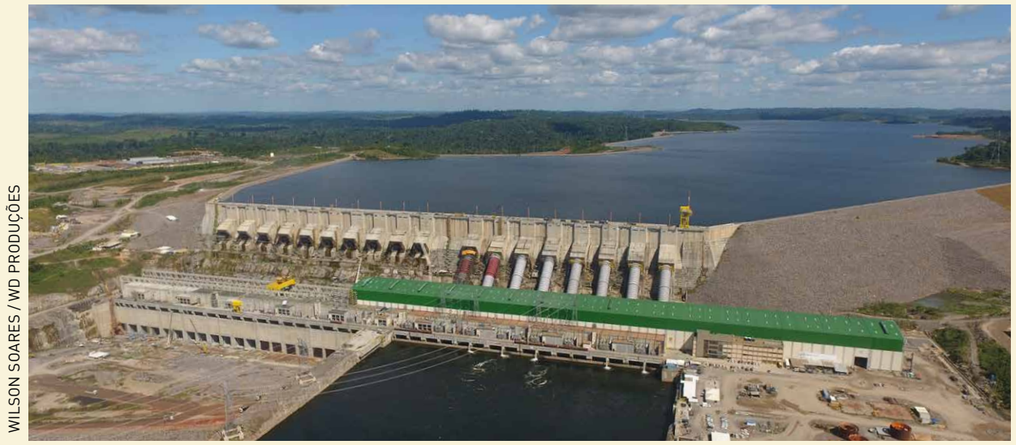


WILSON SOARES / WD PRODUÇÕES

WHY WE SHOULD NOT BUILD LARGE HYDROPOWER DAMS IN THE AMAZON
(OR ANYWHERE ELSE)

Emilio F. Moran
Michigan State University – USA

ABSTRACT
Large hydropower dams and plants have been an engineering feat and a source of national pride in both the Global North and South. They were promoted as a source of clean energy almost unquestionably until the environmental awakening of the 60's. Since then, the growing number of documented socioenvironmental impacts caused by large dams have put this energy source under scrutiny. Nevertheless, dam builders continue to promote this solution based on outdated arguments and unfulfilled promises connected to the creation of jobs, stimulation of the regional economy by the production of vast amounts of cheap electricity, improvement of local water quality and infrastructure, amongst others. Considering that most of the large dams currently planned or under construction are situated in socio-environmentally sensitive areas, such as the Amazon, which conservation is of high importance for reaching of climate goals, this paper deconstructs myths created by dam boosters in order to reach the conclusion that large dams should not be built in the Amazon (or anywhere else).

RESUMEN
Las grandes presas y centrales hidroeléctricas han sido una proeza de ingeniería y una fuente de orgullo nacional tanto en el Norte como en el Sur Global. Fueron promovidas como fuente de energía limpia de forma casi incuestionable hasta el despertar medioambiental de los años 60. Desde entonces, el creciente número de impactos socioambientales documentados causados por las grandes presas han puesto esta fuente de energía bajo escrutinio. Sin embargo, los constructores de presas siguen promoviendo esta solución basándose en argumentos obsoletos y promesas incumplidas relacionadas con la creación de puestos de trabajo, la estimulación de la economía regional mediante la producción de grandes cantidades de electricidad barata, la mejora de la calidad del agua y de las infraestructuras locales, entre otras cosas. Teniendo en cuenta que la mayoría de las grandes presas actualmente planificadas o ya en construcción están situadas en zonas socioambientalmente sensibles, como la Amazonia, cuya conservación es de gran importancia para alcanzar los objetivos climáticos, este documento deconstruye los mitos creados por los promotores de las presas para llegar a la conclusión de que no deberían construirse grandes presas en la Amazonia (ni en ningún otro lugar).

