WORLD RIVERS REVIEW
Published by International Rivers Vol. 25 / No. 3 Sept. 2010

INSIDE

INTERNATIONAL RIVERS
people • water • life
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Down and Out Downstream

New Study Documents the Forgotten Victims of Dams

by Peter Bosshard

In the 1970s, Kharochan was a bustling town in Pakistan's Indus Delta. The local farmers grew rice, peas, coconuts, mango and guava on their rich soils. From the nearby harbor Sokhi Bandar – the "Port of the Prosperous" – traders exported silk, rice and wood. When I visited in 2006, no traces of prosperity were left in Kharochan. The port had been swallowed by the sea, and the groundwater had become saline in large parts of the delta. A white crust of salt covered the earth, and turned Kharochan's fertile fields into parched land. More than half the region's population lived below the poverty line, and thousands had left their homes for the sprawling city of Karachi.

An Indus Delta fisherman – one of 472,000 downstream victims of large dams. Photo: Ann-Kathrin Schneider

The Indus Delta has not been struck by a natural disaster. Its plight is human-made. The Indus – the world's tenth-largest river in terms of the water it carries – has been plugged by 19 dams and is being sucked dry by 43 large canals. The Indus no longer reaches the sea in most years, and its sediments no longer replenish the delta. As a consequence, Pakistani experts told me, 8,800 square kilometers of agricultural land have been lost to the sea since dam building began – an area the size of Puerto Rico.

The suffering of the people of the Indus Delta is hardly unique. According to a team of researchers led by Brian Richter, director of The Nature Conservancy's Global Freshwater Program, a stunning 472 million people have likely been harmed by dams built upstream of their homes. This first-ever attempt to quantify the downstream impacts of dams was recently published in a special issue on dams of the online journal *Water Alternatives*.

The number was calculated using a database of all rivers that have at least one-tenth of their annual flow stored by the world's 7,000 largest dams. The researchers then estimated how many people lived within 10 kilometers of these rivers on floodplain lands. By cross-referencing their calculation with specific case studies, the researchers concluded that their estimate of 472 million potential downstream victims of dams is likely to be conservative.

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World Rivers Review
Volume 26, Number 3
ISSN Number 0890 6211

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Printed on 100% post-consumer recycled waste paper with vegetable-based inks

Commentary

PAKISTAN'S HARSH LESSONS

There are three vital global lessons to learn from the ongoing flood catastrophe in Pakistan. The floods are just the latest evidence indicating that the rise in the planetary temperature has reached a tipping point. Weather extremes are the new normal. There's no going back, at least not in our lifetime, and very likely not in that of our children. We must act, and quickly.

First and foremost, we should be doing everything we can and more to cut our greenhouse gas pollution. We can't stop warming entirely, but we can slow the rise in heat and limit the maximum temperature level. Every bit of delay will add to the future suffering of poor places that had little to do with creating the climate mess, and make it harder and more expensive to fix.

Second, we urgently need to step up efforts to protect ourselves from this new normal. We need to do all we can to stop weather disasters becoming catastrophes. This means, in the jargon of disaster management, increasing the resilience of our infrastructure, economies and communities – and our rivers. In flood-prone, highly populated areas like Pakistan, greater resilience would include better emergency warning and evacuation systems, better flood protection for key infrastructure, and plans to help communities recover once the waters recede.

Adapting to the new normal isn't just about dealing with excess water in major flood events, but also having too little. Major droughts are becoming more frequent, and longer. As global water expert Sandra Postel writes in this issue (p. 8), we'll need to get much more aggressive in conserving water if we are to avoid water conflict. There are no substitutes for water, and we can't live without it. "It is through water that we will experience the impacts of climate change most directly," she notes.

Third, the way we have mismanaged the Indus – and countless other rivers around the world – for the past century has provided various short-term benefits, but at a major long-term cost that we are now having to pay. As climate scientist Dr. Margaret Palmer explains in an interview in this issue (p. 4), "To manage for global change, we need to manage in a way that makes rivers more resilient – in other words, able to absorb disturbances and bounce back on their own."

We have reduced small- and medium-scale flooding on many rivers through building dams and embankments. But in doing so we have greatly increased the scale of, and our vulnerability to, very big floods. This is a highly risky and dangerous approach in an era when megafloods are becoming ever less "extreme" and ever more "normal." Increasing resilience to floods is going to require reversing our river management mistakes through restoring rivers and floodplains, including by taking out embankments and dams.

In Pakistan, two of the world's biggest dams, and a vast associated system of barrages and diversion canals, have greatly reduced the amount of water and sediments carried by the Indus in most years. The most obvious consequence of this has been the destruction of the farmlands, fisheries and mangrove forests of the Indus Delta, one of the 20th century's great environmental disasters (see p. 1).

But another consequence is that the river normally lacks sufficient flows to carry away the riverine sediments that are not trapped behind dams. And sediments that once would have been deposited onto the floodplain in "normal floods" are trapped within thousands of miles of embankments. These sediments build up on the riverbed, steadily reducing its capacity to handle large flows.

Then, inevitably, a major flood comes, the shrunken river channel, straight-jacketed within its embankments, can no longer hold the flow, and the Indus surges out over the densely populated floodplain.

The Pakistan floods should be a warning to all of us that time is of the essence in addressing climate change. But it also serves to remind us that the hydrological past is no longer a reliable guide to the hydrological future, and we need to rethink our management of rivers to take account of this. We at International Rivers envision a "a new normal" that emphasizes healthy rivers which are better able to support our communities and all life, and are more resilient in the face of a changing climate.

Patrick McCully

MAKING WAVES

In the News

"Ikuko Matsumoto, a researcher with International Rivers, worries that people affected by Nam Theun 2 have also lost access to forests and rivers. "I think the most important issue for villagers is the food security issue," she says in a telephone interview from Khammuan Province where she visited communities affected by Nam Theun 2 just days after its turbines began humming. "Their everyday life relies on fishing, rice cultivation, and collecting material from the forest. How can companies and the government help restore a similar way of life? That is the biggest challenge and I really haven't seen much success."

"Laos turns to hydropower to be Asia's battery," *Christian Science Monitor*, July 2, 2010

Happy World Rivers Day

The sixth annual World Rivers Day, September 26, is just around the corner. Here is a sampling of planned events:

As many as 100,000 participants are expected at more than 100 events on the 30th anniversary of British Columbia Rivers Day – the event that launched World Rivers Day. Also in Canada, the citizens of Lillooet are hosting a "Salmon in the Canyon" festival to raise awareness of the Fraser River's status as "the world's greatest salmon river." In Patagonia, Chile, local communities are planning a big celebration to honor the Baker River. And in Australia, the community group "Turning the Pages" will celebrate the Pages River with an event featuring a writing competition, the unveiling of a a design for a River Walk, a large kinetic sculpture, and a tree planting.

More info: **www.worldriversday.bcit.ca**

Ame travels on the Srepok River, Cambodia.

Welcome, Ame!

Ame Trandem is the newest member of the International Rivers' Mekong team. Ame has worked for many years with local groups in Cambodia on dam campaigns. Ame will focus on Mekong mainstream dams and coordinate the Save the Mekong coalition. We're excited to have her on the team!

