

POWERING A SUSTAINABLE FUTURE: THE ROLE OF LARGE HYDROPOWER IN SUSTAINABLE DEVELOPMENT

*Patrick McCully and Susanne Wong, International Rivers Network
Prepared for the UN Symposium on Hydropower and Sustainable Development,
Beijing, China, October 27-29, 2004.*

Abstract

One of the greatest global challenges facing the 21st century is how to improve the livelihoods of the two billion people who currently have inadequate or no access to modern energy services, while simultaneously reducing the energy sector's environmental impact. The large hydropower lobby is promoting their technology as a key solution for meeting this challenge. The social, economic and environmental impacts of large hydropower, however, highlight the serious limitations of large hydropower in sustainable energy development. This paper examines the role of large hydropower in sustainable development and suggests principles to ensure cost-effective, environmentally sustainable and socially equitable development of the world's energy resources.

Keywords: hydropower, energy, sustainable development, human rights, biodiversity, indigenous people, environment, World Commission on Dams

1. Introduction

One of the greatest challenges of this century is how to provide energy to and improve the livelihoods of the two billion people who currently have inadequate access to modern energy services. The UN Commission on Sustainable Development has identified access to sustainable energy services as an essential element of sustainable development. Access to adequate, clean energy services is vital in improving the health and overall quality of life of the rural poor and in reducing poverty.

The key question to consider is how to provide energy in a way that is consistent with the goals and principles of sustainable development, ensuring a better quality of life for all people, including future generations. As has been pointed out by the World Commission on Dams (WCD), a global framework for sustainable development has been established with the adoption of the Universal Declaration of Human Rights, Rio Declaration on Environment and Development and the UN Declaration on the Right to Development. Principles of sustainable development of particular relevance to energy provision include: improving the well-being of entire populations, ensuring that development is people-centered, participatory and equitable; integrating environmental concerns into decision-making processes; and taking into account the full range of costs and benefits of development (WCD, 2000).

Proponents argue that large hydropower is a key tool in sustainable development (IHA, *undated*). The poor social, economic and environmental performance of large hydropower, however, shows that the technology can only play a role in sustainable energy development if its planning and management are subject to strict guidelines and criteria, alternatives are fully considered, and projects are implemented through transparent and accountable processes. This paper proposes that hydropower planning and management must be reformed along the lines recommended by the WCD if large hydro is to play a role in the cost-effective, environmentally sustainable and socially equitable development of the world's energy resources.

2. Role of large hydropower in sustainable development

2.1 Providing power to underserved populations

The UN Commission on Sustainable Development has identified access to sustainable energy services as an essential element of sustainable development. The Commission states that to implement the UN's Millennium Development Goal of halving by 2015 the proportion of people living on less than a dollar per day, "access to affordable energy services is a prerequisite."

Currently, two billion people lack adequate access to modern energy services. The majority of this population lives in rural areas either too remote or too poor to support traditional sources of electricity. It is estimated that roughly 6 of every 10 rural dwellers does not have access to electricity (Winrock International, 1998). In sub-Saharan Africa, 80% of the population has no electricity.

The nature of large hydropower – capital-intensive, slow to build, centralized, dependent on large centers of demand and long, expensive and often inefficient transmission lines, means it is particularly inappropriate for meeting the needs of the unserved and rural areas. In many low-income countries, especially in Africa, power ministries, supported by foreign donors, have devoted large proportions of government budgets, aid funds and institutional resources and attention to building and managing large hydropower projects. Meanwhile, distribution networks have been starved of investment. Around 4% of the land area of Ghana is flooded under the world's most extensive reservoir – yet 70% of Ghanaians have no access to electricity. The world's second largest reservoir by volume, Kariba, is shared by Zambia and Zimbabwe. Yet only a fifth of Zambians and a quarter of Zimbabweans have electricity. Paraguay owns half of the world's most powerful hydropower plant, Itaipú, yet almost half of Paraguayans have no electricity.