RÉSUMÉ
Les grands barrages et les grandes centrales hydroélectriques ont été une réussite technique et une source de fierté nationale dans les pays du Nord et du Sud. Ils ont été promus comme une source d'énergie verte et renouvelable de manière presque incontestable jusqu'à la prise de conscience environnementale des années 60. Depuis lors, le nombre croissant d'impacts socio-environnementaux documentés causés par les grands barrages a mis cette source d'énergie sous surveillance. Néanmoins, les constructeurs de barrages continuent de promouvoir cette solution en s'appuyant sur des arguments dépassés et des promesses non tenues liées à la création d'emplois, à la stimulation de l'économie régionale par la production de grandes quantités d'électricité bon marché, à l'amélioration de la qualité de l'eau et des infrastructures locales, entre autres. Considérant que la plupart des grands barrages actuellement planifiés ou déjà en construction sont situés dans des zones socio-environnementales sensibles, telles que l'Amazonie, dont la conservation est d'une grande importance pour atteindre les objectifs climatiques, cet article déconstruit les mythes créés par les promoteurs des barrages afin d'arriver à la conclusion que les grands barrages ne devraient pas être construits en Amazonie (ou ailleurs).

RESUMO
Grandes barragens e usinas hidrelétricas têm sido uma realização de engenharia e uma fonte de orgulho nacional tanto no Norte como no Sul do Globais. Elas foram promovidas como uma fonte de energia limpa quase inquestionavelmente até o despertar ambiental dos anos 60. Desde então, o crescente número de impactos socioambientais documentados causados por grandes barragens tem colocado esta fonte de energia sob escrutínio. Entretanto, os construtores de barragens continuam a promover esta solução com base em argumentos ultrapassados e promessas não cumpridas ligadas à criação de empregos, estímulo da economia regional através da produção de grandes quantidades de eletricidade barata, melhoria da qualidade da água local e da infra-estrutura, entre outros. Considerando que a maioria das grandes barragens atualmente planejadas ou já em construção estão situadas em áreas socioambientalmente sensíveis, como a Amazônia, cuja conservação é de grande importância para o alcance das metas climáticas, este artigo desconstrói mitos criados pelos impulsionadores de barragens para concorrer à conclusão de que grandes barragens não devem ser construídas na Amazônia (ou em qualquer outro lugar).

For nearly a century, we have been building large hydropower dams. First in the Global North (mostly in the US and Europe) and since the 1970's mostly in the Global South. In both hemispheres, governments promoted the building of hydropower dams on the grounds that they would provide inexpensive energy supplies, facilitate rural electrification, and promote economic development. Governments saw them as nation-building projects that reflected on their growing capacity to accomplish large projects and their growing economic prowess.

During the Great Depression in the 1930's they were an important component for creating employment for the many who had lost their regular jobs and could feel pride in a large-scale project such as this. The Tennessee Valley Authority, the Grand Culee, and other large projects were vanity projects that projected the engineering capacity of the nation (i.e. the USA) at a time of great national self-doubt. They addressed the need to provide jobs at a time of great unemployment during the Great Depression and provided rural electrification at a time when the nation was becoming urban/industrial and rural areas were depopulating. Their capacity to mobilize the nation was a prelude to World War II and the need to face a global crisis by showing great industrial capacity and the need for cheap power to make it possible. Hydropower came to account for up to 40% of the nation's electricity in this period[1]. The result was that by the time the dam building frenzy stopped there were over 82,000 large dams in the U.S. alone[2] (CHEN J. et al.2016).

During this entire period and until the first awakening of the environmental crisis in the late 1960's, only the benefits were touted and talked about. The engineering feat was a source of national pride that trumped other possible concerns. There was much less, if any, attention given to the many families and communities that had to be resettled to make room for the vast reservoirs that were created to harness the power of water to generate electricity. The good for the nation of having plentiful energy was seen as part of the normal sacrifice required to achieve these great things. There was little if any mention of what happened to the fish that freely swam in those rivers that were now dammed, or to the people who farmed the floodplains along those rivers or who had to be resettled (COLSON 1971).