This Kapayo man was one of hundreds attending the meeting to oppose Belo Monte Dam. Photo: Antoine Bonsorte/Amazon Watch

In a strong display of unity, indigenous leaders from across Brazil met in August at the Terra Livre Regional Encampment in Altamira to express their united opposition to the Belo Monte Dam on the Xingu River. More than 500 indigenous people from 27 different tribes gathered by the banks of the Xingu to discuss strategies to stop the mega-dam, which the project consortium is hoping to begin building in September. The group declaration states, "We want to alert everyone that the Amazon will be irreversibly damaged should the madness of over-exploitation of natural resources continue. We request the support of everyone, from the countryside to the city, for the life of the Amazon is at risk."

International Rivers has partnered with Amazon Watch and actor Sigourney Weaver to produce a new Google Earth video tour, "Defending the Rivers of the Amazon." The tour takes viewers through the Xingu Basin to reveal what would be lost if the Belo Monte Dam were built. The tour animates the flooding associated with the dam and its impacts on indigenous peoples and the region's spectacular biodiversity. See for yourself what is at stake: **www.internationalrivers.org/en/node/5756**

Interview

Climate Change, Rivers and Dams: We're in Hot Water

by Katy Yan

Rivers are the planet's lifelines, but the double threat of human interventions combined with climate change is already seriously compromising their health – and, by extension, ours. A major study last year found an overall decline in total discharge of most of the world's major rivers – changes that could affect up to a billion people. Here we interview ***Dr. Margaret Palmer,*** *director of the Chesapeake Biological Laboratory at the University of Maryland and a leading expert on how climate change impacts rivers.*

WRR: What are your biggest concerns for our major rivers?

MP: Over the past 50 years, the amount of runoff has changed substantially for many rivers due to the combined effects of withdrawals, dams, and climate change. The impacts of human alteration of the land around rivers are harming rivers at a far higher rate now than is climate change. But if climate change is added as an additional stressor on top of immediate anthropogenic impacts, rivers may not be able to supply the ecosystem services – like clean drinking water – that people depend on.

The effects of climate change on rivers are manifest through increases in temperature and changes in river discharge. Some parts of the world will experience higher flows and others lower flows, but all will experience warming. The impacts will be dramatically worse in basins that are otherwise impacted either by flow modification (for example, by excessive water withdrawals) or development. In particular, urban areas that have substantially higher rainfall or that will have more intense storms may have more flooding. The reason is that urban areas typically have less riparian wetland and in general less wildland along rivers, which act to store water that can be released later.

WRR: Your research shows that areas impacted by dams would require more management interventions to mitigate the impacts of climate change than free-flowing rivers. Why are free-flowing rivers more resilient to climate change?

MP: Free-flowing streams in wild areas have tremendous capacity to adjust to changes in discharge and sediment inputs (both of which are expected to change in many areas under future climate scenarios). But they need room to do this. When a channel changes shape or migrates across the landscape, it's because the river is adjusting to a new flow or sediment regime. When you try to lock it in place or cut off its supply of sediment (due to dams), the ability of the stream to adjust and reach a new equilibrium is lost. We need to "free" rivers so they can move across the landscape and have some degree of buffering capacity which intact riparian corridors and wetlands and floodplains provide.

On the other hand, streams can do little about an increase in air temperature. If river water warms too quickly – say, 3-4 degrees C in the next 25 years – then the organisms living in the stream are unlikely to be able to adapt fast enough to cope with this. At first, we will see declines in reproductive output or survival of young. Over time, populations of some species will decline, while those species able to withstand warmer water (often nonnative species) will increase. However, keep in mind that if deforestation has occurred in a watershed, temperature increases above historic levels will be far greater and more harmful ecologically.

To manage for climate change, we need to manage in a way that makes streams more resilient. It will be far cheaper and save more lives if we act now to protect rivers and the people they support.

WRR: Which river basins are key hotspots that will require extensive management?

MP: Basins that require major management decisions include for example the Nile in Africa which is already experiencing significant reductions in flow by the time the river reaches Egypt. The Nile Basin supports more than 180 million people and poverty is high. Its water is critical to irrigation in Egypt, Sudan, Uganda and Ethiopia, yet given growth in water extractions and hydropower needs in the upper portions of the basin, climate change poses a major concern for the river and the people it supports.

The water that feeds the Indus River is from glaciers in the Himalayas and with increasing temperatures, glacial melting with significant increases in river discharge will occur. A rapid reduction in glaciers could mean future water supplies may become increasingly limited, yet millions of people in northwestern India and Pakistan depend on the river.

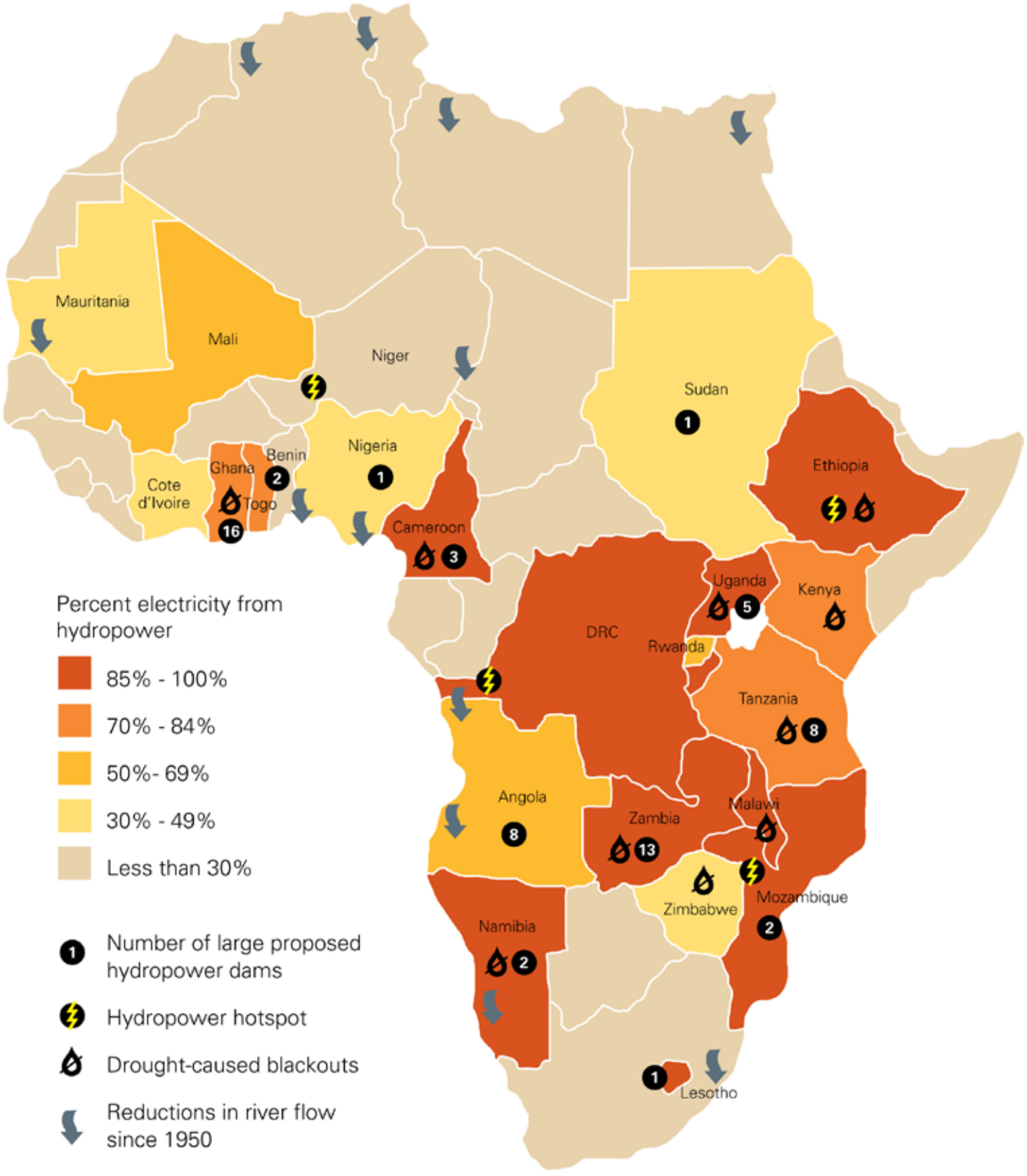
WRR: How should river basin management change to reflect a changing climate?

