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And The Walls Came Tumbling Down

Dam Safety Concerns Grow in Wake of Failures, Changing Climate

by Patrick McCully

It has been a bad year for dam safety. In February, five dams in Pakistan burst after torrential rains swelled local rivers. The biggest of these – the 35-meter Shadikor Dam – killed at least 80 people, injured many more and left 4,000 families homeless. The Shadikor Dam was only two years old. It appears that no warnings were given to people downstream.

Two months later, at least 62 people died in a dam-created flash flood on the Narmada River in India. Again, there was no warning. The banks of the river were crowded with Hindu pilgrims a day ahead of the new moon, a period when many bathe in the holy river to wash away their sins. The tragedy occurred after the gates of the Indira Sagar Dam, about 60 miles upstream, were opened without warning. The dam operator, the Narmada Hydroelectric Development Corporation, denied responsibility, saying the releases were standard practice, and that state officials should have informed them about the festival.

In March, heavy rains caused the Bande Sultan Dam in southeastern Afghanistan to burst, killing an unknown number of people. The governor of the province said that thousands of hectares of land were flooded and hundreds of shops destroyed.

Last August, India had to shut down the World Bank-funded Nathpa Jhakri Dam for a second time just months after it began operation. Operators feared that upstream flooding would overtop the dam. Construction on the 60-meter-high dam had been seriously delayed by rockslides in the project area before construction started, and later, by flash floods.

Two months earlier, a dam break in Brazil's northeastern state of Paraíba killed five people and destroyed hundreds of homes. Paraíba's current governor claimed his predecessor had rushed the Camará project to completion for electoral reasons,

despite known construction problems.

So are dams getting inherently less safe?

Yes and no. Certainly, dam-construction techniques have improved over the past 50 years.

According to a survey by the International Commission on Large Dams (ICOLD), around 2.2% of all dams built before 1950 had failed by 1995, but only 0.5% of dams built between 1950 and 1995 failed. (The picture is less sanguine in China, where some 3,200 dams have failed since 1950 – 4% of the 80,000 classified dams in the country).

Of the 300 behemoth projects defined by the industry as “major” dams, almost all of which have been built since 1950, only Vaiont in Italy has so far caused a major disaster. A couple of known near misses, however, shows that major dams, some of which have the potential to kill hundreds of thousands, even millions, of people, can in no way be considered as inherently safe (see box, page 9). As author Jacques Leslie puts it, “Dams are loaded weapons aimed down rivers, pointed at ourselves; they're proof of the gambling nature of the societies that build them.”

While individual dams built today are likely to be much more secure than dams built 50 years ago, the global stock of dams as a whole is ageing, and as dams get old they become increasingly more expensive to maintain. Around the world, 5,000 large dams are at least 50 years old; the average US dam is in its forties.



The Teton Dam fails. (1976)

The American Society of Civil Engineers reported in March that there are around 2,600 “unsafe” dams in US. These are dams with “deficiencies that leave them highly susceptible to failure.” This represents a 23% increase since 2001. According to preliminary results of a study by the Association of State Dam Safety Officials, the total investment to bring US dams into safety compliance or remove those that are no longer needed tops \$30 billion.

The lack of investment in maintaining or removing unsafe dams in the US means that numerous small dams are washed away in floods every year. New Jersey alone lost three dams during Tropical Storm Floyd in September 1999, four in a flood in the following August, and 12 during an unprecedented summer deluge in 2004.

Worldwide, as in the US, there is systematic underfunding of dam maintenance. No figures are available for the cost of making the world's dams safe. But if securing US dams would cost \$30 billion and the US has an estimated 10% of the world's dams, a ballpark figure for the global under-investment in dam safety would be \$300 billion.

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It's Extreme Not to Be Green

The recently released Millennium Ecosystem Assessment, a UN-sponsored analysis of the overall health of the planet, reveals the extent to which humanity's destruction of the natural world is threatening our ability to thrive on the planet. The report – the largest-ever assessment of environmental changes and their impacts on human well-being – reveals the rapid and accelerating degradation to ecosystems that are essential to life on Earth.

Freshwater ecosystems are in particularly precarious shape. For example, the assessment found that wetlands provide services to humanity valued as high as \$15 trillion annually, including the water supply on which up to three billion people depend. Yet current human practices are degrading and destroying these wetlands at a faster rate than any other type of ecosystem. And channelized rivers, the report notes, are more apt to result in extreme flood damage; more than 100,000 people were killed by floods in the 1990s, with damages totaling \$243 billion.

Large dams have probably done more harm to freshwater ecosystems than any other human intervention. The Millennium Assessment notes that the amount of water impounded behind dams has quadrupled since 1960, and that six times more water is held in reservoirs than flows in natural rivers.

Not only are a degraded environment and declining water resources health issues, but they are also increasing the gap between rich and poor. The assessment notes that levels of poverty remain high and inequalities are growing: over one billion people survive on less than \$1 a day, and up to two billion are affected by water scarcity. Some 1.8 million people die annually due to inadequate sanitation or water supply.

The assessment states that: "Any progress achieved in addressing the goals of poverty and hunger eradication, improved health and environmental protection is unlikely to be sustained if most of the ecosystem services on which humanity relies continue to be degraded." It calls for "radical changes in the way nature is treated at every level of decision-making and new ways of cooperation between government, business and civil society."

Noteworthy efforts have been made to improve the quality of development projects – for example, the guidelines devised by the World Commission on Dams. The WCD's transparent and participatory approach to decision-making would help steer investment away from large dam-and-canal irrigation schemes toward approaches that help the poor be masters of their own development while reducing the environmental impacts of water and energy consumption. It would raise public awareness of the advantages of decentralized options and force developers to take responsibility for the costs of adequately assessing, mitigating and compensating for the negative impacts of large dams.

Yet the widely acclaimed WCD report was deemed too extreme by many in the powerful dam lobby. Today, after a decade during which big-dam building has been in steady decline, the World Bank, numerous developing-country governments and the dam industry are pushing for a revitalization of large dam construction, and the sidelining of the WCD report. This is truly an extreme reaction. Returning to the bad old days of big dams (and other "business as usual" approaches to human development) will worsen our ecological tailspin, the social ills of developing countries, and the gap between haves and have-nots.

The dam industry is not alone in resisting "radical change." Those now entrenched in promoting a business-as-usual approach – the oil, auto, and timber industries, to name just a few – will fight calls to find new ways of doing business and bringing development to poorer countries without destroying the environment. These entrenched defenders of the status quo can be expected to keep up their fight to keep the environmental movement marginalized, "too extreme" to accommodate human progress.

Most of us who toil in the "green trenches" have been labeled extreme at one time or another, often just for holding an opinion that differs from that of the powers-that-be. The efforts to label NGOs as extremist have greatly intensified in the current political climate.

What the Millennium Assessment shows is that fighting against environmental protection and for the development status quo is the extreme position. If the international community is to reduce both poverty and environmental degradation, we need tools to discourage business-as-usual approaches to development and to promote innovative, pro-poor and pro-environment schemes.

It is time to turn the tables on what is labeled radical and what is considered mainstream. Those who refuse to heed the recommendations of forward-looking bodies such as the WCD and the Millennium Ecosystem Assessment are the true extremists, and they should be sidelined.

Lori Pottinger

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Bujagali Dam Takes a Step Forward

by Lori Pottinger

The Ugandan government announced in April that it has selected the Aga Khan's Industrial Promotion Services (IPS) to build Bujagali Dam, a large hydro project proposed for the Nile near Lake Victoria. The energy ministry said construction work could begin next year, and is expected to take three to four years.

The Aga Khan IPS is part of a larger foundation, based in Switzerland, which focuses on development projects in poorer nations. It was one of the three firms short-listed by the government last year to bid on the project after the original developer, the US-based AES Corp., pulled out in 2003. The controversial project had been shelved since 2002, when a corruption investigation of a project partner was launched.

The energy ministry now says that construction of Bujagali will cost about US\$400 million, down from the approximately \$580 million contract arranged between the World Bank and AES. The project's costs as proposed by AES were found to be excessive

in an analysis by independent energy economists. In addition, under the terms of the original contract, Ugandan taxpayers could have been saddled with paying high fees to the company even when drought significantly reduced the dam's output.

Local groups working on Bujagali have questions about the new reduced cost, resettlement, impacts on cultural resources and many other issues. They have been pressing the government for more transparency and "equal opportunity" civil-society participation in the planning process. A public statement signed by 83 participants at



Bujagali Falls.

Photo: Patrick McCully

an NGO-sponsored public meeting on the dam project says, "The government should ensure that pertinent information on the project is available to [civil society groups]; this will enable them to participate from the point of knowledge ... Civil society is ready to work in partnership with government to ensure that such participatory consultative meetings are successful."

Uganda's Rural Electrification Needs Are Great

Uganda has very low rates of electrification in general, but rural areas (where the majority of Ugandans live) are worse off than urban areas, and large hydro projects like Bujagali will not bring electricity to rural areas. According to the energy ministry, only 3% of households in rural areas have access to electricity. The Executive Director of the Rural Electrification Agency, Godfrey Turyahikayo, recently called on the government to take stronger action to promote rural electrification to reduce poverty in rural areas. Turyahikayo said the government has neglected the issue and provided inadequate financing for projects.

Currently, a total of 15 rural electrification projects with a combined capacity of 100 megawatts are in the pipeline in Uganda. Government recently stated that it would begin heavily subsidizing rural electrification projects, according to local media. The source of the funds is a World Bank rural electrification project.