All this began to change with the environmental awakening in 1968 that began to question the rosy view that was common. The damage to the river in terms of its ecology, and biodiversity began to be talked about, and the economic damage that dams inflicted on resettled people began to be topics of concern. Cost-benefit analyses began to evaluate the returns from dams and found them to be less than ideal. Such was the fervor about dams, that major financial institutions began to provide financing to build them in developing countries. The Kariba Dam in Zambia was among the early large dams to be built in poor countries. Anthropologists were hired to accompany this project, e.g. Thayer Scudder and Elizabeth Colson, and they documented with great detail the disruptions caused by the Kariba Dam and how much human populations suffered from this dislocation. Seventy years later, Scudder reports, they have yet to report an improvement in their lives over the pre-dam period.

In the short period of one decade, dam building in the US and Europe virtually came to a halt. Large dams were found to be associated with enormous social and environmental negative outcomes, and in the meantime the energy generated was found not to justify them—particularly as new sources of energy had become available to replace it. Nuclear, oil and gas grew in availability, and they did not seem to be associated with the same negative social and environmental impacts that had begun to be associated with large dams. The contribution of hydropower to the U.S. electrical supply declined to 6.1% of energy consumption. Dam removal, rather than construction, has become common in the US and Europe (PERERA et al. 2021): over three thousand dams have been removed in Europe and 546 in the U.S..

— Despite all the negative views that had begun to surround large dam construction in the North, developing countries of what has come to be known as the Global South began to build numerous large dams in the mid-1970's. As before, they were promoted by governments seeking to accelerate their economic development, and financial institutions such as the World Bank were glad to oblige them with accessible loans and technical advice.

New arguments for building them were used, such as the prospect of energy independence, freedom from having to import fossil fuels (an important reason following the creation of OPEC in 1973), and the plentiful energy needed to power economic development and industrialization. It is not surprising, then, that a lot of the power generated by hydropower dams was directed at energy intensive industries and to the growing new cities that began to sprout all over the developing world. In countries like Brazil, which in this period was ruled by a military dictatorship (1964-85), the process was top down and defined as building a strong economy powered by hydropower, and one in which dissent from this priority was forcibly suppressed. Hydropower development was a top-down process, characterized by little consultation with the people near dams, and where the energy was sent to the urban and industrial sites of national priority. The same was true in countries like China, Egypt, and Ethiopia. These nation-building projects were given such importance in the national psyche that repressing any opposition was seen as patriotic, and the use of violence to ensure that they were built promptly to meet national priorities became common place. A recent meta-analysis of large dam projects across the Global South found that lack of consultation with local people affected by dam construction was common in both autocratic and democratic political systems, as in both cases the large dams were given such importance that they resulted even in democratic systems in authoritarian undemocratic behavior (GARCIA et al. 2022).

As more dams are built, there is also a growing number of studies that show the broad negative impacts that have resulted, and questions grow as to whether they should continue to be built. Already in the past 50 years in the Global North, there are few being built and a growing number of dams that are being removed. In the Global North, dams are often past their expected lifespan and have become dangerous as the structures crack and the danger of them breaching and flooding communities downstream grows with each passing day. Despite the dangers they present, people have built recreational areas and second homes around the reservoirs and people are reluctant to give up what have become intergenerational recreational habits and wealth transfers. There is little funding provided for monitoring their safety, or for their repair. Old dams are a growing danger to communities downstream.