MP: Current practices in river basin management should move aggressively toward restoring or preserving those natural features that contribute to a river ecosystem's resilience. Most of these features also benefit humans. For example, riparian wetlands and floodplains help store water so they reduce flooding and also help recharge the groundwater, which means more water will be available in the river – and for people – during dry periods. To accomplish this, river management will have to include moving people and infrastructure out of floodplains, removing levees, and allowing vegetation to grow back. ●

Dr. Palmer isn't always this serious. Watch her talk about mountain-top-removal mining with comic "news anchor" Stephen Colbert: http://tinyurl.com/356g53x. It's seriously funny.

Hydrodependency in Africa: Risky Business

The world gets about 20% of its electricity from hydropower, but in Sub-Saharan Africa that number is 60% (excluding coal-heavy South Africa) – and many countries get more than 80% of their electricity from dams. Drought-caused blackouts are common, and expected to get worse with climate change. Hundreds more dams are being planned, many of them in already dangerously hydrodependent regions. This map shows the current status of hydrodependency across the continent, and plots some key proposed dams in these places. Finally, we include some information about reduced river flows and major droughts that have already begun to affect African energy sectors.



A Flood of Dam Safety Problems

by Lori Pottinger

The catastrophic flooding in Pakistan provides a terrifying warning of how global warming is changing the hydrological cycle. Almost every month seems to bring unprecedented rainstorms and floods somewhere across the world, and their severity and frequency seems to be rapidly worsening. These floods pose a major threat to the world's dams, and to the many millions of people who live below them. Here we report on a few of the worst examples of dam-induced flooding in recent months.

Brazil

Northeast Brazil – better known for severe drought – was hit by devastating floods in early July. The floods left 50 people dead and an estimated 150,000 homeless, and damaged towns, farms, bridges and factories. An estimated 80% of the housing in the town of Branquinha was destroyed.

The latest dam burst in northeast Brazil. (Leo Caldas/Revista Veja)

In addition to abnormally high rainfall, the unprecedented flood damage was worsened by a series of dam bursts along two rivers. The dam bursts reflect a lack of adequate safety measures on both public and private dams, the latter typically for large sugarcane plantations. In the Northeast region, it is estimated that there are at least 100,000 small and medium dams, most of which were built with little or no regard for environmental impacts and dam safety; at least 200 are reported to be at risk of failure.

The latest dam bursts in the Northeast highlight a recurring problem in Brazil. In the past five years, at least six similar episodes were reported in different parts of the country. Last year, the Algodoes Dam failed in Brazil's northeast, killing at least seven people.

According to Renata Andrade, a specialist in environmental risk and river basin management at the Catholic University of Brasilia, "Populations living downstream from dams are increasingly vulnerable to flooding, due to a lack of dam safeguards and emergency preparedness programs. In the case of the Mundau River, there was no alert system in place to inform local populations of the imminent risks of the dam bursts and the subsequent flooding."

Coming too late to help the victims in the Northeast, the Brazilian Congress in April passed a bill to create the National Dam Safety Program and Policy. The new law calls for the creation of a national commission of dam safety, a risk management system with safety inspections, and emergency plans for dams, including rules of accountability in case of dam bursts. The level of implementation of the new law and its effectiveness remain to be seen.

United States

A dam in eastern Iowa suffered a catastrophic failure in late July, emptying a nine-mile-long reservoir and flooding nearby communities. Thanks to local officials' early warning system and the location of the dam in a low-population rural area, no injuries were reported. The dam failure caused millions of dollars in property damage, and left 900 "lakefront homes" without a lake.

The US has thousands of ageing dams, many privately owned. The American Society of Civil Engineers gave a "D" to the nation's system of 85,000 dams in a report on dam safety last year. More than 4,000 are deemed deficient, including some 1,800 that could potentially cause a loss of life if they failed.

"I think we have found over the last five years that the number of dams that states have identified as being deficient or unsafe is growing at a rapid rate, and that rate is much faster than we are able to do repairs," said Brad Iarossi, a society spokesman and former head of Maryland's state dam safety program.

The 88-year-old Lake Delhi Dam did not have an emergency spillway or additional dam gates to accommodate a record flow of water. The dam was reportedly inspected in 1999, and was not considered high hazard.

According to the *Des Moines Register*, "Inspectors have said for decades that the Lake Delhi dam could barely handle a historically heavy flood - and one inspector predicted such an event might push water over the top of the dam."

Pakistan

At least one dam failed in late July during the torrential rains in Pakistan. The Tanga Dam in Baluchistan province gave way, inundating seven villages.

Close Calls

The number of close calls on potential dam failures has also been especially high. Here are a few from the recent record.

China

The huge Three Gorges Dam had some dangerous days during China's recent flood disaster. The dam experienced the biggest surge of water since it began operating four years ago, and its reservoir rose 4m (13ft) in just a day.

In addition, the dam's safety was compromised when the floods washed a thick layer of debris into the reservoir, threatening to jam a key floodgate on the dam. The debris layer was thick enough to support vehicles driving over it.

The flood was the first big one since the dam's completion. "One [flood control official] said the dam's flood-control abilities 'should not be overestimated,' another reportedly said they were 'limited,'" according to *The Economist.*

In recent years, Chinese officials have downgraded the dam's flood-control capacity from "able to withstand the worst flood in 10,000 years" in 2003, to 1,000 years in 2007, and to 100 years in 2008.

Pakistan

Rising water levels threatened to overwhelm the country's biggest dams. Affected dams included the Warsak Dam in Punjab,

Continued opposite

Pakistan: Why is the Indus So Flood-Prone?

by Peter Bosshard

As we write this, Pakistan is still under water, and millions are coping with the aftermath of the hugely destructive floods. But once the water has subsided and the victims have received support, Pakistan and the international community will need to learn the lessons of the current disaster. Are the floods a natural or a human-made disaster? What kind of flood management will help to prevent or mitigate future catastrophic floods in a time of climate change?

The floods in Pakistan have devastated huge sections of the country. Photo: DFID

Daanish Mustafa, a water expert from Pakistan who teaches at King's College in London, shed light on the current Pakistan flood disaster in a recent interview with the BBC. Mustafa explains that by walling in the Indus and destroying natural floodplains, Pakistan has substituted high frequency, low-intensity floods for low-frequency, high-intensity events.