A 2004 report by the Kenyan group African Energy Policy Research Network (AFREPREN) says the privatization of Uganda's electricity sector shares at least some of the blame for the slow pace of rural electrification in Uganda. The group notes that rural electrification was a low priority in power sector reform measures undertaken by Uganda in recent years. "Reforms appear to have failed to link rural electrification to the overall objective of improving the performance of the power sector," according to AFREPREN. "For example, the issue of licenses and concessions is not explicitly linked to the ability of the concessionaire to increase electricity access among the poor."

The AFREPREN report notes that "Uganda's rural electrification target is a paltry 10% by the year 2012. This is an extremely low target and unlikely to make a substantial difference. Data from other African countries (notably, Ghana, South Africa and Zimbabwe) demonstrate that for the same period of time, it is possible to achieve much higher levels of electrification."

The AFREPREN report is available at http://www.afrepren.org/Pubs/WorkingPapers/wpp317_sum.htm

Better Options

The civil society groups also called for the development of alternative energy sources before Bujagali. "The government ... should seriously and immediately consider developing hydroelectric power from other cost-effective sites such as Ayago and Karuma, and should explore and invest in alternative energy sources such as geothermal, solar, biogas, as well as smaller dams," their statement urges. Because so few Ugandans can actually afford grid-based electricity, they add, "Government should also take deliberate steps to develop the country's abundant but dwindling fuel wood energy resources for the majority poor."

The 30-meter-high Bujagali Dam would have serious environmental impacts. The cumulative impacts of Bujagali along with two existing upstream dams is expected to be significant, but the government and project backers have thus far refused to do a cumulative-impacts analysis before undertaking the project. (The World Bank, when it was involved, said such an analysis would be undertaken later, as part of the regional planning efforts for the Nile known as the

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World Bank Approves Nam Theun 2 Dam

Project's Economic Viability Remains in Doubt

by Aviva Imhof

On March 31, the World Bank Board of Directors voted to approve up to \$270 million in grants and guarantees for the controversial Nam Theun 2 Hydropower Project in Laos. Four days later, the Asian Development Bank also approved a package of loans and guarantees for the project. The decision came as a blow to IRN and our partners, who had been working for more than a decade to stop the project.

Shannon Lawrence, of the Washington, DC-based group Environmental Defense, said, "The approval of Nam Theun 2 sets a dangerous precedent for the World Bank, which is preparing to step up its support for high-risk dam projects. The project does not comply with the World Commission on Dams recommendations, nor has the Bank made any real efforts to bring it into compliance. This is a travesty for an institution which claims to support the core values and strategic priorities of the WCD."

While the dam will go forward, IRN and our partners can draw some comfort from the fact that the project is significantly better than if international NGOs had not been involved. (Laos does not have a viable local civil society movement, and affected communities cannot speak out on controversial developments.) Until a couple of years ago, for example, project developers claimed that there would be "more water and therefore

more fish" along the Xe Bang Fai River, and that as a result, people would be better off. But today, due to NGO efforts, project proponents recognize that Xe Bang Fai communities will be negatively affected by the project due to losses of fisheries and other impacts and therefore deserve compensation for their losses. The company has allocated \$15 million in mitigation and compensation for affected communities.

In addition, the company formerly claimed that no families living along downstream tributaries of the Theun River would be affected by the project, but the latest draft of the Social Development Plan acknowledges that at least 1,600 families living downstream will be affected due to fisheries losses, and deserve compensation for their losses. This issue, too, was first raised by NGOs.



Photo: Alongkot Chukrew

Nam Theun 2 will flood the habitat and breeding grounds for one of the last remaining populations of wild elephants in Laos. Asian elephants are globally endangered.

FAST FACTS

Nam Theun 2 Hydropower Project, Laos

Project Description

The 48-meter high Nam Theun 2 Dam will be located on the Theun River, a major tributary of the Mekong. Water will be stored in a reservoir on the Nakai Plateau and diverted down a huge escarpment to a powerhouse, before being released into another Mekong tributary, the Xe Bang Fai. The project is being developed by the Nam Theun 2 Power Company, which includes Electricité de France as the lead investor, two Thai companies and the Lao government.

Purpose

The project is supposed to generate revenue for the cash-strapped Lao government

by exporting power to neighboring Thailand.

Affected people

Around 6,200 indigenous people living on the Nakai Plateau will be resettled to the edge of the reservoir. The project will negatively affect more than 100,000 people living downstream of the project along the Xe Bang Fai, Nam Phit and Theun Rivers.

Schedule

A host of international financial institutions and private banks have pledged support for the \$1.3 billion project. Construction began in early 2005 and is supposed to be completed by May 2009.

Several of the World Bank Board members insisted upon more stringent monitoring mechanisms for the project and demanded twice-yearly reports on progress in implementing social and environmental management plans. The German government asked the World Bank, Asian Development Bank and Lao government to address outstanding mitigation and compensation issues from the nearby Theun-Hinboun Hydropower Project in a timely manner, and stated that resolution of the issues at Theun-Hinboun are "a precondition for our approval for the projected future Bank funding in this sector in Laos."

Theun-Hinboun, located 50 kilometers downstream of Nam Theun 2, has had a severe impact on the livelihoods of more than 25,000 people in 57 villages downstream and upstream of the dam. These impacts have included declines in fish catches of between 30 and 90 percent; the destruction of vegetable gardens and dry-season drinking water sources; loss of fishing nets; and increased difficulties with transportation. While the company has been implementing a \$5 million mitigation and compensation program for the affected communities, many impacts remain unresolved.

The US government was the only government to abstain from voting for the project at the World Bank Board of Directors, signal-

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ing its disapproval. According to US Treasury spokesperson Tony Fratto, "Our abstention was based on reservations about the outstanding risks related to environmental and social issues, the Lao PDR's macroeconomic conditions, and recourse measures if the NT2 project is not implemented as planned. There are also defects in the environmental assessment process."

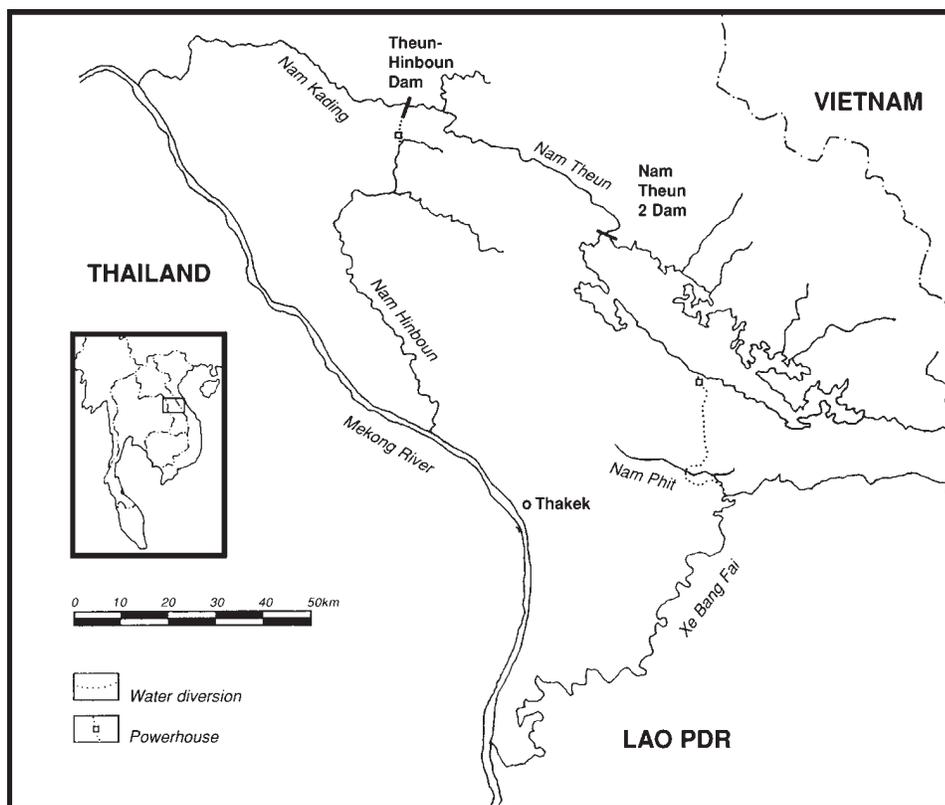
The Best Chance for Laos?

Nam Theun 2 has been heralded by the World Bank as Laos' best chance for development. Upon approval of the project, World Bank President James Wolfensohn said, "To get out of [the] poverty trap, the country has few options to generate income.... We believe that a sound approach to selling hydroelectricity, supported by improved government policies, is the best way for the country to increase the amount of money it can invest in health, education and basic infrastructure for the benefit of the poor."

However, between 2009, when project revenues will come online, and 2020, net revenues for the Government of Laos will total \$20 to \$30 million per year, only 3% of government revenues. Throughout the 25-year concession period ending in 2034, according to the World Bank, "revenues are expected to amount to around 5% of projected [Lao Government] revenues." The revenues from Nam Theun 2 are clearly not sufficient to bankroll the country's development.

More importantly, money is useless unless it's well spent. Repeated World Bank efforts to ensure that the Lao government has an effective system of budget management, adequate administrative capacity, and transparency have largely failed. According to a 2004 International Monetary Fund report, "expenditure management [in Laos] remains weak, undermining the capacity of the government to deliver effective social sector programs." Corruption is another factor that is known to interfere with revenues reaching the poor.