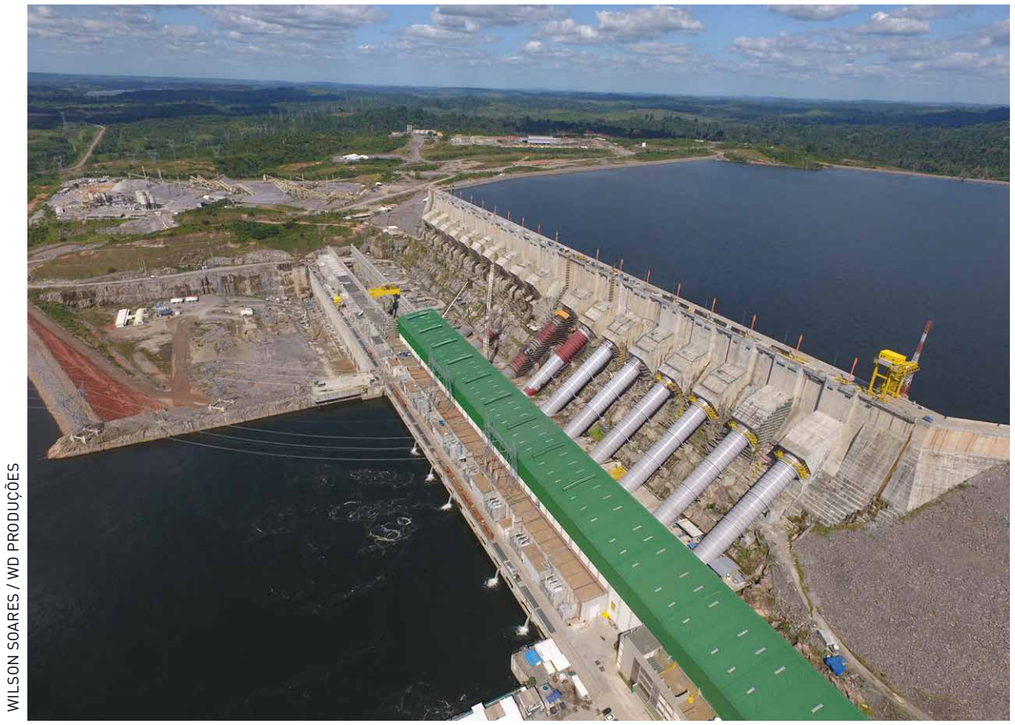
Most of the large-dams (with a capacity of more than 1GW each) are planned or already under construction in environmentally sensitive areas, especially concentrated in Asia around the Yangtze Basin and Mekong Basin, and in South America around the Amazon Basin (ZARFL et al 2014:165). However, even in countries in the Global South, which remain committed to this energy solution there are signs that the tide is turning. There is a growing chorus of social movements, environmental movements and civil society that is demanding that dam builders abide by their obligation to consult with local communities and find ways to improve their lives—rather than permanently damage their livelihoods. Research on the social and environmental impacts is growing in sophistication and into a broad consensus that large dams are irredeemably bad for local people and for the local environment. Even a scholar like Thayer Scudder who was among the first to study them since the Kariba dam, and who has worked closely with the World Bank and other organizations to improve the social and environmental impacts of dams has in recent work come to the conclusion that everything has been tried, and that large-scale dams should not be built, because they seem to be unable to do what they promise, which is to improve people's lives.

We concur, and in this analysis we will bring together this consistent evidence of why large dams are inevitably destructive and that even their greenness and sustainability are questionable. The need for this paper arises from the recent claim by the International Hydropower Association, an industry lobbying group, that prepared a document for COP26 in Glasgow in which it argued that to meet the goals of the Paris Accords, it would be necessary to double the production from hydropower globally by 2050.

When one reviews the damages that the current dams have brought about, and one imagines what doubling this impact would mean for human communities and to fish biodiversity and riverine ecology one can only shudder at the destruction that this will mean. While IHA of course suggests that this doubling would occur in a sustainable way, there is little if any evidence that the hydropower sector has ever been able to meet the social or environmental goals that were supposed to be met. The most memorable, of course, was what happened after the World Commission on Dams finished its work and made recommendations for how to reduce the social and environmental impacts of dams: most hydropower building countries, led by China, Brazil and India, refused to accept the recommendations of the WCA, on the grounds that this would slow down their economic development (WCD 2000). The World Bank which had supported the Commission's work from the start, at the end said that it also could not support the recommendations because they could not interfere in the sovereignty of nations. What were the demands of these recommendations? That dam builders consult with the people near where dams were built, and that they be involved in the process of deciding how, where and whether to build them, and to ensure that people's livelihoods were left better than before. These are hardly excessive demands, but most countries refused to do abide by them, and they continue to behave contrary to those 20-year-old recommendations.