"Unfortunately, the river managers in Pakistan … do not recognize the importance of wetlands to modulating the flow," said Mustafa. "Instead, The focus has been on dams, which have their usefulness, but wetlands unfortunately have been drained and settled and removed. As a result, the river's excess water has nowhere to go."

The Indus has one of the highest silt loads in the world. Due to dam building, the silt now gets deposited in the riverbed and reservoirs. As a consequence, the riverbed is elevated, its capacity to drain floodwater dwindles, and the pressure on the levees increases. Dam builders have often failed to take such changes into account.

In 2004-10, the World Bank rehabilitated the Taunsa Barrage on the Indus at a cost of $144 million. Mushtaq Gaadi, who teaches at Quaid-i-Azam University in Islamabad, notes that local NGOs objected to the rivers engineering perspective and urged the World Bank to pay more attention to the sediment deposition. The Bank refused. Now the embankments near the barrage have breached, and caused huge devastation in areas that are not normally flooded. "The very structures meant to control flooding have partially caused and definitely exacerbated the flood problem itself," Gaadi concludes.

Due to climate change, extreme weather patterns such as the current floods are becoming more and more frequent. Managing floods is a more appropriate response to such a scenario than trying to control them. According to Mustafa, "The kind of monsoon patterns you are seeing this year is very unusual. The scary part is we have seen this sort of unusual monsoon pattern about four or five times this past decade… The fundamental message is that the past averages are not going to hold. There is going to be greater uncertainty in the future. That being the case, then we have to be a lot more proactive and have to think about, well, if this becomes the pattern, then what?" ●

Listen to the BBC interview: www.bbc.co.uk/worldservice/news/2010/08/100818_indus_wt_sl.shtml

Dam Safety *continued from previous page*

Pakistan's most populous province; Tarbela Dam (Pakistan's largest), and Mangla Dam.

North America

Dams on the Texas-Mexico border were closely watched as two tropical storms brought high runoff to that region in July. Two dams in the region have for years been deemed unsafe by the US International Boundary and Water Commission.

According to a report in *The Brownsville Herald,* of the four unsafe dams in South Texas, deficiencies at Amistad Dam are "urgent" and at Falcon Dam are "high priority." Sinkholes at Amistad Dam were first identified in 1990. Inspectors noted that Falcon Dam's entire foundation was in need of further evaluation. Both dams also have a hazard-potential classification of "high," meaning that loss of life or significant property damage is expected if the dams fail.

The dams are "multipurpose" projects that are meant to store water and, ironically, provide flood control. A failure of the Amistad Dam could release 4.9 million acre-feet of water, the *Herald* reports. (An acre-foot is enough to cover one acre in a foot of water.)

And in Kentucky, Wolf Creek Dam, one of the country's largest, was recently designated "high risk" for failure by the US Army Corps of Engineers, requiring "emergency measures" to reduce an "imminent risk of human life" in the Cumberland River valley.

The dam was built on porous limestone. Over time, water has seeped into cracks in the rock, eroding holes and caves. A sinkhole could cause this entire earthen embankment to collapse.

The state has handed out warning radios to all 1,700 residents of Burkesville downstream of the dam

"If you live downstream from the dam, it doesn't matter whether the dam was attacked by terrorists or whether it failed because of fatigue and age and lack of repair. The people downstream are all impacted the same," said Patrick Natale of the American Society of Civil Engineers.

At this writing, the dam's reservoir levels had been lowered to allow repair crews to work.

The US Army Corps also announced it will begin a US$44 million repair to a dangerous dam near Seattle this fall. The Howard Hanson Dam on the Green River was weakened by heavy rains in January 2009, increasing the dangers of flooding in the heavily developed Green River Valley downstream. The dam's water level is being kept at about half of normal until the repairs can be made. ●

Adapting to a New No

When it comes to water, the past is no longer a reliable guide

by Sandra Postel

Water, like energy, is essential to virtually every human endeavor. The growing number of water shortages around the world and the possibility of these shortages leading to economic disruption, food crises, social tensions, and even war suggest that the challenges posed by water in the coming decades will rival those posed by declining oil supplies.

In fact, our water problem turns out to be much more worrisome than our energy situation, for three main reasons. First, unlike oil and coal, water is much more than a commodity: it is the basis of life. Our decisions about water – how to use, allocate, and manage it – are deeply ethical ones; they determine the survival of most of the planet's species, including our own. Second, also unlike oil and coal, water has no substitutes. The global economy is transitioning away from fossil fuels, but there is no transitioning away from water. And third, it is through water that we will experience the impacts of climate change most directly.

The rise in global temperatures driven by the past 150 years of humanity's greenhouse gas emissions is fundamentally altering the cycling of water between the sea, the atmosphere, and the land. Climate scientists warn of more extreme floods and droughts and of changing precipitation patterns that will make many dry areas drier and wet areas wetter. They warn of melting glaciers and ice caps that within a few decades could severely diminish the river flows upon which nearly a third of the world's people depend.

The effects of climate change are already calling into question the very assumptions that have underpinned water planning and management for decades. In 2008, seven top water scientists argued persuasively in the journal *Science* that "stationarity" – the foundational concept that natural systems vary and fluctuate within an unchanging set of boundaries – is no longer valid for our understanding of the global water system. In other words, when it comes to water, the past is no longer a reliable guide to the future. The data and statistical tools used to plan $500 billion worth of annual global investments in dams, flood-control structures, diversion projects, and other big pieces of water infrastructure are no longer trustworthy.

This is not just a problem for the planners and civil servants who run our local water systems. It raises very serious questions about community health, public safety, food security, and risk management. Will those levees keep the river within its banks? Should that expensive new dam be built when its useful life will be shortened by silt washed down from flooding mountainsides? Will farms get needed irrigation water once the glacier-fed river flows have dwindled? How do we guard against what once seemed unthinkable – the drying up of prime water sources?

The water challenges confronting us locally, regionally, and globally are unprecedented. They call for fundamental changes in how we use, manage, and even think about water. The good news is that it's within our economic and technological ability to have a future in which all food and water needs are met, healthy ecosystems are sustained, and communities remain secure and resilient in the face of changing circumstances. The path most of the world is on, however, will not lead to this more desirable state.

How we got here

Although renewable, freshwater is finite: The quantity available today is virtually the same as when civilizations first arose thousands of years ago. As world population grows, the volume of water available per person decreases; thus, between 1950 and 2009, as world population climbed from 2.5 billion to 6.8 billion, the global renewable water supply per person declined by 63%.

For most of modern history, water management has focused on bringing water under human control and transferring it to expanding cities, industries, and farms. Since 1950, the number of large dams has climbed from 5,000 to more than 45,000. Globally, 364 large water-transfer schemes move 400 billion cubic meters (1 cubic meter equals about 264 gallons) of water annually from one river basin to another – equivalent to transferring the annual flow of 22 Colorado Rivers. Millions of wells tap underground aquifers, using diesel or electric pumps to lift vast quantities of groundwater to the surface.