Meanwhile, the project will have serious impacts on the lives and livelihoods of tens of thousands of rural Laotians. Nam Theun 2 will displace 6,200 indigenous people living on the Nakai Plateau and will negatively affect another 100,000 people living downstream of the project along the Xe Bang Fai and Theun Rivers who rely on these rivers for fish, drinking water, and agriculture. About one in fifty Laotians will be affected



by Nam Theun 2. Most of these people are subsistence farmers dependent upon natural resources for their livelihoods.

Cooking the Books

Not only are the benefits to Laos from Nam Theun 2 relatively small, but the project is of questionable economic viability. The World Bank claims that Nam Theun 2 is a good deal for Thai consumers, who will be forced to purchase over 90% of the electricity from the dam for the next 25 years. But the economic analyses for the project, which were released just a week before the World Bank Board meeting, contain several unjustified assumptions that systematically favor Nam Theun 2 over other options.

Two Thai economists and a power-sector analyst reviewed the economic analyses for Nam Theun 2. Their findings were startling. According to the reviewers, World Bank consultants working on the economic analyses were faced with escalating project costs, straining earlier claims of Nam Theun 2's economic viability. As a result, the consultants fudged values of key variables in order to make the project appear economically favor-

able in comparison with its main competitor, natural gas fired turbines.

Dr. Chris Greacen, one of the reviewers, said, "Our analysis identifies a number of erroneous assumptions that account for much of Nam Theun 2's claimed economic benefit. In the most glaring example, authors of the report made a 10-fold to 12-fold increase, with no explanation, in operations and maintenance costs for gas turbines. The impact of this change was worth \$99 to \$111 million of Nam Theun 2's claimed economic benefit of \$188 million. If, as it appears, the consultants cooked the books in order to justify subsidizing this white elephant, then it is a tragedy for the people of the Mekong region."

According to Dr. Greacen and colleagues, the World Bank economic analysis also severely undervalued the loss of electricity from the Theun-Hinboun Hydropower Project, which is located about 40 km downstream from the NT2 site and which will produce less power as a result of water diversions for NT2. Each unit of electricity from Theun-Hinboun was valued at less than one-third the value of electricity from NT2.

The World Bank also used a Power Development Plan (PDP) for Thailand that was out of date and was never adopted by the Thai government. This "NT2 PDP" allowed the World Bank to claim that Thailand would need the power from Nam Theun 2 by 2010, when it is due to come on-line. They did this

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What is IRN Doing?

IRN will monitor implementation of the project and will work to ensure that the developers, the World Bank and the Asian Development Bank uphold their commitments to the affected people.

A World of Hurt

New Research Reveals Massive Impacts of Damming on World's Large Rivers

The extent to which dams affect the world's large river systems is the focus of a major new study by a research team from the Landscape Ecology Group at Umeå University, Sweden. The rivers studied drain 54% of the world's land area and carry 60% of the planet's river-water. The researchers found that of 292 large river systems, 172 are affected by dams. WRR interviewed the researchers – Mats Dynesius and Christer Nilsson and Cathy Reidy – to discuss the significance of their findings.

Q: Your research reveals that more than half of the world's large rivers are fragmented and regulated by dams. Can you sum up the significance of these findings?

A: The damming of great rivers is among the most dramatic, deliberate impacts that humans have had on the natural environment. Most big river systems, including the 20 largest and eight of the most biologically diverse, now have dams on them. Damming has been particularly hard on specific biomes*: for example, most large river basins in deserts (82%) and in Mediterranean-type ecosystems (99%) are impacted by dams. If you consider that 83% of the discharge of the 292 large rivers studied is impacted, and that only minor portions of some biomes include hydrologically untouched river systems, our findings are a call for action. If we want to sustain the world's biodiversity and riverine goods and services, then we need to replace large dam building with alternate solutions. Substitute energy sources include solar and wind, and regional energy needs can be met with smaller reservoirs or run-of-the-river dams. Further action should include removing some of the existing dams in the more heavily impacted parts of the world, and an international attempt to save some of the last wild rivers.

*A biome is a major ecological community type (such as tropical rain forest, grassland or desert)

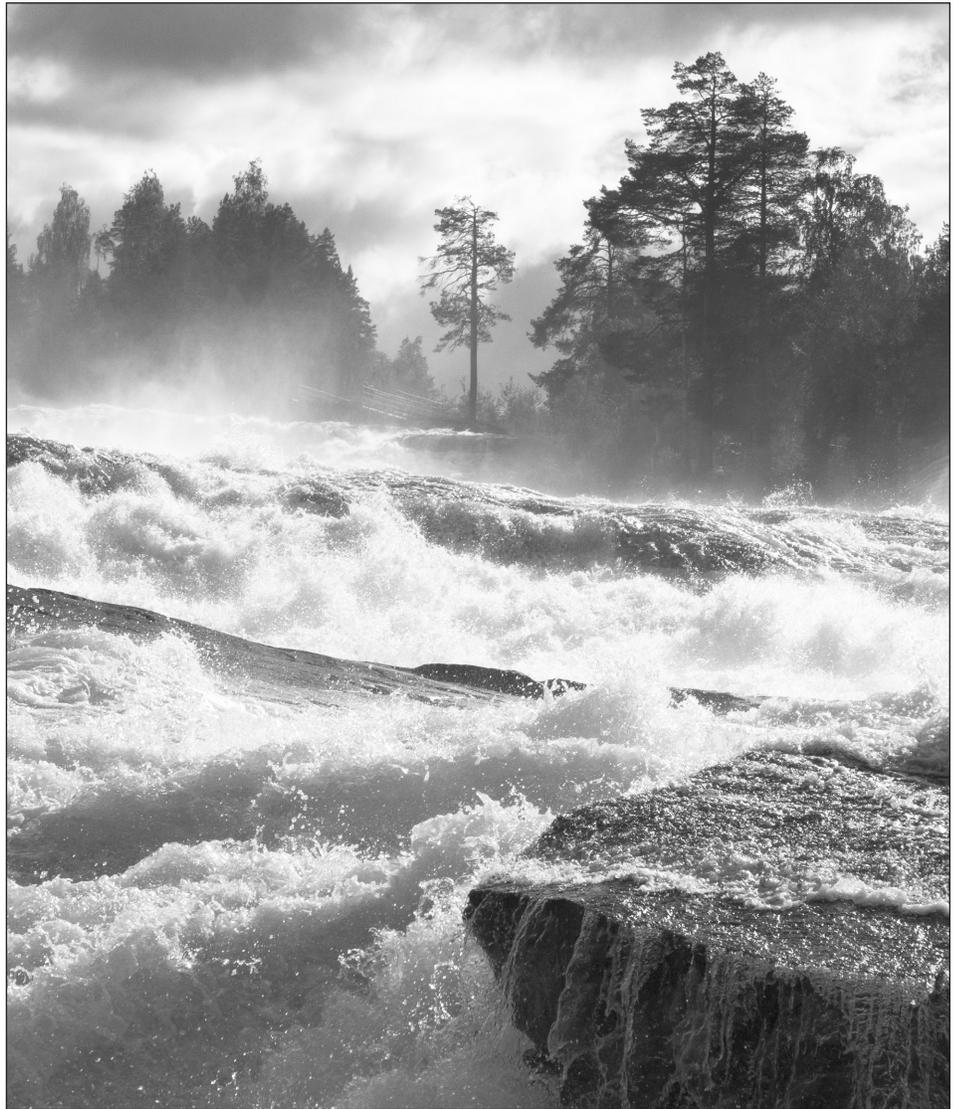


Photo: Roland Jansson

Extensive damming of the world's rivers makes free-flowing rivers like Sweden's Pite even more precious. A 1987 law prevents hydropower projects on Sweden's last four free-flowing rivers, including the Pite.

Q: You found that dams now hold back 15% of the world's annual freshwater runoff. Many rivers have "staircases" of dams that can hold more than their whole annual flow – or more than four years' worth, in the case of Akosombo on the Volta River in West Africa. Sediment, too, is held back behind reservoirs, affecting coastlines around the world. To what extent can "environmental flows" (more natural flows) from existing dams and "artificial floods" help reverse some of the environmental damage done by these two phenomena?

A: The experiments in artificial flooding made so far – for example, in the US's Grand Canyon – suggest that some ecological processes might be restored to varying degrees. For example, sediment redistribution and fish migration will recover partly, and the downstream invasion of exotic species can be held back. However, the effects will vary by flow prescription. There needs to be some regularity of flooding, and some (infrequent) floods need to be larger than the others. Single floods will have only short-term importance. Full recovery (or close to) cannot be achieved unless dams are removed, especially

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cially in cases where rapids are permanently impounded or when most of the water passes underground and only a “minimum flow” is directed through the old river channel.

Q: There are clear “cumulative impacts” of various kinds of environmental degradation – for example, climate change and air pollution may start small, through individual acts, but the effect has become global. Is there a similar cumulative effect on global environmental health from the 45,000 dams now blocking the Earth’s rivers?

A: There are surely cumulative effects, but we do not have quantitative data on this. However, a general example can be seen in the hydrologic alteration of biomes and subsequent disruption of global processes. As a biome’s hydrology becomes totally altered by dams (there are several approaching this state, including temperate forests and savannahs), inducing dramatic changes in land cover and flora and fauna, that biome’s biological and physical role in the planet will change and affect global environmental health. Also, the overall reduction in freshwater and sediment input to the seas may have unexpected consequences. The fact that floods that cause upwelling in seas are heavily restricted by dams is another impact which might have cumulative effects, for example on the nutrient balance of seas.

Q: Do you think the common practice of having a project environmental assessment for large dams is an effective way to assess whether or not a project should be built, based on environmental concerns?