THE PROMISES MADE BY DAM BUILDERS

Dam builders have always highlighted a number of promises that dams would help to address: plentiful energy at a low price; increase in good paying jobs locally; provide energy necessary for regional economic development; and improved water quality and sanitation. Most of these promised benefits from dam construction end up as broken promises and the regional economic development is rarely achieved. Let's examine the evidence for each of these promises. The evidence is strong from the experience with Amazon dams built in recent years.



WILSON SOARES / WD PRODUÇÕES

FIG 1 Belo Monte dam in the Xingu Basin of the Amazon. This was the third largest dam in the world at the time it was completed in 2016. It has an installed capacity of 11 GW but many months a year it produces only 4 GW, and in July to November of 2022 it was unable to produce any energy at all due to low water levels. Most of its energy serves distant cities and industries in Southeast Brazil.

Plentiful energy and lower prices for energy seems like a laudable goal and one that countries and local populations support and have reasons to believe would be delivered. Indeed, large scale hydropower dams can produce substantial energy. In the Brazilian Amazon, Belo Monte in the Xingu has an installed capacity of 11 GW, Jirau and Santo Antonio in the Madeira have an installed capacity of over 3 GW each. Earlier Tucurui was designed to produce 8.2 GW, Samuel 216 MW and Balbina 250 MW (the latter two famous for its huge social and environmental impacts, enormous greenhouse gas emissions judged to be greater than a coal power plant and low power generation) and so on (FEARNSIDE 2005). **FIG. 1**

There are two important details that dam boosters forget to mention to civil society when they advocate building these dams: one, that rarely will a dam produce the installed capacity and will actually produce substantially less due to seasonal variation in the amount of water in the reservoir. Even before it was built, specialists had predicted that Belo Monte would be capable of producing no more than 4 GW during several months of the dry season. This turned out to be the case after it was built. And in 2022, which has turned out to be a spectacularly dry year, all turbines had to be turned off in July and have remained off and unable to produce ANY energy at all as late as November. To make the promise even less real, when energy is produced, most of it is sent to distant urban areas and industrial interests, with very little if any of the abundant energy made available to people in the region where it was built. In other words, the promise of plentiful energy and lower prices for energy is not fulfilled. In fact, people in both the Xingu and Madeira regions have seen the price they pay for energy go substantially up after the construction of these three dams. **FIG. 2**

The increase in good paying jobs locally is always trumpeted as a win-win for dam building and who is to disagree. Except it does not happen. Most labor hired to build a large-scale dam are professionals (called *barrageiros* in Brazil) who follow the dam construction companies at all levels of the skill scale. At Belo Monte upwards of 30,000 people were hired to build it. What happens is the hiring of a few hundred local people to satisfy this promise, the rest come from this professional class of itinerant skilled laborers. Sometimes locals are even trained to do the new jobs. But they are rarely kept for long in the payroll and are let go before 90 days