But the benefits of water development have not been shared equitably. More than 1 billion people lack access to safe drinking water, and some 850 million people are chronically hungry. Moreover, many regions have overshot their sustainable limits of water use. An unsettling number of large rivers – including the Colorado, Rio Grande, Yellow, Indus, Ganges, Amu Darya, Murray, and Nile – are now so overtapped that they discharge little or no water to the sea for months at a time. The over-pumping of groundwater is causing water tables to fall across large areas of northern China, India, Pakistan, Iran, the Middle East, Mexico, and the western United States. As much as 10% of the world's food is produced by overpumping groundwater. This creates a bubble in the food economy far more

The Aral Sea – a global poster-child of bad water management – once supported a major fishery until dams and irrigation diversions drained it. Photo: Dieter Telemans.

rmal

e to the future

Lake Chad, once the fourth largest lake in Africa, has lost 80% of its surface area in the past 30 years, and can now be virtually crossed on foot. Photo: Cédric Faimali

serious than the recent housing, credit, or dot-com bubbles, for we are meeting some of today's food needs with tomorrow's water.

It is tempting to respond to these predicaments with bigger versions of the familiar solutions of the past – drill deeper wells, build bigger dams, move more river water from one place to another. Indeed, many leaders and localities are responding in just that way. By some estimates, the volume of water moved through river-transfer schemes could more than double by 2020.

In a world of changing rainfall patterns and river flows, substantial hydrologic uncertainty, and rising energy costs, such projects are risky. They often worsen social inequities, such as when poor people are dislocated from their homes to make way for the dams and canals and "downstream" communities lose the flows that sustained their livelihoods. And serious environmental damage routinely follows on the heels of such projects. Moreover, large-scale infrastructure built to accommodate river flows today may be poorly matched to climate-altered flows of the future.

In addition, giant water projects require giant quantities of energy. Pumping, moving, treating, and distributing water take energy at every stage. The energy required to provide drinking water to a typical southern California home can rank third behind that required to run the air conditioner and refrigerator.

A Smarter Path toward Water Security

As with many challenges, finding the best solutions requires first asking the right questions. Typically, when planners and engineers see a water shortage on the horizon, they ask themselves what options exist to expand the supply. The typical answer: Get more water from a distant river, deeper wells, or a desalination plant.

But as the limitations of these "supply-side" options have become more apparent, a vanguard of citizens, communities, farmers, and corporations has started asking a different question: What do we really need the water for, and can we meet that need with less? The upshot of this shift in thinking is a new movement in water management that is much more about ideas, ingenuity, and ecological intelligence than it is about pumps, pipelines, dams, and canals.

This smarter path takes many forms, but it embodies two strategic attributes. First, the best solutions work with nature, rather than against it. In this, they make effective use of "ecosystem services" – the benefits provided by healthy watersheds, rivers, wetlands, and other ecological systems. And second, through better technologies and more informed choices, these solutions seek to raise water productivity – the benefit derived from each liter of water extracted from a river, lake or aquifer.

Working with nature is critically important to building resilience and reducing the energy costs associated with water delivery and use. Healthy rivers and watersheds, for instance, filter out pollutants, mitigate floods and droughts, recharge groundwater supplies, and sustain fisheries. They do this work with free energy from the sun. By contrast, all the technological alternatives – building and running a treatment plant to remove pollutants, artificially recharging groundwater, constructing dikes and levees, raising fish on farms require external inputs of increasingly expensive energy.

Of course, one of the most important "services" healthy watersheds perform is the provision of clean drinking water. If a watershed is doing the work of a water treatment plant – filtering out pollutants, and at a lower cost to boot – then it often pays to protect that watershed. New York City, for instance, is investing some $1.5 billion to restore and protect the Catskills-Delaware watershed (which supplies 90% of its drinking water) in lieu of constructing a $6 billion filtration plant that would cost an additional $300 million a year to operate.

Other innovative ideas are coming from Latin America, where some cities are establishing watershed trust funds. For instance, Rio de Janeiro in Brazil collects fees from water users to pay upstream farmers and ranchers $71 per hectare ($28 per acre) to protect and restore riparian forests, safeguarding the water supply and preserving habitat for rare birds and primates. A public watershed protection fund in Quito, Ecuador, started in 2000 in partnership with The Nature Conservancy, receives nearly $1 million a year from municipal water utilities and electric companies. Quito's water fund has become a model for other Latin American cities.

There are many ways communities can work with nature to meet their water needs while reducing energy costs and building resilience. Communities facing increased flood damage, for instance, might achieve cost-effective flood protection by restoring a local river's natural floodplain. After enduring 19 flood episodes between 1961 and 1997, Napa, California, opted for this approach over the conventional route of channelizing and building levees. In partnership with the Army Corps of Engineers, the $366 million project is reconnecting the Napa River with its historic floodplain, moving homes and businesses out of harm's way, revitalizing wetlands, and constructing levees and bypass channels in strategic locations.

Many communities are revitalizing their rivers by tearing down dams that are no longer safe or serving a justifiable purpose. Over the past decade some 500 dams have been removed from US rivers, opening up habitat for fisheries, restoring healthier water flows, improving water quality, and returning aquatic life to rivers. In the 10 years since the Edwards Dam was removed from the Kennebec River near Augusta, Maine, fish populations have returned in astounding numbers, reviving a recreational fishery that adds $65 million annually to the local economy.

Of all the water we withdraw worldwide from rivers, lakes, and aquifers, 70% is used in agriculture, 20% in industries, and 10% in cities and to wns. With water suppli es tightening, we will need

Continued on page 15

Amazon Indians Take Over Dam Site

by Zachary Hurwitz

The impacts of dams on indigenous peoples in the Amazon has been much in the news of late, as Brazil's Lula government attempts to push through the monstrous Belo Monte Dam on the Xingu River (see p. 3 for an update on opposition to the dam). But it's not just megaprojects like Belo Monte that are troublesome. In July, a smaller dam being built on the Aripuanã River in the state of Mato Grosso brought heightened tensions between indigenous people in the Amazon and those who seek to exploit the area's natural resources.

The Dardanelos Leap will be destroyed by the dam. Photo: Aguas da Pedra

In late July, energy company Aguas da Pedra, builders of Dardanelos Dam (261 MW), dynamited a cemetery belonging to the Arara indigenous tribe. The location of the cemetery had not been included in the dam's environmental impact assessment.

"We have been waiting since 2005. We're tired. This was a big cemetery, with all our ancestors, many generations of our tribe, which is right in the construction site. It is a sacred place for us," said tribal leader Aldeci Arara.

In response, 11 tribes led by the Arara, Cinta-Larga, and Rikbaktsa invaded the construction site. Dressed and armed for war, they held close to 100 Aguas da Pedra employees hostage, demanding that construction be halted and US$5.7 million be paid in compensation for the invaluable loss of their ancestors and the damage to the Aripuanã River, whose fish species have disappeared and whose waters have become polluted since construction began.

Rikbaktsa indigenous leader Jair Tsaidatase told reporters that "if they don't accept our negotiations, we will set the dam on fire."

One day after taking the construction workers hostage, the members of the tribes took five project engineers and managers in exchange for releasing the 26 construction workers. The five hostages were later released and an agreement struck between the dam company and the indigenous groups.