A more plausible solution to meeting the energy needs of rural populations is the implementation of renewables such as efficient biomass, biogas, wind, solar, and smaller hydropower plants. Building small, geographically dispersed units of capacity close to the end user minimizes transmission costs and power losses and spreads out the local economic development benefits of project construction and access to power. This distributed power enables new capacity to be added incrementally in step with rising demand, and has lower capital investment requirements and is quicker to build than large, centralized projects. It is also important to note that electricity is often not the first priority for meeting local energy needs, and that poverty reduction may in many cases be best achieved through implementation of non-electrical energy options such as improved cooking stoves and wind pumps.

2.2 People-centered development

One of the core principles of the Rio Declaration states that "Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature." The Declaration also states that "All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world." Principle 3 of the Rio Declaration states that "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."

The mass of evidence on the impacts of dams on affected communities demonstrates that large hydropower projects have not been implemented using people-centered development processes. The basic rights, needs and concerns of people affected by dams have not been adequately considered in project development. As a result, dam-affected people have faced severe impacts to their natural resources, livelihoods and well-being, which has in many cases led to their impoverishment. This has jeopardized not only their developmental and environmental needs but also that of their future generations.

According to the WCD, the benefits derived from dams “have been considerable.” Yet “in too many cases an unacceptable and often unnecessary price has been paid to secure these benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment.”

An estimated 40-80 million people have been forcibly evicted from their homes to make way for the world’s 48,000 large dams. While only a minority of the world’s large dams generate electricity, the largest dams which have displaced the most people and had the greatest environmental impact almost always have a hydropower function.

Even where displaced people are resettled onto sites provided by project authorities, they often suffer food insecurity and lack adequate access to water for drinking, household use and irrigation. Alcoholism, depression, domestic violence and disease often increase.

According to the WCD, many displaced people have received no compensation and “where compensation was provided it was often inadequate,” so that “those who were resettled rarely had their livelihoods restored.” Cash compensation is rarely enough to purchase comparable replacement land. When land-for-land compensation is provided, those displaced typically receive smaller amounts of poorer quality land. Unable to subsist on their new plots, farming families frequently end up living as migrant laborers or slum dwellers.

The impacts of dam-building on people living upstream and downstream of dams “have been particularly devastating in Asia, Africa and Latin America, where existing river systems supported local economies and the cultural way of life of a large population containing diverse communities.” Communities have lost access to traditional means of livelihood, including agricultural production, fishing, livestock grazing, fuelwood gathering and collection of forest products (WCD, 2000).

Millions living downstream of dams have suffered impacts from changes in river flow. These impacts include declines in fisheries, poor water quality and disruption of the annual floods which once irrigated and fertilized their fields and recharged their wells. In Africa, the loss of the annual flood has devastated traditional floodplain farming, fishing and grazing along rivers such as the Senegal, Niger, Zambezi, and Volta (McCully, 2001).

The World Bank’s 1994 resettlement review and the WCD’s findings show a consistent pattern of excluding important groups of people from estimates of project social costs. The numbers of these uncompensated affected groups can be greater than those officially counted as “affected.” The WCD states that many of the complex negative social impacts of dams “are – even today – often not acknowledged or considered in the planning process and may remain unrecognized during project operations.”

Because of their massive costs, huge hydropower projects have entrenched corruption among elites in hydro-dependent countries and in many cases, especially in Latin America, are responsible for a major proportion of these countries’ foreign debt. In all but the largest developing countries, the planning and implementation of large hydropower projects are dominated by foreign consultants and contractors. The low-income majorities in these countries see few if any benefits from large hydropower projects.

2.3 Supporting indigenous people

The Rio Declaration says that states should recognize and duly support the identity, culture and interests of indigenous people. This commitment has rarely been respected by hydropower planners.

Large dams have had serious impacts on the lives, livelihoods, cultures and spiritual existence of indigenous and tribal peoples (WCD, 2000). The impact of dams upon indigenous peoples is especially harmful as most of their communities have already suffered centuries of exploitation and

displacement. The trauma of resettlement is also exacerbated because it severs their strong spiritual ties to their land, disrupts their cultural practices and destroys the natural resources their livelihoods depend on.