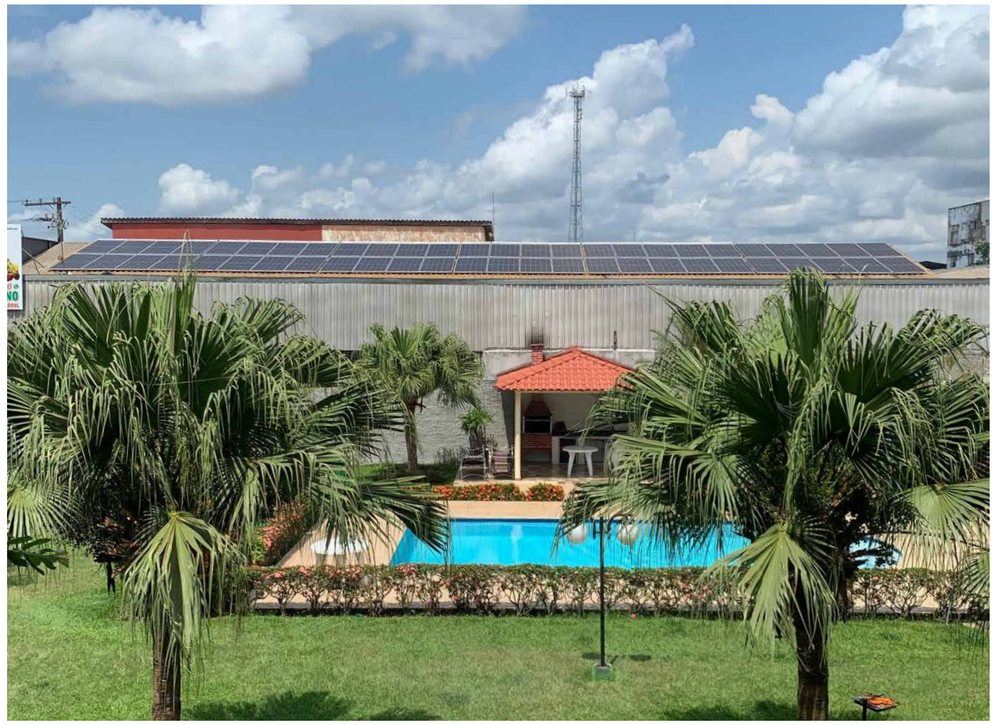


FIG 2 Due to the high prices for energy in Altamira, the city that was the host community for Belo Monte, households and businesses have started installing solar panels. A home with three bedrooms and two baths energy bills used to run up to 1,500 reais per month, after installing solar panels their bills declined to around 100 reais. A growing number of households are installing them, and the government and energy sector instead of providing incentives, will begin charging a 60% penalty to new installers in 2023 in order to discourage this sensible development.

have passed. The professionals are much more used to the 24/7 rhythm of dam construction, with three shifts working a turn, and the work carried out day and night without rest—unless there are demonstrations to bring the work to a stop.

— The promise of energy to drive regional economic development is one of biggest broken promises.

Large-scale dams routinely send most of the power produced to distant energy intensive industries (e.g. bauxite mining, steel production) or large urban areas. This is true for the dams being built in the Amazon, as well as those being built in Congo, where most of the energy of Inga has been promised to mining interests in South Africa. The result is that the region where the dams are built remains without the inexpensive power to power local regional economic development, while other regions thrive.

The promise of improved water quality and improved sanitation is a basic promise and a sensible one. It is even required by law in Brazil when building large scale infrastructure such as dams. Yet, an examination of the process at Belo Monte dam in Brazil, is that many neighborhoods remain without potable water even years after the dam was completed, and the sanitation processing plant was inadequate to handle the waste from the population.

In short, the promises were not kept, and it was a lost opportunity to improve the lives of people in the region where the dams were built (CALVI et al. 2019). Instead, the population did not experience an improvement in their water infrastructure, nor in the availability of cheaper energy, or in good paying jobs. What jobs were made available were relatively few and ephemeral. By year 5 of the construction, most dam-related jobs had disappeared as most employees were dismissed or went to the next big project. What they did get left with was with social ennui, growing criminality from the boomtown period that brought an explosion of drugs and prostitution. There was little effort to prepare for these expectable outcomes which have been documented in the past for other dam and resource-driven booms, such as with fracking.

THE ENVIRONMENTAL DAMAGES RESULTING FROM HYDROPOWER DAMS

Dam boosters like to highlight the benefits of dams (see above) but they rarely mention the environmental damages that result. The literature is full of these consequences, first in the US and Europe, and now in the Global South. Dams stopped being built in the Global North in the mid-70's as the environmental awareness since that time was able to document the negative outcomes for the environment from dams: increasing deforestation; declining fish biodiversity; reduction in sediment flow downstream to maintain river ecology; disappearance of floodplain agriculture; and disappearance of niches where unique river processes took place.