Dardanelos is one of a series of hydro projects on the Aripuanã that includes the Juína, Faxinal I, and Faxinal II dams. Construction plans for Dardanelos also include destroying the "Dardanelos Leap" (Salto de Dardanelos), a world-famous ecotourism site known for its spectacular waterfall and incredible biodiversity. Similar to the Belo Monte Dam, the project would divert the Aripuanã River through a water diversion canal, leaving indigenous people living downstream of the dam high and dry.

The tragedy highlights the fragile state of relations between the region's indigenous people and dam companies. In 2007, hundreds of the Enawenê Nawê led an occupation of the Telegráfica Dam and set fire to it, one of nine smaller dams on the nearby Juruena River, five of which are owned by agribusiness giant Grupo Amaggi. In 2008, further east on the magnificent headwaters of the Xingu, hundreds of Kamaiurá and Ikpeng held hostage workers of the Paranatinga II Dam, which diverted the Culuene River. Paranatinga II was one of the original six dams proposed as part of the Belo Monte complex in 1980, the only part of the complex to be built so far.

The dam occupations are linked to bad practices currently at the heart of the Brazilian hydroelectric industry and in the granting of environmental licenses. Brazil's dam industry regularly omits crucial data from impact studies due to internal pressure to meet political timelines and the promissory expectations of investors, rather than fulfilling legal obligations to perform comprehensive studies of a given project's impacts.

Frequently, impact assessments consider flooding to be the only direct impact on indigenous people, leading to engineering designs such as river diversion canals. Yet the impacts of such engineering "fixes," such as downstream river desiccation, or the discharge of pollutants and the transformation of water chemistry and quality, are not considered to directly affect indigenous people.

"Important aspects in the lives of these indigenous people were not considered by the company. The construction is not located inside of the indigenous reserve, but is right on top of an indigenous cemetery. The company dynamited something of inestimable value for them," said Antônio Carlos Ferreira Aquino, the regional coordinator for Funai, the government agency that deals with indigenous issues. "They don't want money in their hands, what they want is a sustainable program in the area that will recover the loss they have suffered."

For now, the current occupation is over and the Arara and others have gone home. But with so many big dams proposed or under construction in the Amazon, the next confrontation is only a matter of time. ●

Members of the Cinta Larga tribe, one of 11 affected by the Dardanelos Dam.

Korea's Rivers Feeling Impacts from 4-Rivers Project

Activists Step Up Campaign to Stop River-Killing Project

by Randy Hester, Jong Ho Hong and Marcia McNally

Since we last reported on South Korea's massive 4-Rivers diversion project (*WRR*, Sept. 2009), a great deal has happened and the battle to stop the project has intensified. The project continues to be severely criticized by well-qualified scientists, environmentalists, and citizens in Korea and abroad. A lawsuit was filed in November 2009 by academics, 10,000 citizens, and 420 citizen's groups, reflecting the depth of opposition. In 2010, *Science* published a damning article on 4-Rivers, and major research papers detailing the project's anticipated impacts were issued by Birds Korea and Korean Federation for Environmental Movements (KFEM). Nonetheless, the environmental review was pushed through and construction has begun.

Two months ago, members of SAVE International, an environmental group which began at the University of California, Berkeley, did field research on 4-Rivers with members of the Professors' Organization for Movement Against Grand Korean Canal (POMAC). The trip began with a visit to a still-pristine branch of the Nakdong River. We were fortunate to visit a beautiful stretch called the Dragon's Home, named for its dramatic meanders. The river has wide floodplains, sandy beaches, richly vegetated edges, and a great diversity of wildlife indicating a healthy, sustaining riverine system and a portrait of unparalleled natural beauty.

Our next stops graphically demonstrated what is in store for Korea's rivers. The group visited the construction sites of the Sangju Dam on the Nakdong River and Kangcheon Dam on the Han River. The delegation observed first-hand the removal of millions of cubic feet of sand to create deep shipping channels and the loss of thousands of acres of rich wetlands known to support critically endangered species of birds.

Local action against the 4-Rivers has escalated in recent months. In June, the day before mayoral elections in Korea, a Buddhist monk burned himself to death in protest. For the past month, three environmental activists have been protesting at the top of 27-meter-high Ipo Dam on the Han River, another of the 16 dams under construction in this huge scheme. The activists are enduring heavy rain, summer heat, typhoon conditions, and police threats in order to raise their voice to stop what they call the "River Killing Project."

Legal battles to stop the construction are currently heating up at each of the 4-Rivers sites. POMAC is pressuring National Assembly members to cancel or reduce the national budget for 4-Rivers in 2011. POMAC predicts that once the 2011 budget is approved, the government will have enough financial resources to complete most of the core construction and the project will become irreversible. Working in their favor, the June 2 election was considered a progressive victory and vote of no confidence for President Lee's agenda. Most important, it yielded two new mayors actively working to block 4-Rivers locally. ●

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Activists protest the 4-Rivers Project at the South Han River. Photo: Park Jong-hak/KFEM

4-Rivers construction underway on the Nakdong River. Photo: Lauren Stahl

Protesters have turned the Ipo Dam into a protest site against the 4-Rivers project. Photo: Ohmynews

News Briefs

South African high school students install solar panels on their school's roof. Photo: Nicolas Fojtu/Greenpeace

Clean energy potential in South Africa

Africa's biggest energy user, South Africa, should stop binging on coal and adopt renewable energy now, say two big environmental groups. The local chapters of WWF and Greenpeace recently released reports urging faster adoption of clean energy sources.

The WWF study says that half of South Africa's electricity generation could come from renewable energy sources by 2030. The group also devised a new tool – the free, downloadable "sustainable national accessible power planning (Snapp)" tool – to allow for the modelling of different energy scenarios.

Greenpeace is also pushing for cleaner energy production in South Africa. The group is calling for a minimum of 36% of the country's electricity to come from renewable energy sources by 2030, and a big increase in energy efficiency, which they estimate could cut electricity use by 30%. Greenpeace estimates that 78,000 green jobs could be created with a drive to adopt renewables and efficiencies.

A University of Cape Town researcher recently found that wind power could provide an unexpected 35% of South Africa's electricity. His study states that almost half of the nation had enough wind to be considered a "good" supply and that sizeable inland regions were an "excellent" resource.

The study says that wind energy is now cheaper than coal: "Eskom's latest coal-fired power station, Kusile, will produce power costing about R30m per megawatt of installed capacity. Wind developers in SA are working at a far lower cost: R20m-R25m per megawatt of installed capacity."

South Africa has been slow to adopt renewables, but is finally taking some steps toward energy efficiency. For example, a plan to expand the use of solar water heaters intends to install 450,000 systems in the next three years. And the national utility Eskom is also in the midst of a door-to-door roll-out of energy-saving compact fluorescent lamps (CFLs). Since the program started in 2003, more than 40 million CFLs have been installed, saving 1,759 MW. Yet Eskom's own estimates show potential for tens of thousands of megawatts in efficiency savings.

India's first dam-free zone

The government has scrapped the controversial Loharinag Pala Dam on the Bhagirathi River in the Indian Himalaya.

The river is a key tributary of the Ganges, and has great religious significance for Indian Hindus. A prominent Indian scientist had fasted nearly to death to protest the project.

As part of the decision, the government has created India's first dam-free zone in the ecologically sensitive area, through which the river will flow freely for 135 kilometers.