The impact of hydropower on indigenous people is highlighted with the Kaptai and Bakun hydropower projects. Construction of the Kaptai dam in Bangladesh displaced 100,000 Chakma people and flooded their cultivable lands. As a result, 40,000 Chakma moved to India. The Chakma never gained citizenship for themselves or their children in India, and subsequent land conflicts have cost 10,000 lives since the project was completed (WCD, 2000). In Malaysia, 10,000 indigenous Kenyah and Kayan people were forcibly relocated for the Bakun hydropower project. Reports indicate that affected people are struggling to survive on resettlement sites, where unemployment and hunger are prevalent (Coalition of Concerned NGOs on Bakun, 1999).

Indigenous and tribal peoples have suffered disproportionately from dams in terms not just of the seriousness of the impacts, but also the proportion of indigenous and tribal people affected compared to their percentage within national populations. In India, 40-50% of all those who have been displaced by dams are *adivasis* or tribals, who represent just 8% of the Indian population. Almost all the larger dam schemes built and proposed in the Philippines are on the ancestral lands of the country's 6-7 million indigenous people (WCD, 2000).

2.4 Integrating environmental concerns

Environmental protection is one of the key principles of sustainable development, with the recognition that serious or irreversible damage to the environment threatens the health and economic well-being of communities around the world. The Rio Declaration states that environmental protection “shall constitute an integral part of the development process” and that “States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem.” The declaration also states that the precautionary approach should be widely applied.

Instead of taking a precautionary approach to development, hydropower planners and developers have built projects which have caused severe and irreversible impacts on ecosystems. The WCD found that dams have had “complex, varied and often profound” impacts on ecosystems worldwide. An estimated 60% of the length of the world's large river systems are highly or moderately fragmented by dams, inter-basin transfers and water withdrawals for irrigation. This massive alteration of the world's riverine habitats has led to the irreversible loss of species populations and ecosystems. Up to 35% of freshwater fishes are estimated to be extinct, endangered or vulnerable. A significant but unknown share of shellfish, amphibians, plants and birds that depend on freshwater habitats are also at risk (WCD, 2000).

Reservoirs flood forests and other terrestrial and riverine ecosystems including irreplaceable habitats for endangered species. Dams “alter the natural distribution and timing of streamflow” thus compromising “the dynamic aspects of rivers that are fundamental to maintaining the character of aquatic ecosystems;” block sediment flows, leading to the erosion of downstream river channels and coastlines; block species' migrations; and reduce the productivity of downstream riparian areas, floodplains and deltas (WCD, 2000).

In Brazil, the 1,815 MW-Porto Primavera hydropower project blocked fish migration and diminished upstream fish catch by 80%, affecting the livelihoods of 700 fishing families (Kudlavicz, *undated*). Before construction of the Pak Mun Dam in Thailand, the Mun River was considered one of the most fertile fishing grounds in Southeast Asia (*The Nation*, 2000). After project completion, 169 out of 265 species of fish in the river were negatively affected. Of these, 56 species completely disappeared. The WCD estimated that fish catches in the reservoir and upstream of the dam declined by 60-80 percent after the dam was built, resulting in losses to villagers of about \$1.4 million per year. The

Commission also confirmed that the fish ladder "has not been performing and is not allowing upstream fish migration" (Amornsakchai *et al.*, 2000).

Reservoirs in the tropics can emit significant quantities of greenhouse gases, especially methane. Emissions from large reservoir-based tropical hydropower schemes can be greater than those from gas-fired plants with a similar output (McCully, 2002).

Dam proponents argue that the environmental impacts of dams can be mitigated. Past experience, however, shows that mitigation efforts have largely failed. It is often too expensive, too difficult or simply impossible to recreate the characteristics of wild rivers and the web of life they support. The WCD noted that

“Efforts to date to counter the ecosystem impacts of large dams have met with limited success owing to the lack of attention to anticipating and avoiding impacts, the poor quality and uncertainty of predictions, the difficulty of coping with all impacts, and the only partial implementation and success of mitigation measures” (WCD, 2000).

