emitted when water is discharged through turbines and spillways. Some reservoirs flood "carbon sinks" such as tropical forests, increasing their climate-change impact.

Scientists have studied more than 30 reservoirs, and found emissions at all of them. In the tropics, dam reservoirs are especially potent emitters of the very powerful greenhouse gas, methane. Balbina Dam in Brazil, for instance, produces ten times more greenhouse gas emissions per unit of energy produced than coal plants. Despite having some of the highest-emitting dams on the planet, Brazil is planning to build up to 60 dams in the Brazilian Amazon alone.

Outside of the tropics, the climate change impact of dams is significantly lower than that of fossil fuel-generated electricity but definitely not negligible. For instance, the Wohlen reservoir in Switzerland continues to emit well above the average natural lake in Europe, even after 90 years of operation. While temperate reservoirs emit less than tropical reservoirs, studies show that they should still be taken into account in global estimates of emissions.

Despite the strong evidence that dams are a significant source of climate pollution, reservoir emissions are rarely taken into account in national carbon registries or emissions targets.



Infographic: Ian Elwood

RIVERS THAT CAPTURE CARBON

Major rivers play a surprisingly large role in helping tropical oceans absorb carbon. The vast flow of major river basins delivers phosphorus, iron and other nutrients far offshore, where it is consumed by certain forms of sea life. These microorganisms "fix" carbon by taking it out of the atmosphere. The organisms eventually sink, taking carbon with

them to the deep seafloor. Dams could change the delicate workings of this ecosystem service by holding back the river-borne sediment that feeds this cycle.

At least two major river basins slated for damming – the Amazon and the Congo – are important carbon sinks. A 2009 study on Africa's biggest proposed hydropower project, Grand Inga on the Congo, says that "plans to divert, store or otherwise intervene in Lower Congo River dynamics are truly alarming" and "ignore the river's significant influence on the equatorial Atlantic, which, in turn, is central to many climate change models." Despite its potentially huge impact on increasing greenhouse gas emissions, Grand Inga's proponents hope to garner carbon credits to offset some of its huge price tag.

Scientists predict that damming the Amazon, the Congo, the Mekong and other high-flow rivers in warm-ocean areas could reduce their ability to mitigate climate change. Research on other rivers' carbon-sink capacity is underway.

CLIMATE CHANGE INCREASES HYDROLOGICAL RISK

The most serious consequence of climate change for human society will likely be the changes in rain and snowfall patterns that a warmer world will bring.

The future will bring extremes of drought and flood outside the historical record that will continue to worsen as the climate warms. Large dam developers do not currently take climate change into account in their plans. If they did, dams would need much greater capacities to safely pass high floods, and projections of power generation for hydropower projects would have to allow for the probability of new extremes of drought. These factors would increase the costs and reduce the benefits from dams, thus making the alternatives to them even more attactive.

Large hydropower projects are potentially highly vulnerable to changes in precipitation and streamflow. A 2011 World Bank report states: "Heavy reliance on hydropower creates significant vulnerability to climate change and is a feature that many low- and middle-income countries have in common." The report summarizes the impacts on the hydropower sector as "reduced firm energy, increased variability, increased uncertainty," and recommends an adaptation response that "may require a policy decision to diversify away from hydropower."

Dozens of countries are already over-dependent on hydropower, and most of them are poor. Yet it is in the already hydro-dependent countries where the bulk of new large hydro capacity is planned, such as Brazil, Ecuador, Peru, Ethiopia and Tanzania. Even with our existing climate, many hydro-dependent countries are already experiencing energy shortages when droughts strike, often with severe economic consequences. For example, Kenya (66% hydro-dependent) has regularly incurred significant costs of drought-induced energy shortages. In 2011, Kenya had a 90 MW shortfall in power due to drought, and had to replace lost hydropower with expensive emergency generators. Other African nations also experience regular, costly drought-related energy shortages.

A different kind of hydrological risk is hitting glacier-fed rivers. For example, in the Himalayas – which is experiencing climate change faster than any other region in the world – hundreds of dams that have been planned are based on now-irrelevant historical river flow data. Dam safety is a major concern in glacier-fed river basins, which are likely to be subject to much higher flows as the pace of glacial melting increases. The sudden bursting of glacial lakes is another major safety concern. As glaciers in high-altitude regions melt, they can form large lakes behind temporary dams of ice and rock. When these natural dams collapse, millions of cubic meters of water are released, resulting in massive flash floods. A Himalayan dam boom could put millions of people at risk from catastrophic floods and dam breaks.