The fate of the 600 MW project had been hanging in balance for the past few years with the government first deciding to suspend the work, and then partially resuming construction, citing huge financial costs it had already incurred on the project.

Two other large dams proposed by the state government for the Bhagirathi had already been scrapped by the government.

Dams filling with silt

Sedimentation of dams is a growing problem, resulting in poor performance, loss of water storage and hydropower production, and potential safety problems including greater risk of flooding. According to dam sedimentation expert Gerrit Basson, by 2006, 35% of the total storage capacity for hydropower reservoirs had been filled with sediment. By 2050 it's expected to rise to 70%. For non-hydro dams, in 2006, 33% of the available capacity was filled with sediment, rising to a predicted 62% by 2050. The total yearly cost of this problem is about US$17 billion, according to Basson. Climate change could speed up the rate of sedimentation.

Water for sturgeon

The latest effort to save North America's largest freshwater fish from extinction began in June, when water was spilled over Montana's Libby Dam to encourage the wild Kootenai River white sturgeon to spawn for the first time in more than three decades.

The ancient sturgeon, a toothless fish from the days of dinosaurs, can reach 19 feet long and top 1,000 pounds. It takes 20-30 years for white sturgeon to mature and reproduce. Before Libby Dam was built in 1974, the river supported an estimated 10,000 Kootenai sturgeon. Fewer than 500 mature adults remain. Biologists say the wild fish could become extinct within a decade without help.

This year, the dam spilled added water for a week. Drought made for smaller spills than hoped, and only seven fish made it to the spawning grounds in Idaho. Spills are planned again for the next two years.

Most of the 24 species of sturgeon worldwide are threatened with extinction. The plan to save the Kootenai fish came out of a 2008 settlement with the Center for Biological Diversity.

Global plan for green energy

Senior officials from 24 nations, which collectively account for 70% of global emissions, agreed to a clean energy program that could eliminate the need for more than 500 mid-sized power plants around the world over the next 20 years.

The program will work to bring super-efficient home appliances to market, reduce the energy use of large buildings, support deployment of clean lanterns in developing countries, and create a global atlas of wind and solar capacity and help train workers in these fields.

But the program also includes a Sustainable Development of Hydropower Initiative – spearheaded by the dam-building nations Brazil, France, Mexico and Norway. The group says its first action will be to "inventory a river basin in an African country for potential hydropower resources." We're guessing it won't focus on micro-hydro.

Sun-powered water heating for Kenya

Kenya has made it mandatory for all new buildings in urban areas to include solar water heaters, as part of a new nationwide push to reduce electricity use. The Energy Regulatory Commission estimates that water heating accounts for about 25% of electricity consumed by households.

China water project relocation begins

China has begun its biggest relocation program since Three Gorges Dam, with 330,000 residents to be resettled by 2014. The first 500 villagers were moved in mid-August; a total of 60,000 people will be relocated by the end of September, according to the Chinese government. The controversial South-North Water Diversion Project will siphon water from the Yangtze River to serve drought-prone cities like Beijing and Tianjin, to curb over-withdrawal of groundwater, and to supply more water to industry.

"We felt sorrow when the whole village gathered to have our last dinner in our hometown together," one resettler was quoted as saying.

The massive diversion project, expected to cost US$62 billion, will feature thousands of kilometers of canals, and is expected to worsen pollution problems on the Yangtze – problems that have worsened since the construction of the Three Gorges Dam.
(Read our new report on this project's resettlement: www.internationalrivers.org.)

Hoover Dam reservoir shrinking

Hoover Dam's Lake Mead, the enormous reservoir of Colorado River water that supplies water to Arizona, Nevada, California and New Mexico, has shrunk to historic low levels. Nearly full in 1999, Mead is now at 40% capacity, and continues to shrink by the day. Water rationing may be on the horizon for Las Vegas, Los Angeles and Phoenix.

It's not likely to get better any time soon. According to Richard Seager, a climate scientist at Columbia University's Lamont-Doherty Earth Observatory, the southwestern US may experience a "permanent drought" with impacts similar to the Dust Bowl of the 1930s.

The Southwest's chronic overuse of Colorado River water began in 1922, when the Colorado River Compact overestimated flow by as much as a few million acre-feet. Over the past decade, the Southwest has suffered the sharpest temperature increase on the continent. Various studies predict that climate change will reduce the runoff that feeds the Colorado River anywhere from 6% to 45% over the next half-century, according to the *New York Times*.

Water and gas don't mix

The Arizona-based Center for Biological Diversity is suing two US government agencies for their approval of a natural gas pipeline across four Western states. The group says the 678-mile Ruby pipeline will harm endangered fish species.

The suit challenges decisions by the Bureau of Land Management and US Fish and Wildlife Service that allow construction of the pipeline across more than 1,000 rivers and streams.

"The Ruby Pipeline will cause severe damage to rivers and streams, sensitive habitats for a host of fish and wildlife species and some of the most pristine lands in western North America," said Noah Greenwald, program director at the center.

Australia's powerful surf

Two oceanographers from Australia's national science agency have calculated that Australia could meet much of its energy needs from wave energy alone. Australia's present-day electricity consumption is 130,000 gigawatt-hours/year. The scientists show that if 10% of the near-shore wave energy available along Australia's southern coastline could be converted into electricity, half of the country's present-day electricity consumption would be met.

Australia has committed to reducing greenhouse gas emissions by 60% of year 2000 levels by 2050. "Convert 10% of available wave energy from a 1,000-km stretch in this area to electricity, " the lead scientist said, and "the quota could be achieved by wave energy alone."

The World Energy Council has identified Australia as one of the world's most promising sites for wave-energy generation.

Unplugged dams in Ethiopia

Despite having nine full dams generating more than enough electricity to meet national needs, Ethiopia still suffers from regular power interruptions, particularly during peak hours, reports the *Addis Fortune*. The interruptions are largely due to the ageing, inadequate, outdated transmission lines.

For example, Tana Beles – Ethiopia's largest operating hydropower dam –was inaugurated in May 2010, yet the power it is generating is not reaching its intended recipients. The Ethiopian Electric Power Corporation (EEPCo) has yet to finish the power lines that connect it to the national grid. Critics worry that EEPCo's current building spree of new power plants, which includes the controversial Gibe 3 Dam, could worsen the transmission-line backlog.

Bushmen denied water rights

Xoroxloo Duxee died of dehydration after the Bushmen's water borehole was disabled. Photo: Survival

A Botswana judge has ruled that Bushmen in the Central Kalahari Game Reserve are not allowed to drill wells, giving them no right to water in a hot, arid land. The decision forces them to walk at least 40 km (25 miles) to fetch water. The Botswana government has been trying to force the Bushmen out of the Kalahari ever since diamonds were discovered there in the 1980s.

"Tourists to the reserve staying at Wilderness Safaris' new lodge will enjoy use of a swimming pool and bar, while Gem Diamonds' planned mine in the reserve can use all the water it needs – on condition none is given to the Bushmen," states Survival International. The government has also drilled boreholes to attract wildlife to posh safari camps.

Bushman spokesman Jumanda Gakelebone said, "If we don't have water, how are we expected to live?"