A: It is better than nothing, but not very effective because environmental concerns are difficult to value properly. A big problem is that dams are treated individually, which means that decisions are based on established practice (“we have built similar dams before”) rather than on the fact that very few free-flowing rivers remain, or that

regional and even global ecosystems are declining from the preponderance of dammed rivers. If every individual project would be evaluated at a larger scale where factors such as number of nearby dams, total effects on the actual biome, etc., were included, better decisions could hopefully be made.

Q: Your research shows that the biodiversity supported by free-flowing rivers has a better chance of adapting to climate change than that associated with dammed rivers. Can you explain this? What should this mean for policy makers and water managers in dry countries?

A: Every species has a climatic optimum, so when climate changes, populations will have to redistribute to accommodate to the new conditions. Rivers and riparian corridors are major conduits for dispersal of both aquatic and terrestrial organisms, but when these are blocked by large dams, opportunities for redistribution will be obstructed. For dry countries, the focus needs to be shifted to alternative water harvesting and irrigation methods. For example, two types of water efficiency come immediately to mind that could be replicated: India’s recent successes with small-scale rain-water harvesting, and Israel’s incredibly efficient drip irrigation methods. Integrating these sorts of water management practices at the national level could have dramatic improvements on watershed sustainability.

Q: As your report notes, two of the most-dammed countries in the world – China and India – are planning many more dams for some of their most fragmented rivers. For example, China wants to build 49 more dams on the Yangtze alone, and India hopes to link 37 of its rivers in a vast scheme to move



China wants to dam the now wild Nu (Salween) River.

Photo: Salween Watch

water from one region to another. What do you think it will take to change this picture? What are some next steps that could help decision-makers in developing countries balance the political and economic pressures that lead them to over-develop rivers and instead help preserve healthy rivers as a public good?

A: We are not socio-economists, and even researchers in that field are having a tough time helping developing nations meet their populations’ needs with minimal human and environmental costs. Human populations tend to only consider environmental needs once their own needs are met, and then it might be too late. That said, reducing global population growth – e.g., by means of fighting poverty and improving the status of women – would be the most important step. This would increase the possibilities of sharing resources between humans and nature in a more sustainable way. Another very important step would be to make national efforts to use water resources more efficiently. In dry regions, much could be improved by better balancing irrigation and crop choices (as mentioned above). In regions using rivers mainly for power generation, more efficient use of electricity is critical.

Q: What motivated your team to undertake this study?

A: In the 1980s, there was a very heated debate in Sweden about the last free-flowing rivers. We (Christer Nilsson and Mats Dyrnesius) got involved as researchers because we had information about the natural qualities of these rivers. We were once told by a spokesman for the power industry that we should not be concerned if the last free-flowing rivers in Sweden got impounded, because “in the rest of the world, most rivers are free-flowing.” The skepticism we felt toward this argument triggered the start of the study. ■

For More Information

The team’s report on their findings, “Fragmentation and Flow Regulation of the World’s Large River Systems,” appears in the April 15, 2005 edition of the journal *Science*.

The team says its next step is to investigate how the world’s dams have affected the vulnerability of freshwater fish. For this project, the scientists will investigate extinctions caused by habitat losses. The upcoming research will predict the global distribution of freshwater fish that are threatened by extinction. In addition, the team will attempt to determine the global distribution of river systems that are affected by habitat loss because of dams.

Dam Safety Continued from page 1

The above calculation begs the question of what is a “safe” dam. This question is now virtually impossible to answer because of a new variable in the dam-safety equation: climate change. Engineers design dams and their spillways to cope with the extreme floods that they predict using past records of streamflow and precipitation. It is vital that spillways are adequately sized – if a spillway is overwhelmed there is a high risk of a dam break.

But the assumption that we live in a stable climate no longer holds. Streamflow patterns are changing and are almost certain to continue to change, and at an accelerating rate, over the lifetime of the world’s dams. As noted in a World Commission on Dams’ background paper: “The major implications of climate change for dams and reservoirs are firstly that the future can no longer be assumed to be like the past, and secondly that the future is uncertain.” While the climatic future is indeed filled with uncertainties, one trend upon which climatologists almost universally agree is that we will see (and indeed are already seeing) more extreme storms and floods. And yet, alarmingly, the vast majority of dam proponents and operators deny that climate change is even relevant for dam safety. The president of a major dam engineering firm told this author last year that climate change is “a problem for dams in 20 or 30 years, but not now.”

Another “natural” phenomenon that is expected to pose an increasingly severe risk to dams in high mountain areas is Glacial Lake Outburst Floods (GLOFs). Glacial lakes are formed when rivers are blocked by natural ice dams. Catastrophic flash floods can be caused if these ice dams melt. Global warming is causing a rapid melting of the world’s glaciers and seems to be increasing the number of GLOFs. Dams in Nepal and elsewhere in the Himalayas are at particular risk.

The world’s more than 45,000 existing large dams have not been built to allow for a rapidly intensifying hydrological cycle. In this sense, all dams should now be considered unsafe. The several hundreds of billions of dollars that may be necessary to make existing dams “safe” under our existing climate would likely be dwarfed by the expenditure needed to upgrade the world’s stock of dams to allow for floods far bigger than predicted by hydrological history.

New dams could allow for larger floods than predicted from the historical record. But there are so many societal, technological, ecological and climatological variables to

consider that we cannot know with any degree of precision the likely magnitude of future extreme floods. And so we cannot know with any degree of precision what should be the capacity of spillways for new dams.

The world’s more than 45,000 existing large dams have not been built to allow for a rapidly intensifying hydrological cycle. In this sense, all dams should now be considered unsafe.

There is no indication that governments and dam operators are willing to invest in bringing existing dams to what might be considered safe under the obsolete assumption of a stable climate. IRN is unaware of any examples of dams currently planned or under construction that are designed to take account of the fact that future hydrologies will not be like the past. (This is ironically true even for hydro projects that are claiming subsidies through carbon credits: their developers are benefiting from the need to address global warming while they pretend that global warming is not actually happening.)

Things Fall Apart

A huge number of things can go wrong with a dam. The two main reasons for dam failures are “overtopping” (responsible for around 40% of failures) and foundation problems (around 30%). Embankment dams, which make up about four-fifths of the world’s dams, are most vulnerable to being washed away when water flows over their crest. There are usually a number of interrelated reasons why any particular dam collapses. A dam may be overtopped, for example, because of the inadequate capacity of its spillways to discharge floodwaters, because of a spillway blockage with flood-borne debris, or due to mechanical or electrical problems which prevent the spillway gates being opened in time. The spillway gates may also be opened late because of poor operator judgment or incorrect predictions of the size of flood entering the reservoir. Internal erosion caused by leaks through the core of a dam can also cause it to slump and be overtopped.

Building a totally safe dam is simply not possible. US dam-safety expert Robert Jansen

says that dams “require defensive engineering, which means listing every imaginable force that might be imposed, examination of every possible set of circumstances, and incorporation of protective elements to cope with each and every condition.” This is clearly an unattainable target. In the real world, the degree of “defensive engineering” applied to the design of a dam will be decided by economics. The safer a dam – the greater the capacity of its spillways to cope with floods, the better the quality of its construction materials, the more extensive the exploration of the local geology – the more it will cost. ICOLD itself recognizes the conflict, stating in its 1987 guidelines on dam safety that: “For every dam project, a balance has to be found between dam safety and economy.”

There will always therefore be pressure for dam builders to cut corners on safety. A confidential 1991 World Bank report notes that because of “financial factors and local pressure to take shortcuts or ignore poor quality work,” construction quality in India is “deficient for a number of dams, posing serious potential risk to downstream populations.” The report explains how during construction “large illicit profits can be made by using substandard materials.” There are more than 4,000 large dams in India, with hundreds more under construction.

Even the most high-profile projects can suffer from “cut corners,” which can lead to safety issues later on. In 1998, top Chinese officials criticized shoddy construction on the massive Three Gorges Dam, saying that corruption and technical shortcuts led to the use of concrete with the strength of “mashed tofu” on the 185-meter-high dam.

Safety Precautions Missing

Despite the massive risk to human life and property posed by large dams, few countries have comprehensive dam safety legislation. Such laws should cover the engineering criteria that new dams must meet; the regular inspection and repair of old dams; and the preparation of emergency evacuation plans.

Studies in the US have shown that where early warning systems and evacuation plans are in place, the fatalities caused by dam bursts are on average reduced by a factor of more than 100. However, such plans have been made for only a handful of the world’s dams, mostly in the US, Canada and Australia. The first step in an emergency plan should be to draw up and make public a detailed “inundation map” of areas at risk if a dam should burst. Yet of the few countries that have produced adequate inundation maps, some regard them as so

confidential that they do not allow even the emergency services to see them. This obsessive secrecy is sometimes due to concerns over the maps being used by the enemy in times of war; in other cases the authorities simply do not want to admit that all dams are potential threats to people living below them.

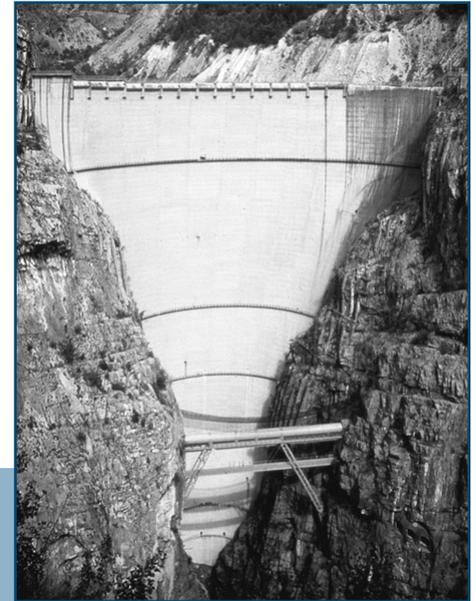
Clearly, there is an urgent need worldwide for dam safety legislation to be introduced, improved, and acted upon. In developing countries, in particular, lack of funds is a major constraint to making existing dams safer. Such funds should be provided under the climate adaptation programs that developed countries are obligated to finance under the UN's climate convention. Dam operators should also have to set aside part of their operating revenues to create a fund to be used for dam maintenance and, eventually, decommissioning.