One of the starkest examples of the difficulties with mitigation is the effort to restore fisheries in the western United States. Since 1996, the US government has spent about \$435 million annually to mitigate the impacts of dams on fisheries in the Columbia River basin. These efforts have relied on water releases, hatchery programs, and collection and transport of salmon around the dams. Despite this enormous expense, many of the wild salmon stocks in the region are either extinct or on the brink of extinction (Ortolano *et al.*, 2000).

2.5 Taking account of costs and benefits

Sustainable development requires that policies and decisions are taken based on the comparison of the full range of relevant costs and benefits and on careful analysis that will strengthen environmental protection, protect cultures and consider the needs of future generations (WCD, 2000; World Bank, 1992; UK Government, 1999). Studies by the World Bank and World Commission on Dams indicate that the costs and benefits of hydropower projects have not been adequately assessed and that projects have often not met their expected cost, performance or economic targets.

While the operating costs of large hydropower dams are low compared to fossil fuel plants, their construction costs are extremely high, running into the billions of dollars for major projects. Studies have also shown that hydropower projects are unusually prone to cost overruns. World Bank research published in 1996 found that inflation-adjusted cost overruns on 66 hydropower projects funded by the Bank since the 1960s averaged 27%. This compared with average cost overruns on World Bank thermal power projects of 6% and on a sample of over 2,000 development projects of all types of 11% (Bacon *et al.*, 1996).¹

Multipurpose projects, many of which include hydropower components, appear to have even greater overruns than single purpose hydropower projects: the World Commission on Dams found an average overrun of 63% on 45 multipurpose large dams studied. There is little indication that the industry's ability to estimate construction costs is getting any better – the most recent of the dams studied in detail by the WCD, Thailand's Pak Mun large hydropower project commissioned in 1994, had a 68% overrun.

In terms of economic returns, the WCD found that hydropower projects often fail to deliver their expected benefits. The WCD analyzed project evaluation reports carried out by the multilateral development banks. Of 20 large hydropower dams evaluated, 11 failed to meet their economic targets.

¹ Average overruns would have exceeded 27% if four “outlier” dam projects with exceptionally large overruns had been included. See also WCD (2000).

Nine of the 20 had an economic internal rate of return (EIRR) under 10%. Infrastructure projects in developing countries are usually only judged acceptable if they have an EIRR exceeding 10-12%.

While the costs of hydropower projects have been broadly underestimated, the power generation benefits of hydropower projects have been overstated. Of the 63 large dams with a hydropower component reviewed by the WCD, 35 generated less power than predicted. Of the dams that met their generation targets, a quarter were only able to do so at the cost of increasing their originally planned installed capacity.² Part of the reason for the overestimates of hydropower generation is the lack of scientific certainty regarding hydrology and sedimentation rates, and the tendency of project planners to exaggerate the reliability of future streamflow and underestimate the impact of sedimentation.

Many countries have heavily invested in hydropower projects on the basis of overly optimistic projections and been subject to energy shortages when drought strikes. Worldwide, large hydropower contributes at least 20% of generation in 91 countries and more than half of total electricity supply in 63 countries. Almost all of these 63 countries are in the global South and ex-Soviet Union. Many of these overly hydropower-dependent countries, including Albania, Brazil, Ghana, Norway, Sri Lanka, Tajikistan and Vietnam, have suffered serious power shortages due to droughts (IRN, 2003).

In June 2004, the World Bank issued a \$43.8 million credit to help Tanzania implement emergency measures to avert a prolonged power shortage due to an extended drought that has affected the country's predominantly hydropower system. World Bank staff speculated that the shortage "could result in a severe contraction of economic activity and services estimated at about 6 percent of Tanzania's GDP" (World Bank, 2004). Due to water shortages on the Yellow River, the Huangheyuan hydropower station in China's Qinghai Province was suspended this year after only three years of operation.

Global climate change is greatly increasing rainfall variability and unpredictability, making hydropower production more undependable. Countries that are heavily dependent on hydropower must diversify their energy sources if they are to reduce their vulnerability to climate change.