The most immediate impact from the start of construction is increasing deforestation, as vast areas of forest need to have vegetation removed to make room for the construction of the dam itself, and for the areas to be flooded by the reservoir. Even after being completed, the dam continues to have a negative impact on land cover for years thereafter. A recent global study of 601 dams found that within a 50 km radius of a dam there was significantly lower "greenness" or vegetation as measured by AVHRR than in more distant areas, and that this impact was greater the larger the dam was (FAN et al. 2022).

— Given that there are plans to build some 140 additional dams in the Amazon, this is reason enough to reconsider building any more dams, as deforestation is one of the most important things to avoid if we want to reach the Paris Accord goals. Deforestation, too, has a further impact on reducing rainfall to provide the water and precipitation necessary to sustain hydropower production (STICKLER et al.2013; SILVANO et al. 2005).

The impacts on the river and its ecology are particularly notable, and most difficult to reverse. Dams affect both the monetary value of the fisheries, and the biodiversity found in these rivers. It is this fishery that supports the food security of millions of people, and that is threatened by hydropower development. In the Mekong, it is estimated that 60 million fishers would be harmed by the 11 hydropower dams planned that would destroy a fishery valued at 2 billion dollars a year. In the Amazon, the numbers are not so high, or as well documented, but a growing body of research shows that large species with migratory behavior were most negatively affected (WINEMILLER et al. 2016). A recent synthesis of studies in the Madeira river found that fishing income declined by 30% and that yields declined by 31% (ARANTES et al. 2021). The damage comes from blocking the migration of many species who need to spawn annually, and are blocked from doing so, from the warming of the water in reservoir areas which change what fish can sustain themselves in water warmer than their thermal optimum, and from the flooding of areas of forest which are an essential part of the niches for many specialized species. (JUNK et al. 2007; WELCOMME et al. 2010; BAYLEY 1981; SILVANO et al. 2005; MCGRATH et al. 2017)

CONCLUSIONS

In 2014, ANSAR et al. raised the same question we have returned to: should we build any more large dams. The answer then, and the answer now, is a resounding NO. After more than a century of dam building, the evidence is clear that governments and dam builders make promises that they have not kept. Efforts to improve their record over a century, even with mechanisms that tried to provide incentives to improve their behavior towards people and environment, have failed. SCUDDER (2005), one of the oldest scholars accompanying the building of dams and resettlement programs, has concluded more recently that he too thinks it is time to conclude that we should not build more large dams. The industry, through its current booster organization in the IHA, is largely unrepentant and now claims that they can do better, and forcefully has advocated at COP26 that to meet the goals of 1.5 degrees we need to double hydropower production. The governments of countries most actively promoting hydropower expansion, have refused to abide by the modest recommendations of the WCD (2000) to consult with local populations and engage them in the process of development and decision making about dams that affect them. They still largely refuse to consult in any meaningful way (MAYER et al. 2022; GARCIA et al. 2022) and they behave using the autocratic practices that were seen in Kariba and the Aswan dam from the start. Belo Monte and more recently built dams persist in this tradition of poor consultation and broken promises. It is time to say enough is enough, and give other technologies such as biomass, geothermal, solar and wind an opportunity to do better.

NOTES

1 www.energy.gov/eere/water/history-hydropower.

2 U.S. Army Corps of Engineers. 2018 National Inventory of Dams. www.usace.army.mil.

BIBLIOGRAPHY

ANSAR, Aatif et al.
2014 "Should we build more large dams? The actual costs of hydropower megaproject development". *Energy Policy* 69:43-56.

ARANTES, Caroline C.et al.
2021 "Functional Responses of Fisheries to Hydropower Dams in the Amazonian Floodplain of the Maderia River". *Journal of Applied Ecology*. DOI:10.1111/1365-2664.14082.