These suggestions were discussed at a workshop on "Addressing Existing Dams" in Nairobi in 2004 sponsored by the UN Environment Programme's Dams and Development Project. Representatives from the dam industry, NGOs, governments and international agencies agreed on a set of recommendations, including:

- Governments should put in place dam safety legislation;
- Financial institutions should support dam safety programs in developing countries.
- Initial project cost estimates should include the cost of dam safety programs, to be paid out of future revenues.
- Emergency preparedness and evacuation plans should be put in place for every dam involving risk to downstream populations.
- Local communities should be involved in drafting disaster management and evacuation plans and should be provided with relevant information on dam-break risks.
- The impacts of climate change should be considered in dam safety assessments and dam safety should be considered in climate change adaptation planning.
- An international study is needed on the impacts of climate change on dam safety.

Unsafe dams kill. The dam industry must take seriously its responsibilities on the issue of dam safety, and it must stop denying the reality of a warming planet as regards to dam safety. Dam industry associations, and in particular ICOLD should issue recommendations on how to incorporate the increased hydro-

logical uncertainties due to climate change into the dam-design process. Dam funders, in particular the World Bank, need to make much greater efforts to help borrowers implement dam safety legislation and to make existing dams safer. They also must ensure that any new dams they support allow for the new hydrological uncertainties and that feasibility studies should include funds for ongoing monitoring and maintenance, and eventual decommissioning. Untold thousands of lives depend on the industry and its funders taking these actions. ■



Dam-induced earthquakes led to a deadly overtopping of the 261-meter Vaoint Dam in Italy in 1963. Nearly 2,000 people died.

A Brief History of Dam Failures

There have been 48 dam failures that killed more than 10 people outside of China in the past 100 years. (Inside China, an estimated 3,200 dams have failed since 1950.) The following is a brief history of some of the world's worst dam failures, and a couple of near-misses.

Teton Dam, US (1976): A 20-story-high wall of water poured out of the failed dam, destroying 4,000 homes and 350 businesses in three small towns, and damaging thousands of acres of farmland. Killed 11-14 people. Death toll would have been much higher but for the timely evacuation of 12,000 people the morning before the dam broke.

Vaoint Dam, Italy (1963): A reservoir-induced earthquake contributed to this deadly dam disaster. The 261-meter dam set off earthquakes as soon as its reservoir began to fill. One tremor set off landslides that plunged into the reservoir, creating a huge wave that overtopped the dam by 110 meters. About two minutes later, the town of Longarone was leveled and almost all its 2,000 inhabitants killed.

Henan Province dams, China (1975): As many as 230,000 people died in this domino-effect collapse of dams on the Huai River, some 85,000 in the flood waves and the rest from resulting epidemics and famine. The disaster began with the failure of the large Banqiao Dam in a typhoon, which resulted in the collapse of as many as 62 dams downstream. The Chinese government kept the incident secret for about 20 years, but information on the disaster was eventually leaked to the outside world.

Tarbela Dam, Pakistan (near-miss):

This 143-meter-high embankment of earth and rock is perhaps the world's most problem-stricken major dam. Only an expensive program of emergency repairs and continual monitoring and maintenance have prevented its reservoir from bursting through the embankment and devastating the densely populated Vale of Peshawar below. The full story of how close the mammoth dam came to being breached has never been fully revealed, but a leaked document reveals a catalogue of mishaps, beginning with the first reservoir impoundment. The hugely expensive operation to stabilize the dam almost doubled the cost of the project.

Glen Canyon Dam, US (near-miss): Heavy floods caused the rock sides of one of the dam's two spillway tunnels to partially collapse in 1983. Operators had to close the spillways fearing that erosion of the tunnel sides could weaken the rock holding the dam in place. The reservoir would have overtopped the gates of the spillways had not plywood boards obtained from a local lumberyard been fastened to the top of the gates, holding back the reservoir for a few more nerve-wracking days. Government engineers predicted overtopping if the reservoir reached 3,708.40. The reservoir finally peaked at 3,708.34 feet. Less than an inch saved the lower Colorado from probably the most massive flood in human history.

Getting Personal: New Book on Dams Gets to Heart of the Matter

Deep Water: The Epic Struggle Over Dams, Displaced People, and the Environment, by Jacques Leslie. Farrar, Straus & Giroux (New York), August 2005 (can be pre-ordered).

This excellent new book takes a refreshingly personal approach to the story of big dams and the people affected by them. Author Jacques Leslie, impressed with the work of the World Commission on Dams and drawn to the issue of water, decided to hit the road with three former WCD commissioners. His account of his immersion in the world of dams – often gripping, always thought-provoking, and generous with the kind of detail one must have to fully comprehend the controversies – brings a fresh perspective to this “epic struggle.”

Using lively language and strong story-telling, Leslie engages the reader in the intricacies of the debate, from the sad sagas of the legions of dam-displaced people to the hubris of the dam-builders. While acknowledging the benefits dams have brought, he clearly spells out the great human and environmental costs of the past century’s era of big-dam building. “If Hoover Dam evokes glory,” he writes, “Las Vegas, only 30 miles away, is its malignant twin. Even now, Hoover provides 90% of Las Vegas’ water, turning a desert outpost into the fastest-growing metropolis in the country.” He sets out to weigh the costs – social, environmental and economic – against the benefits of trying to engineer our way out of looming water crisis, and comes away convinced that we can (and must) do much better.

Leslie travels to parts of the world where water shortages are already a serious problem – Southern Africa, India and Australia – and finds that while each dam project may be different, the negative impacts are depressingly similar. But it’s who he travels with that makes this book so rich: India’s Medha Patkar, a leader of the people’s movement opposing dams on the Narmada River; Thayer (Ted) Scudder, an American anthropologist and dam-resettlement expert; and Don Blackmore, an Australian water manager who walks a

tightrope between thirsty farmers and ecosystems in need of a healthy river. He travels through the Narmada valley with Medha and other colleagues from the “Save the Narmada Movement”; across the Okavango Delta, along the Zambezi River, and into the remote river valleys of mountainous Lesotho with Scudder; and throughout Australia’s Murray River basin – whose entire annual flow is less than one day of the Amazon’s – with Blackmore. The travels with the Gandhi-like

Medha are the most

exhausting, the most heart-wrenching, and the most inspiring; the days with Scudder (a quirky, sometime-supporter of large dams who’s yet to meet one that met his careful standards for resettlement), the most eclectic; and the time with Blackmore perhaps the most hopeful, as water-management compromises are made to help restore a much-used river to health.

Deep Water is rich with the kind of startling, frustrating facts that dam activists have come to expect in their campaign work. On India’s Sardar Sarovar Project (SSP), Leslie notes, “The money paid for the engineers’ quarters was more than the project’s entire allocation for resettlement.” Leslie comes away offended by the SSP’s inhumanity, the “happily corrupt” officials pushing it, and the massive missteps in judgment by key players such as the World Bank and Indian Supreme Court. The SSP, he writes, is a “complete embodiment of the international battle over dams. The displacement of indigenous people, environmental impact, resettlement, water scarcity, energy production, spirituality, political and corporate corruption, human rights – the Narmada project encompasses them all ... The valley is where the evidence of dams’ destructiveness that has accumulated over decades finally collided with the optimism of engineers.”

Leslie trails Medha for weeks, trying to get at why she has devoted virtually her

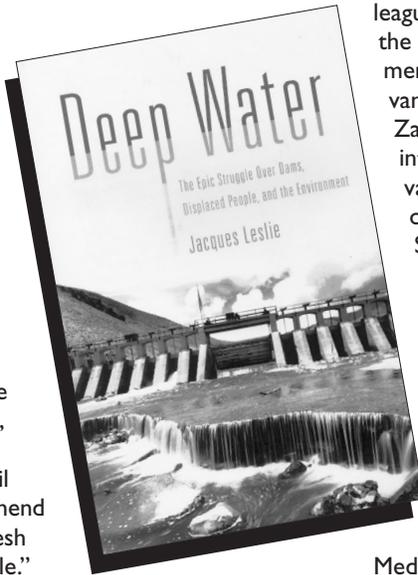
entire adult life to trying to stop the SSP (and at times risking her life to do so). He is respectful, curious, sometimes baffled, and always humbled by the experience. “Prominence was never Medha’s goal. If it had been, she surely would have found an easier way to attain it than fighting for dislocated tribal people. ... Indian dams alone have displaced between 21-55 million people. In response, hundreds of tiny rights groups manned by earnest social activists much like Medha have arisen throughout India. They fight disheartening and usually futile battles against government-sanctioned injustice; for this, their typical rewards are police beatings and poverty wages.”

He registers surprise that the Indian dam-fighters believed a distant body such as the WCD could actually effect change in places like the remote villages of the Narmada valley. These activists are not urging “revenge or revolution,” he notes, “but merely that their country abide by the recommendations of an international commission.” Instead, the Indian government angrily turned the WCD away when it proposed an India-based meeting, after it became clear the commissioners were intending to visit the Narmada valley.