World Bank and WCD reports show that social costs are not adequately considered in development planning processes. This contravenes an important sustainable development principle stating that the social and environmental costs of development must be internalized. Studies indicate that the numbers of people requiring resettlement or compensation for lost lands, homes, jobs and sources of livelihood have been regularly underestimated. An internal World Bank review, published in 1994, looked at a group of projects that according to planning documents would cause the displacement of 1.34 million people (63% of them by dams). The review estimated that the actual number evicted was almost two million (World Bank, 1994).

3. Moving towards a brighter future

Globally, large hydropower projects have inflicted severe and sometimes irreversible harm to ecosystems and negatively impacted affected communities, compromising the welfare of future generations. While considerable resources have been invested in hydropower projects, they have often exceeded cost estimates and failed to deliver expected generation benefits. Many hydro-dependent countries have suffered from power shortages and blackouts when drought strikes – a situation likely to worsen with a changing climate. Concentrating investments in large, centralized hydropower projects will likely slow efforts to provide for the needs of the 2 billion people who currently lack adequate access to energy services.

These considerations raise serious questions regarding the role of large hydropower in sustainable development. Based on this information, some would argue that hydropower should be excluded

² The WCD's figures are likely to give a conservative estimate of dam underperformance as the majority of data used in its analyses came from dam operators and were not independently verified.

entirely from future energy development. However, a more constructive way forward is to change development processes that have allowed the unsustainable development of hydropower. The leading tool for ensuring sustainable energy development is the report of the WCD. The WCD recognized the serious impacts and limitations of dam development and proposed a new framework for energy and water development based on respect for human rights. This framework is based on the main pillars of sustainable development, including the Universal Declaration of Human Rights, Rio Declaration on Environment and Development and the UN Declaration on the Right to Development. The Commission's recommendations were grounded in the core values of equity, efficiency, participatory decision-making, sustainability and accountability.

The report states:

“the end of any dam project must be the sustainable improvement of human welfare. This means a significant advance of human development on a basis that is economically viable, socially equitable, and environmentally sustainable. If a large dam is the best way to achieve this goal it deserves our support. Where other options offer better solutions we should favour them over large dams.”

Complying with the WCD is a process, not just a simple checklist. The process is a people-centered approach based on the principles of recognizing the rights and risks faced by different groups of stakeholders, and negotiating their consent at all key stages of the decision-making process. The process starts by reaching agreement on the societal needs for energy and water development, and then on the best means for meeting those needs (with priority given to improving the effectiveness of existing infrastructure).

The WCD sets principles and guidelines for doing project impact assessments and feasibility studies independently, transparently and competently. It recommends a full accounting of costs and benefits, raising environmental and social criteria to an equal level with economic ones. It also recommends using the precautionary approach and respecting the needs of riverine ecosystems for water in sufficient amounts at the right times. In addition, those affected should be among the first to benefit from projects, and outstanding claims for damages caused by past projects should be resolved before constructing new dams.

While the WCD does not propose any single metric for deciding upon the “sustainability” of a project, its whole approach is “grounded in the accepted international norms of sustainable and equitable human development...” (WCD, 2000). The WCD approach assumes that the stakeholder forum established to oversee project choice and implementation will, with guidance from the policy principles and guidelines recommended by the Commission, choose the best option – which is assumed to be the most sustainable option.

3.1 Support for WCD's recommendations

Many involved in promoting, building and managing dams have been hostile to the WCD report. This is hardly surprising: adopting the WCD's recommendations will result in screening out many unsustainable hydropower projects and fewer large dams will be built. But many governments, companies and international agencies as well as a large number of civil society organizations around the world have accepted that the WCD recommendations represents the international best practices standard for energy and water planning.

The WCD recommendations are mentioned in the environmental and dam-related guidelines of the German, Swiss, and French Export Credit Agencies. The Overseas Private Investment Corporation of the US has incorporated key language from the WCD report into its environmental guidelines. A 2003 review by German technical assistance agency GTZ concluded “there is unanimous consent that the WCD recommendations provided welcome and useful input for the reform process of ECAs.

Moreover, at this point it seems almost impossible for ECAs to ignore the WCD recommendations when considering support for large dam projects.”

The strongest support for the WCD at the national level has come from Germany. GTZ are providing assistance in establishing policy and institutional frameworks for implementation of WCD. German development bank KfW says that “in processing any dam-building project KfW follows the rule of verifying its compatibility with the WCD recommendations.”