BAYLEY, Peter.B.
1981 "Fish Yield from the amazon in Brazil: Comparison with African River yields and Management Positbilities". *Trans Amer Fish Soc* 110 (3):351-359.

CALVI, Miquéias. et al.
2019 "The construction of the Belo Monte Dam in the Brazilian Amazon and its consequences on regional rural labor". *Land Use Policy* 90 doi.org/10.1016/j.landusepol.2019.104327.

CHEN, Ji et al.
2016 "Population,water, food, energy and dams". *Renew Sustain Energy Rev* 56: 18-28.

COLSON, Eizabeth
1971 *The Social Consequences of Resettlement*. Manchester: Manchester Univ. Press. 277p.

FAN, Peilei et al.
2022 "Recently constructed hydropower dams were associated with reduced economic production, population, and greenness in nearby areas". *Proceedings of the National Academy of Sciences of the United States (PNAS)*. 119 (8): doi.org/10.1073/pnas.2108038119.

FEARNSIDE, Philip M.
2005 "Brazil's Samuel Dam: lessons for hydroelectric development policy and the environment in Amazonia". *Envir. Manag.* 35 (1): 1-19.

GARCIA, María Alejandra et al.
2022 "Are large scale hydroelectric dams inherently undemocratic? *Global Environmental Change* 71. https://doi.org/10.1016/j.gloenvcha.2021.102395.

JUNK, Wolfgang J. et al.
2007 "Freshwater fishes of the Amazon River basin: their biodiversity, fisheries and habitats". *Aquat. Ecosyst Heal Manag* 10 (2):153-173.

LETURCQeTurcq, Guillaume
2018 *Dams in Brazil: Social and demographic impacts*. Springer Publ. 145p.

MAYER , Adam et al.
2022 "Pretend Participation: Procedural Injustices in the Madeira Hydroelectric Complex". *Global Environmental Change*. Vol. 75. doi.org/10.1016/j.gloenvcha.2022.102524.

MCGRATH, David G. et al.
2017 "Fisheries and the Evolution of Resource Management on the Lower Amazon Floodplain". *Human Ecology* 21(2):167-195.

MORAN, Emilio.F. et al.
2018 "Sustainable hydropower in the 21st century". *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 115(47): doi.org/10.1073/pnas.1809426115.

MORAN, Emilio F. et al.
2022 "Advancing Convergence Research: Renewable Energy Solutions for Off-Grid Communities". *Proceedings of the National Academy of Sciences of the United States (PNAS).*119(49): doi.org/10.1073/pnas.2207754119.

PERERA, Duminda, et al.
2021 "Ageing water storage infrastructure: An emerging global risk". UNU-INWEH Report Series, 11. *United Nations University Institute for Water, Environment and Health*. https://doi.org/10.53328/QSYL1281.

SCUDDER, Thayer
2005 *The Future of Large Dams*. London: Earthscan. 389p.

SILVANO, Renato et al.
2005 "Clean Energy and poor people: ecological impacts of hydroelectric dams on fish and fishermen in the amazon rainforest". *Energy, Environ Ecosyst Deve Landsca Archit* 139-147.

SICKLER, Claudia et al
2013 "Dependence of hydropower energy generation on forests in the Amazon Basin at local and regional scales". *Proceedings of the National Academy of Sciences of the United States (PNAS)* 110 (23):9601-9606.

WCD World Commission on Dams
2000 *Dams and Development: a new framework for decision Making*. London: Earthscan. 408p.

WELCOMME, Robin L. et al.
2010 "Inland Capture Fisheries". *Philoso Trans R. Soc B Biol Sci* 365 (1554): 2881-2896.

WINEMILLER, Kirk O. et al.
2016 "Balancing hydropower and biodiversity in the Amazon, Congo and Mekong". *Science* 351: 128-129.

ZARFL, Christiana et al.
2014 "A global boom in hydropower dam construction". *Aquat Sci* 77(1):161-170.