As for most of us working in the dam field, Leslie is especially appalled by the callous treatment of people to be resettled by dams. In Lesotho, he meets a woman who looks stunned by her new life in a resettlement area. “Maybe the nation has benefited,” she said, “But my family hasn’t.” He describes the cumulative human impacts of the disruption of well-established communities and lifestyles by large dams: “By splintering tribal communities and forcing their demoralized members to take residence in nearby cities, dams have reduced human diversity as clearly as they have depleted biodiversity.”

The book’s epilogue is a post-mortem for the world’s big dams. Noting that dams are not built with their own decommissioning in mind, despite their limited lifespans and the dangers of ageing dams, Leslie writes, “Dams are loaded weapons aimed down rivers, pointed at ourselves; they’re proof of the gambling nature of the societies that build them.” He paints a none-too-comforting scenario of poorly maintained dams with ambiguous or non-existent plans for their upkeep and eventual

continued opposite



removal, sitting on earthquake faults or besieged by higher flows from climate change. "Take your pick of mortal scenario: cumulatively, they're more plausible than the assumption that megadams will be successfully financed, adroitly managed, and properly maintained into perpetuity." Their crumbling edifices will be "relics of the 20th century, like Stalinism or gasoline-powered cars, symbols of the allure of technology and its transience ... of the delusion that humans are exempt from nature's dominion."

In Leslie's somewhat apocalyptic vision, the dams are the ephemeral things, not the rivers – and therein lies the hope.

– Lori Pottinger

New Film on Biobío Dam

Switch-off (85 minutes, Spanish with English subtitles. Directed by Manel Mayol, 2005). For more information, visit www.switchoffthemovie.com

Flowing from the Andes to the Pacific, the Biobío is Chile's longest river, symbolic because it represented the last line of resistance for the Pehuenche-Mapuche indigenous people in their battle against the Spanish invaders. Manel Mayol's new film, *Switch-off*, shows the modern-day revolt of the Pehuenche against the plans by Spanish transnational Endesa to build Ralco Dam on the Biobío. The film hits hard in telling the story of political repression in Chile, by the country's former president, electricity sector, and judiciary in running roughshod over indigenous peoples' rights.

As part of a vanishing breed of documentaries produced in 35 mm film, rather than video, the artfully photographed and

creatively edited *Switch-off* is rich in imagery and texture, and has attracted the attention of major international film festivals, such as the Munich and the Toronto Hotdocs festivals, and undoubtedly will be showing in many more. With a slower pace than television documentaries, the film lingers on landscapes vanishing under the waters of Ralco's reservoir, and permits its characters to explain in detail how their lives were destroyed by the dam.

The Pehuenche were let down at every turn: by Chilean government agencies, where critical voices are simply removed from office; and by Chilean courts, which accepted non-challengeable testimony by hooded witnesses with electronically distorted voices, under the justification that Pehuenche opposing the dam are "terrorists." Despite the fact that not a single Pehuenche has been found in possession of a firearm, several Pehuenche leaders have been forced into hiding, or have left Chile in exile.

In a revealing sequence that unfolds throughout the film, Mayol records his phone conversations with Endesa's public relations specialist, in attempting to schedule an interview with Endesa's president. After getting the runaround, Mayol asks in desperation if the company is willing to go on record in any way at all. The PR person finally admits that the company's attitude is, the less publicly said about Ralco, the better.

Poignant scenes with traditional Pehuenche and younger indigenous political leaders demonstrate the web of misinformation, deceit and cynicism by which Endesa manipulated the Pehuenche into accepting relocation from lands along the Biobío to infertile terrain higher up in the Andes.

Switch-off is also an important film on the impacts of globalization, especially in light of Endesa's future plans to dam the major rivers of Patagonian Chile. The film includes chilling revelations regarding Endesa's enormous political power in Spain and Chile, including its lobbying the Spanish government to drop charges against former Chilean dictator Augusto Pinochet, and its near-monopoly on water rights in Chile.

The filmmakers were also willing to take chances in filmic terms, and define their own style with line-drawing animation, punk rock and electronic music.

Switch-off should be seen on the big screen if possible, and likely will be shown in the US, Europe and Chile in the light of its festival successes. The film is available on DVD, as well, and those interested should contact the filmmakers via their web site (listed above)

– Glenn Switkes

Solutions for a Thirsty World

Drought and Water Crisis: Science, Technology and Management Issues, edited by Donald Wilhite. Taylor & Francis/CRC Press (London, Boca Raton), 2005.

This collection of essays is brim-full of good ideas, encouraging case studies, and scary scenarios about what will happen if we do not improve our approach to drought and water management. Drought exacerbates all the water issues facing us today, including water scarcity, transboundary water conflicts, environmental degradation and protection, and climate change. The book's purpose is to move society from dealing with drought as a crisis to planning for drought in ways that will minimize its damaging effects.

Topics covered include using demand-side management techniques as a "drought-mitigation tool"; the role of water harvesting in mitigating drought, and the risks of climate change.

The editor's preface states, "To make progress, we must first recognize that drought has both a natural and a social dimension. Second, we must involve natural, biological, and social scientists in the formulation and implementation of drought-preparedness plans and policies."

The 37 contributors are experts in water management and conservation, engineering, emergency preparedness, public policy, environmental sciences and other relevant topics. They describe a range of complexities facing an increasingly water-scarce world – for example, the Southern African drought of 2002-2003 was less meteorologically extreme than a drought a decade earlier, but its impacts were more devastating because "the population was poorer and more vulnerable than it had been 10 years earlier."

Another describes the benefits of water harvesting techniques for reducing water poverty and drought-vulnerability, and explains the barriers to adopting these techniques where they are needed most: "The main reason has been lack of community participation in developing and implementing improved technologies."

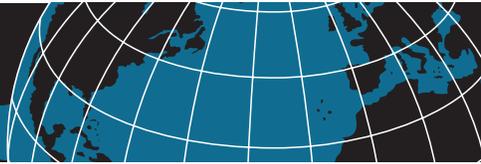
While this book is intended for water managers and policy makers, it deserves a wider audience. As the editor notes, "The key to invoking a new paradigm for drought management is educating the public."

– Lori Pottinger



This Pehuenche family was resettled for Ralco Dam. Free electricity promised them by the dam builders never came, and now they have to sell livestock to pay their electric bill.

Photo: Switch-off



UPDATES

BRAZIL: The 690 MW Barra Grande Dam in southern Brazil continued to be the object of legal challenges, as a federal judge suspended the licensing process pending an independent review of the project's impacts, only to see his decision overturned by a higher court. The US\$500 million Barra Grande, whose principal owner is Alcoa Aluminum, had suffered previous judicial barriers after its environmental impact assessment (EIA) was shown to omit crucial information regarding primary forests in the reservoir area.

Brazilian environmental protection agency Ibama, responsible for the licensing of the nation's hydroelectric dams, was widely criticized for extending an environmental license to the controversial project. Ibama has since fined the engineering and environmental consulting firm Engevix \$3.8 million for using false data in its EIA for Barra Grande. The EIA omitted the existence of 2,000 hectares of primary araucaria pine forests and more than 2,000 hectares of forests in an advanced state of regeneration. Engevix, which has carried out EIAs for dozens of Brazilian dams, will also be disqualified from preparing future EIAs for federal license approval.

BRAZIL: Tensions heightened at Tucuruí dam in early May, following state electric company Eletronorte's cancellation of a planned meeting with affected populations occupying part of the work site area, and the burning of two construction trucks by the angry families. Some 300 members of Brazil's Dam-Affected Movement (MAB) have camped for four weeks at the site, despite the deployment of the Brazilian military to protect the dam. MAB is calling for immediate support for the 5,700 families they say never received fair compensation for impacts incurred, an agricultural credit line of \$2,000 per family, and access to electricity. MAB regional coordinator Rogério Hohn said, "If we don't mobilize, Eletronorte and [construction company] Camargo Corrêa will deny any responsibility for the impacts we've suffered due to the dam. They've been fooling us for 20 years, and now we won't return home until they offer us a solution."

Elsewhere in Brazil, 10 MAB leaders in the communities affected by Campos Novos Dam in Santa Catarina state appeared in court to contest charges that they had plotted to occupy that dam on March 14. Human rights organizations had protested a judge's ordering preventative detention of the farmers to prevent the dam takeover. Based on the order, officials rounded up six of the MAB leaders in their homes, and jailed them for 23 days.

CHINA: One of this heavily dammed nation's most contentious dam projects, Sanmenxia ("Three Gate Gorge") in central China, has been called a "complete mistake" by one expert, Zhang Guangdou, according to an April 29 report on the dam by Interfax China. Sanmenxia has been blamed for drying up the Yellow River and causing major floods. More than four decades after the reservoir was filled, plans are still being formulated to improve the dam's operations, while a number of experts have called for its closure.

Liu Hongbin, vice chief of the Sanmenxia Yellow River Hub Management Bureau, was frank about the flaws in the project. "They didn't think enough about the silt problem during the process of construction," he told Interfax. The river is yellow from a high volume of silt, which has caused problems for the dam from the start. Against the advice of various experts, the Sanmenxia reservoir was originally designed to collect silt in order to leave the lower reaches silt-free. The original design did not include sluice gates.

Silt build-up has caused problems serious enough to warrant emergency replacement of the generating units, the addition of silt-discharging channels, and other costly rehabilitation efforts. Still, a water resources expert involved in the construction of Sanmenxia told China Central Television last year that these drastic efforts have still failed to solve the problems in any fundamental way, despite a significant reduction in planned output capacity and in the height of the dam.