The German environment ministry has issued a policy stating that the German government will only buy Clean Development Mechanism (CDM) carbon credits from hydropower projects that comply with the WCD. The Dutch government has made a similar commitment for its carbon credit purchases. The European Union as a whole agreed in April 2004 that CDM credits from large hydropower projects that do not respect WCD “criteria and guidelines” will not be able to enter the new European Trading System for carbon emissions.

In addition, the UN Environment Program has set up a Dams and Development Project (DDP) to promote discussions on the policy implications of the WCD Report at national, regional and basin levels between governments, civil society and the private sector. A number of Southern governments are taking part in multi-stakeholder dialogues facilitated by the DDP, most promisingly in South Africa. Unfortunately these dialogues have too often been stalled or slowed down by foot-dragging and stonewalling from vested interests in national pro-dam lobbies.

4. Conclusion

Some question whether the WCD recommendations will prevent unsustainable hydropower projects from being built. If followed in good faith, the WCD recommendations will likely prevent such projects. There is no clearly agreed definition of what “sustainable hydropower” actually is, but a reasonable definition would be “a project that passes through a WCD-compliant process.”

Critics have raised concerns about the difficulty of implementing the WCD’s recommendations. And there is valid reason for concern. Decision-making processes that attempt to reconcile competing interests will always be difficult. But the WCD’s recommendations constitute by far the best decision-making framework currently available to avoid the hydropower mistakes of the past. If it is applied, it holds the promise of a huge leap forward toward sustainability in energy and water management.

References

- [1] Amornsakchai, S., et al. 2000. *Pak Mun Dam, Mekong River Basin, Thailand*. Case study prepared as an input to the World Commission on Dams, Cape Town, www.dams.org.
- [2] Bacon, R.W, et al. “Estimating Construction Costs and Schedules,” World Bank Technical Paper No. 325, p. 29, 1996.
- [3] Coalition of Concerned NGOs on Bakun. 1999. *Empty Promises, Damned Lives: Final Report of the Fact Finding Mission 7th-14th May 1999*. Kuala Lumpur.
- [4] International Hydropower Association. “Hydropower: A Key Tool for Sustainable Development,” <http://www.hydropower.org/Downloads/Hydro-Development.pdf>
- [5] International Rivers Network, et al. 2003. “Twelve Reasons to Exclude Large Hydro from Renewables Initiatives.”
- [6] Kudlavicz, M. “Porto Primavera Dam in Rio Parana,” Submission to the World Commission on Dams.
- [7] McCully, P. June 2002. “Flooding the Land, Warming the Earth: Greenhouse Gas Emissions from Dams,” International Rivers Network, Berkeley.

- [8] McCully, P. 2001. *Silenced Rivers: The Ecology and Politics of Large Dams*. Zed Books Ltd., London.
- [9] Ortolano, L., Kao Cushing, K., and Contributing Authors. 2000. *Grand Coulee Dam and the Columbia Basin Project, USA*. Case study prepared as input to the World Commission on Dams, p. 3.5-19.
- [10] "The Pak Mool dam is worse than useless," *The Nation*, May 15, 2000.
- [11] UK Government. May 1999. *A Better Quality of Life: A Strategy for Sustainable Development for the UK*, London, The Stationery Office, Chapter 4.
- [12] Winrock International, July 1998. "Electricity on Demand: Reaching Two Billion Cheaply With Renewable Energy," http://www.winrock.org/REEP/PDF_Pubs/finalrep.pdf.
- [13] World Bank. "Tanzania Obtains Credit For Emergency Power Supply," press release, June 8, 2004.
- [14] World Bank, 1994. *Resettlement and Development: The Bankwide Review of Projects involving Involuntary Resettlement*. Environment Department, Washington, DC.
- [15] World Bank. 1992. *World Development Report, 1992: Development and the Environment*. New York, Oxford University Press.
- [16] World Commission on Dams. 2000. *Dams and Development: A New Framework for Decision-Making*. Earthscan Publications Ltd., London.