BETTER SOLUTIONS FOR MEETING ENERGY NEEDS

There is huge potential to diversify and decentralize energy systems to meet energy needs. Energy diversification is especially important in the many poor nations that now rely excessively on hydropower for their electricity. Small projects take less time to build, are more easily phased, and can thus better adapt to a changing climate. They are also better suited than large centralized projects to bring energy to the many millions of rural families who suffer from energy poverty.

Energy efficiency is the cheapest, cleanest, and fastest solution to bridge the world's energy gap. Up to three-quarters of the

Solar power in an off-grid village in Nepal. Photo: Alex Zahnd

electricity used in the United States, for instance, could be saved with efficiency measures that would cost less than the electricity itself. Developing countries, which will account for 80% of global energy demand growth up to 2020, could cut that growth by more than half using existing efficiency technologies. "That is a reduction larger than total energy consumption in China today," reports the McKinsey Institute.

Even with investment in efficiency, however, many developing countries will require new generation sources. Developing countries often have vast, unexploited renewable energy potential, such as wind, solar, geothermal, and modern biomass energy, as well as low-impact, non-dam hydropower. Such technologies are much more suited to meeting the energy needs of the rural poor, as they can be developed where people need the power and do not require the construction of transmission lines.

For example, in East Africa – where dozens of dams are under construction or planned on rivers dramatically reduced by ongoing drought – energy experts have identified thousands of megawatts of geothermal energy. In hydropower-dependent Ethiopia, where dams are favored by the ruling elite, one brave government energy expert publicly stated that 100 MW of geothermal energy is as good as 200 MW of hydroelectric power, because it's not subject to drought and is inherently more efficient. Yet UN figures show that Africa has tapped less than 0.6 percent of its geothermal potential. Africa also has outstanding solar potential, but has developed almost none of it. By diversifying its hydro-heavy energy sector, Africa would de-emphasize reliance on erratic rainfall for electricity, reduce conflict over water resources, and protect river-based ecosystems and the many benefits they bring.

Clean energy costs are dropping fast. The cost of wind power in good locations is now comparable to or lower than natural gas and coal. Solar is expected to be broadly cost-competitive with conventional energy sources in five years (it already is in some places).

BETTER SOLUTIONS FOR WATER MANAGEMENT

The water challenges confronting the world are unprecedented. They call for fundamental changes in how we use, manage, and think about water. The good news is that it's within our economic and technological ability to have a future in which all food and water needs are met, healthy ecosystems are sustained, and communities remain secure and resilient in the face of a changing climate.

Pursuing more efficient water management allows a more flexible and equitable way to bring water to those in need, while avoiding the major ecological destruction and social problems that come with large dams. Higher water productivity in the global food system is particularly important. Nearly 70% of all the water withdrawn from freshwater ecosystems goes to irrigated agriculture, yet drip irrigation – which often doubles yield per liter of water compared with conventional irrigation methods – accounts for just 2% of the world's irrigated area.

While most agricultural investments in developing countries have gone into major irrigation projects, 60-70% of the world's food is still produced from the 80% of cropland that is rain-fed. We need to ramp up the deployment of techniques that address the needs of the planet's poor majority and help them adapt to climate change. Low-tech solutions to improve the lot of rain-fed farms – such as rainwater harvesting, treadle pumps, improved soil and crop management methods, and water storage tanks – are not only a better investment than big dams for reducing climate risk, they are also cheaper. Paul Polak, founder of International Development Enterprises, estimates the annual cost of bringing 100 million small farming families out of extreme poverty with low-cost water technologies to be $2 billion – less than 10% of the annual investment in large dams in developing countries in the 1990s.

Small reservoirs and rainwater harvesting structures (such as the 300,000 agricultural "tanks" in South India and the seven million ponds in China) are more likely to benefit poorer farmers because they are geographically widely dispersed and more likely to be built and controlled at the community level. Large reservoirs, in contrast, mainly provide benefits to a small group of relatively wealthy large farmers living in fertile plains that usually receive canal water.

PROVIDING FOR THE FUTURE

Breakthroughs in clean and efficient energy technologies and water-efficiency methods are not only better suited to strengthen energy and water access for the poor, they will also strengthen our resilience to climate change. They require greater investment in research, development and deployment. The world's wealthiest countries should assist the world's poorest in developing a cleaner, more efficient energy path and water secure future rather than in destructive projects that repeat the mistakes of the past.

MORE INFORMATION

Explore in Google Earth or watch on YouTube: Take a visual tour of the climate risks of a global dam boom at www.internationalrivers.org/google-earth-climate

Learn what you can do: www.internationalrivers.org/take-action-climate

Footnoted version of this fact sheet: www.internationalrivers.org/node/6910