Last year, 15 officials from Hua County in Shaanxi Province joined in the calls for the suspension of the Sanmenxia project. The county is one of the primary victims of the dam, and has experienced serious floods as a result of accumulating sediment.

"The main issue lies with the distribution of benefits, since the main province being flooded is Shaanxi, while the main beneficiaries [of flood control] are Henan and Shandong," said Liu.

WATERY PLANET

US: With little fanfare, counties, states, and the federal government have collectively spent an estimated \$14 billion or more – at least \$1 billion a year since 1990 – to restore rivers and streams to their natural condition, not including money spent on huge restoration projects like the Everglades.

High-profile restoration efforts include ongoing clean-up of rivers flowing into Chesapeake Bay and proposed dam decommissioning to restore Pacific salmon runs. But the bulk of the 37,000 projects since 1990 have involved smaller rivers that have had an outsized impact on the environment, according to the National River Restoration Science Synthesis, a two-year study by researchers at 11 universities. The study results were reported on in the journal *Science* in April.

"When I started the project, I thought we might find several thousand of these projects," says Emily Bernhardt, professor of biology at Duke University, who participated in the study. "The scale of what we found was amazing. There's been exponential growth."

That finding is tempered by growing signs that the nation's rivers are experiencing more pollution overall – after decades of getting cleaner, the same study notes. From about 1973 to 1998, rivers and lakes in the United States were getting cleaner, but that has now been reversed, according to American Rivers, which helped organize the new study.

More than a third of US rivers are now listed as polluted or impaired. Extinction rates of freshwater fish are about five times the level of land animals. Withdrawals of freshwater from rivers for agricultural and other uses is so extreme in some regions that the rivers no longer reach the ocean all year long, the study says. Aging sewage-treatment facilities could in the next decade return US rivers to historic pollution levels, according to a 2002 report from the Environmental Protection Agency.

Water quality is now beginning to decline for several reasons, American Rivers' Andrew Fahlund says. The Clean Water Act did a good job initially of cutting pollution from "point sources," the big reason for improvements over 30 years. But at the same time, nonpoint sources – runoff from parking lots, streets, agriculture – were getting worse. Today, nonpoint pollution has in many places surpassed those earlier gains.

IRAQ: Extensive wetlands that were once home to Marsh Arabs and a host of wildlife are being partly restored, an international team of scientists reports. Saddam Hussein drained more than 90% of the 15,000 sq km of marshes, in part to punish the Shi'ite Marsh Arabs who opposed him, and to divert water for cities upstream. For eight years, virtually all of Iraq's earth-moving machinery was used in a massive project of dam-building to drain the marshes and uproot the people who lived there. The result was desertification that led to immense dust storms. "Some cities had to plow the dust like snow," said ecology professor Curtis Richardson, a member of a UN-funded team of wetlands experts studying the area. The group released a major report in February, which likened the draining of the marshes to the drying up of the Aral Sea in Central Asia and the deforestation of the Amazon.

Local people have since removed numerous dams and dikes that diverted water from the area, restoring about 20% of the historic marshland. Water coming into the area from the Tigris and Euphrates rivers is surprisingly clean, the team reports, washing away toxic salts that built up when the area was drained. The marsh was important habitat for hundreds of bird species, which had almost disappeared. A number of species are now starting to return, including pelicans, cormorants and wading species. Displaced people are also moving back to the area.

The scientists acknowledge that the marsh will never be completely restored; they estimate 30% can be restored to health. But the restoration is threatened by upstream countries. Turkey's massive Ataturk Dam (completed in 1990) has the capacity to hold five times the annual flow of the Euphrates, which is the major source of water for the marshes. Another threat comes from a new dike being built by Iran, apparently for the purpose of selling water to Kuwait.

A BETTER WAY

SOLAR: A plan to build the world's biggest solar energy power station, covering about 250 hectares and capable of powering 130,000 households, has been unveiled in Portugal. The UK *Guardian* reported in May that the plant would be visible from space. The site is an abandoned pyrite mine in the southern Alentejo region. With 1,890 kilowatt hours of sunshine per square meter each year, the Alentejo is one of Europe's most promising areas for solar power.

At 116 megawatts, the new station will be several times the size of the world's current largest solar plant. The plant's electricity will feed the national electricity grid and be sold at a government-set price. The project is awaiting government approval. It is expected to take 4-5 years to build.

A consortium of mainly German companies will install the solar panels. A German manufacturer of solar panels has said it also plans to build a factory at the site, bringing 250 permanent jobs to one of the poorest regions of Europe. The project will create three jobs for every employee working directly on the solar power plant or in the factory.

WAVE POWER: The Electric Power Research Institute (EPRI) reported in February that generation of electricity from wave energy may be economically feasible in the near future. The study was carried out by EPRI in collaboration with the Department of Energy's National Renewable Energy Laboratory (NREL) and energy agencies and utilities from six states. Conceptual designs were performed for sites in Hawaii, Maine, Massachusetts, Oregon and California.

EPRI's Roger Bedard said the amount of wave energy available off the US coasts is 9-10 times the energy currently generated by the country's hydroelectric dams.

The forecast results will hopefully lead to increased public funding for investment in wave energy research and development, including more demonstration projects.

With proper siting, conversion of ocean wave energy to electricity is believed to be one of the most environmentally benign ways to generate electricity. Offshore wave energy is also expected to minimize public dissent; wave energy devices have a very low profile and are located far enough away from the shore that they are generally not visible. Wave power can be captured by big buoys bobbing on sea swells, or by submerged turbines spinning with the ebb and flow of the tides.

Wave energy is also more predictable than solar and wind energy, offering a better possibility of being dispatchable by an electrical grid systems operator. Another advantage is that water currents are more energy-dense than wind currents – about 1,000 times more.

Wave power was delivered to the electrical grid for first time in August 2004 in Scotland. That pilot project provided enough power for 500 homes.

WARMING WORLD

CHINA: The thawing of glaciers on the Qinghai-Tibet Plateau is threatening to undermine the performance of the mainland's hydroelectric dams, according to Chinese scientists. The *South China Morning Post* reported in March that although retreating glaciers will initially lead to mass flooding, in the longer term this will lead to water shortages. River beds will become more porous as the normally frozen tundra underneath them melts, and more water will leach through the soil.

The Longyang Gorge Dam is just one of China's dams already experiencing the effects of climate change, according to Professor Shen Yongping of the Chinese Academy of Sciences. Shen is the author of a new report on the impact of retreating glaciers. The Longyang Gorge Dam – the largest on the upper reaches of the once mighty Yellow River – struggled to generate electricity during 2003-04 because of very low river flows. The Yangtze is also starting to experience lower flows, Shen said; during the past 15 years, lakes at the source of the Yangtze have decreased by more than 10%.

After the report was released, China's State Council approved a five-year environmental protection plan for the headwaters of the nation's most crucial waterways – the Yellow, Yangtze and Lancang rivers. The plan will relocate more than 55,000 farmers and restore 6.4 million hectares of pasture to grassland.

Making Energy Use More Efficient in India

by Rangan Banerjee

India is home to 16% of the world's population but consumes only 4% of the world's total electricity. India presently consumes only about 400 kilowatt-hours per person per year as compared to the world average of 2,300 kWh/person/year. About half the households in India do not have access to electricity. The development goal of improving the quality of life of the population requires provision of access to electricity to all households. The conventional approach of power planners has been to build additional power plants to meet future projected demands. According to official estimates, the targeted additional generation capacity is 100,000 MW by 2012 (corresponding to a doubling of the existing capacity of 100,000 MW).

What are the problems associated with this approach?

The investments required for this are staggering – at present prices about US\$100 billion (Rs5000 billion), and there just isn't enough money to meet these needs. The result is energy shortages and poor-quality energy services. Direct and indirect economic impacts of outages resulting from capacity shortages are enormous. There are also issues of sustainability associated with the continued use of fossil fuels and large hydro.

What are the alternatives?

One alternative that has significant potential and is cost-effective is energy efficiency and demand-side management. It is important to understand that we do not have a need for electricity per se. We require the energy services provided by electricity – e.g., illumination, heating, cooling and power. For the user, the amount of electricity used is not important as long as the same energy service is provided.

Consider the example of illumination with an incandescent lamp using 60 watts. The light output is 700 lumens. The same light output can be provided by a compact fluorescent lamp with a total power consumption of 14 watts. This results in a saving of more than 75% of the input electricity.

Providing energy services to end-users involves a number of energy conversion steps. At each step there are associated losses. This implies that for every unit of energy that is saved at the end-use, the actual primary energy saved is more than one unit

(for example, in the Indian power system, 1 unit of electricity savings at the end-use would result in about 4 units of primary energy savings of input coal). There is a significant potential for savings by using energy-efficient equipment at the end-user end and for generation and transmission.

Demand-Side Management (DSM) is a set of practices that involves managing the demand for power among some or all customers to meet the overall needs for electricity. It can involve using energy more efficiently, as well as reducing the peak-demand for electricity. This provides benefits to the customer, utility and society. DSM programs might include efficient lighting in the residential and commercial sector, time-of-use pricing for large industrial consumers, efficient motors programs for the industrial sector, solar water heaters for residential and commercial users, efficient water pumping for the agricultural and municipal sectors, and industrial cogeneration.

Can DSM help address the problems of the Indian power sector?

The Indian power sector is facing a payment crisis. There are high transmission and distribution losses and significant commercial losses (theft). In many sub-stations more than half the electricity supplied is not metered. Agricultural water pumping is a major cause for concern. Since electricity is available at subsidized rates (often based on a flat horsepower tariff), agricultural consumers have no incentive to improve pumping system efficiency. This has adverse impacts on the water table as well as using excessive energy. A DSM program for efficient agricultural pumping could help utilities manage agricultural

demand and help control losses. Segregation of agricultural feeders and sub-station level energy audits would help improve power system operation.

There are several barriers to the adoption of efficiency and DSM. Often the measures require initial investments by customers. For example, a compact fluorescent lamp costs about \$3 (Rs 120) as compared to \$0.25 for an incandescent bulb (Rs10). The higher initial cost is a barrier for customers, even though the savings justify the investment. The electricity supply company is also comfortable building large power plants for the centralized grid, but has been reluctant to invest in energy efficiency programs. This reluctance is often due to a perceived uncertainty in the transaction costs and the impacts. For instance, to get a peak saving of 100 MW through an efficient lighting program in the residential sector would require a replacement of about 2 million incandescent lamps. This requires customer acceptance.

The key to this is innovative program design. There are many international examples of successful DSM programs. An Indian utility in Bangalore, BESCOM, has launched an efficient lighting program recently. In this scheme the utility has entered into agreements with suppliers of compact fluorescents for supply through retail outlets to BESCOM customers. Payments are to be recovered from the electricity bill. Another example, the Efficient Lighting Initiative (www.efficientlighting.net), was a GEF funded program for lighting efficiency in Argentina, Czech Republic, Hungary, Latvia, Peru, Philippines and South Africa.

continued opposite

Fast Facts on India's Energy Use

- India is the world's sixth largest energy consumer.
- India is the second most populous country in the world, behind China. Its population is expected to reach 1.16 billion by 2010.
- India's annual electricity generation and consumption have nearly doubled since 1990. The country's projected increase in electricity consumption (expected to be between 2.6-4.5% to 2020) is the highest for any major country.
- Of the half a million or so villages in India, about 80,000 remain completely un-electrified, and many of the rest do not have reliable or adequate power.
- Of all the electricity generated in India, only about 55% is billed and slightly more than 40% is regularly paid for.

From Decentralised Energy Systems India (DESI Power)

Bujagali continued from page 3

Nile Basin Initiative.) Bujagali's reservoir will also inundate high-productivity agricultural lands, and the culturally important Bujagali Falls (which is also a big tourist draw for whitewater rafting businesses). Endemic fish species could be threatened, as well as nesting areas for bats and birds. The project's 70 km of transmission lines will cut through protected forest reserves and farmland.

The proposed Karuma hydro project would, according to the 2001 environmental assessment for Bujagali, have fewer social and environmental impacts than Bujagali, and fewer cumulative impacts on the Nile River. The Karuma project is being promoted by a Norwegian team, but has been sidelined as the government aggressively pursues Bujagali. An official "options assessment" for Bujagali even went so far as to give Karuma a significantly higher price than the developers' own cost estimates,

presumably to make Bujagali look more cost-competitive. This "Bujagali bias" has pervaded the process for choosing the next energy project for Uganda.

Civil society groups have also raised a technical concern about the river's ability to support so many dams. The concern follows the failure of the upstream Owen Falls dam complex to produce as much electricity as it was designed to do. The Ugandan media have reported that the two hydro projects are underperforming by 50-80 megawatts; the energy minister has blamed the shortfall on drought, while a local hydrologist says the project design was based on excessively optimistic hydrological data, and that the dams could even be contributing to a permanent lowering of Lake Victoria's levels. "Government, World Bank and Acres International must give a proper account of the failure of the Owen Falls Extension dam to

deliver the promised electricity, and publicly accept total responsibility and provide compensation for the failure and the consequent decline in the water levels of Lake Victoria following the commissioning of that dam," says the NGO statement.

The World Bank's private investment arm, the IFC, was to be the major lender for the project, but pulled out after AES withdrew. The Bank has not indicated whether or not it will get involved this time. Since the World Bank backed off from the project, the Ugandan government has proposed various funding mechanisms, from an infrastructure development bond to raiding the national social-security fund to pay for the dam. ■

The civil society statement is available at www.irn.org. For more information, contact NAPE (nape@utlonline.co.ug).

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by omitting thousands of megawatts of new power plants that EGAT, the Thai electricity utility, has included in its latest power development plans, and also by claiming that over 2,500 MW of current power plants would be retired in the period to 2009.

The World Bank's analysis of Thailand's energy needs also failed to incorporate findings from a Bank-commissioned study that found that Thailand's "realistically achievable potential" for renewable energy projects, as well as demand-side management and energy efficiency potential, exceeded the expected output of Nam Theun 2, and could provide Thai customers with power that is 25% cheaper.

All of these omissions and changes conspired to make Nam Theun 2 look more favorable than alternatives. In fact, the price the Electricity Generating Authority of Thailand (EGAT) has agreed to pay for NT2 electricity is more than EGAT's available alternatives. Power from gas-fired, combined cycle plants will cost EGAT 14% less than NT2. Implementing energy conservation measures would be much cheaper, costing a quarter of the NT2 power.

A comprehensive alternative Power Development Plan for Thailand, incorporating realistic potential for demand side management, renewable energy and co-generation, was presented to key donor govern-

ments and World Bank officials in advance of their decision on NT2, but was ignored.

Witoon Permpongsacharoen, a member of Thailand's National Economic and Social Advisory Council, and author of the alternative PDP, said "The World Bank's questionable economic calculations strongly suggest that Nam Theun 2 is not a 'least cost' option and is a burden rather than a benefit to Thai consumers. They also suggest that the bank is willing to go to great lengths, including violating its own operational guidelines regarding economic evaluation and disclosure of information, to justify a project that, in turn, justifies the World Bank's existence." ■

DSM in India continued from page 14

Another successful international model that is likely to be replicable is the Super Efficient Refrigerator program that provided a prize of \$30 million to design and manufacture refrigerators that are more energy efficient than the existing refrigerator standards. This resulted in a refrigerator that had a 29% savings over the existing standards. The Indian parliament passed the Energy Conservation act in 2003. This resulted in the formation of the Bureau of Energy Efficiency (BEE) with the mandate of promoting energy efficiency in India (www.bee-india.com). BEE has chalked up an action plan with several thrust areas – industrial energy conservation, demand side management, standards and labelling, energy efficiency in buildings, energy conservation in

building codes, professional certification programs, manuals and codes, energy efficiency policy research and school education.

What needs to be done?

If power planners adopted least-cost planning techniques to meet future requirements, energy efficiency and DSM would be included before new generation. This would reduce the need for new power plants and result in cost-effective efficient power systems. This would need to be mandated by regulators and included in the power planning process. Utilities should set aside a fund for efficiency and DSM. In developing countries like India where the demand for electricity is growing at 7% per year (or more) and the existing level of consumption is low, the bulk of future

demand in coming decades will be built up from new installations, new buildings, new appliances. If we can ensure that we incorporate efficiency beginning with the design stage itself for all new projects, it is likely that we will reduce the additional electricity requirement by 20-30%. The current drive to build more fossil-fuel plants and large hydro projects is unsustainable. As we plan for a transition to the sustainable renewable-energy based systems in the future, we have to aggressively pursue energy efficiency and demand side management. ■

The author is a Professor of Energy Systems Engineering at IIT Bombay, India. His research interests include energy efficiency, DSM, renewable energy, energy planning and policy.

New Report Details the Legacy of Chixoy Dam

by Monti Aguirre

A new report on Guatemala's Chixoy Dam reveals the full extent of social injustices resulting from the project, and recommends legally binding reparations for those harmed by the 22-year-old dam. The dam was built by the military government of the time with World Bank and Inter-American Development Bank support. More than 4,000 people were affected, and 444 people were massacred after resisting forced resettlement.

"The project was approved, financed, and construction began without notifying the local population, legal acquisition of land, or a plan to address compensation, resettlement and alternative livelihoods for the mostly Mayan residents who would be displaced," said anthropologist Dr. Barbara Johnston, author of the report. No assessment of losses were made, nor were there safeguard measures for the 6,000 households in surrounding communities who faced flooding of land, homes and sacred sites.

The report, commissioned by the Peasant Association Río Negro 13 of March Maya Achí, IRN, Reform the World Bank – Italy,

and Rights Action – Guatemala, attempts to document the losses suffered and to provide guidelines for a plan for reparations.

The report includes voices from the community, who describe what happened during project construction, their old way of life and living conditions today. Their ideas for helping to restore their way of life are also recounted. An annotated timeline describes the history of the project.

The major conclusion from the Chixoy study is that the project came at the expense of land, lives, and livelihood in violation of national and international laws. The recommendations put forth by Dr. Johnston include formal and meaningful involvement of government and financing institutions in a "reparations process that seeks to restore the dignity, identity, and integrity of previously self-sufficient communities."

The study's recommendations include:

- Compensation for personal injury and loss of life.
- Restored access to or full replacement of lost lands and other property.
- Renewed commitment to providing free

household access to water and electricity to communities whose lives and lands subsidized the construction of the Chixoy facility.

- Improved housing conditions.
- Access to health and education programs.
- Infrastructure and development to reestablish the socioeconomic linkages between communities whose social fabric was disrupted by the reservoir.
- Infrastructure and economic development of the region in ways that enhances and revitalizes Mayan traditions, while restoring the degraded environment.
- The establishment of a social/economic/cultural development trust fund, held in perpetuity, used to finance projects that benefit the dam-affected communities.
- Legislation that strengthens indigenous rights, and establishes a free and prior informed consent requirement in development.

The study is available at www.irn.org. For more information contact Monti Aguirre: monti@irn.org

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