Lives in the balance

Rivers, floodplains and deltas feed hundreds of millions of people by sustaining fisheries, crops, and grazing land. As the UN Millennium Ecosystem Assessment has found, floodplains are among the most productive ecosystems on Earth. Rivers and floodplains also nurture riverine and mangrove forests, recharge groundwater resources, and provide the silt that builds deltas.

Today, more than 50,000 large dams block the arteries of the planet. They have stopped fish from migrating, withheld nutrients and water from floodplains, dried up wells and riverine forests, and left deltas exposed to saltwater intrusion and erosion.

"It does not make sense to continue to damage rivers' natural life-support systems when far less destructive approaches to dam development are readily available."

The new report presents numerous case studies of these impacts. After the Tucurui Dam was built on the Tocantins in Brazil, the fish catch immediately fell by 60%, affecting tens of thousands of people. The fish yields in the wetlands of Cameroon's Logone River fell by 90% after the Maga Dam was built. Similar impacts have been documented for dams on Ghana's Volta, Thailand's Mun and West Africa's Senegal rivers.

An estimated 40-80 million people have been displaced by dams. Reservoir refugees are usually entitled to compensation for their losses (though in far too many instances they do not get what they need to restore their lives). Most downstream-impacted people don't have any such rights. The people who were displaced by the World Bank's Tarbela Dam reservoir in Pakistan received new homes and some financial compensation. Yet the people who lost their homes to the sea because of the dam's downstream impacts cannot claim any compensation under Pakistan's laws or the World Bank's safeguard policies. The Bank argues that the degradation of the Indus Delta is "part of the bargain struck in order to support large numbers of people in the Indus Basin."

Even if you subscribe to the Bank's argument that some people have to suffer so that others can prosper, it is dishonest for the Bank and dam builders to ignore the impacts of their dam projects on people living downstream.

Even without considering the cost of building a dam, the economic value of floodplains may be higher than the value of irrigated land. Richter and his team found that the downstream impacts of dams on food production on floodplains can outweigh their supposed agricultural and fisheries benefits. On average, fisheries in large reservoirs are 2-3 times less productive than riverine fisheries. In addition, dams can result in disruption, hunger and loss of livelihoods for fishing communities hundreds of kilometers away.

The authors argue that "a sizeable proportion of the human population is being fed by the natural productivity of river ecosystems ... it does not make sense to continue to damage these natural life-support systems when far less destructive approaches to dam development are readily available."

Way Forward

The authors put forward a series of practical recommendations that could help reduce the downstream impacts of dams. They make the case for an integrated planning approach to whole river basins, to prevent dams from being built in the wrong places. Integrated river basin planning takes social, environmental and economic costs and benefits into account, and includes the evaluation of rivers' current benefits through participatory assessments.

The authors also call for dam design and operational plans that strike an optimum balance between economic, social and environmental benefits – for example, through providing adequate environmental flows which are continuously monitored and adapted.

A successful example of the authors' approach is the relicensing agreement between a power company, the Penobscot Indian Nation and environmental NGOs regarding hydropower plants on the Penobscot River in the Northeastern US. Under this agreement, two dams will be removed and the fish passage on another dam was improved. Even so, the total power generation from the dams on the river will be maintained or slightly increased through the rehabilitation of the remaining power plants.

We at International Rivers believe it is morally unacceptable to sacrifice the interests of one population group for the benefit of another in a supposed "bargain" struck by powerful elites. Like other affected people, downstream-impacted communities must be taken into account, and have the right to participate in the decision-making process over projects that affect them. And if indeed a dam is built after such a process, downstream affected people should be entitled to full compensation for their losses. ●

"Lost in Development's Shadow: The Downstream Human Consequences of Dams" is available at
www.internationalrivers.org/en/node/5571

India and Pakistan disagree over dam

India's plans to build a hydroelectric dam on the Kishanganga River, a tributary of the Indus, has sparked legal action from Pakistan, which says the project violates the Indus Water Treaty.

The US$800 million project would redirect water that is used for agricultural production in Pakistan to generate 330 megawatts of energy in India. The river was one of three Himalayan rivers awarded to Pakistan for unlimited use under the 1960 treaty.

There are currently more than 30 other Indian hydro dams on the Indus at varying degrees of development, all of which have been challenged by Pakistan.

In the past 30 years, per-capita water access in Pakistan has fallen by half, according to the Woodrow Wilson International Center for Scholars. India blames Pakistan's water scarcity on climate change and poor water management, while Pakistan claims India's hydropower plans are worsening existing regional problems.

In August, it was reported that a World Bank mediation effort failed to resolve the dispute. Workers building a diversion tunnel for the project also reportedly left the dam site in early August due to local protests against the project.

roughly a doubling of water produc tivity by 2025 to satisfy human needs while sustaining nature's life-support systems. Fortunately, opportunities to get more benefit per drop abound through greater investments in conservation, efficiency, recycling, and reuse, as well as through shifts in what is produced where and when.

Water for Food

Feeding the world is a very water-intensive enterprise. It takes about 3,000 liters of water to meet a person's daily dietary needs. In the United States, with its high consumption of meat (especially grain-fed beef), the average diet requires some 5,000 liters of water per day. Under some very conservative assumptions, it could take as much water as the annual flow of 73 Colorado Rivers to meet the world's dietary needs in 2025.

Once again, the search for solutions needs to begin with a reframing of the question. Instead of asking where we can find 73 Colorado Rivers' worth of water, the question is: How do we provide healthy diets for 8 billion people without going deeper into water debt?

There are many ways we can grow more food for the world with less water. Here are a few examples.

Irrigate more efficiently: For the past two centuries, societies have focused on expanding irrigation as a key to raising crop production. Today, much of the water withdrawn for farming never benefits a crop. Some of it seeps back into aquifers or nearby streams, while some evaporates back to the atmosphere. There are many ways to reduce the waste: Irrigation can be scheduled to better match crop water needs, for example, or drip irrigation can be used to curb evaporation losses. Reducing irrigation demands by even 10% could free up enough water to meet the new urban and industrial demands anticipated for 2025.

Boost yields on rain-fed lands: By one estimate, 75% of the world's additional food needs could be met by increasing harvests on low-yield farms to 80% of what high-yield farms achieve on comparable land. Most of this potential is in rain-fed areas, and it's achievable through small-scale technologies and improved field methods – including, for example, capturing and storing local rainwater to apply to crops via low-cost irrigation systems. Because the majority of the world's poor and hungry live on rain-fed farms in South Asia and sub-Saharan Africa, raising the farms' productivity would directly boost food security and incomes.

Choose less water-intensive diets: Foods vary greatly both in the amount of water they take to produce and in the amount of nutrition they provide. It can take five times more water to supply 10 grams of protein from beef than from rice, for example, and nearly 20 times more water to supply 500 calories from beef than from rice. If all US residents reduced their consumption of animal products by half, the nation's total dietary water requirement in 2025 would drop by 261 billion cubic meters per year, a savings equal to the annual flow of 14 Colorado Rivers.

One of the biggest untapped potentials for smarter water management in all types of enterprises lies in more creative use of information technologies: meters, sensors, controllers, computers, and even cell phones. In Ugandan villages, farmers lacking computers are getting access to the wealth of information on the Internet by calling their questions in to a free telephone hotline called Question Box. The operators, who speak the local language, search for the answers and call the farmers back. A project of Open Mind, a California-based nonprofit, Question Box enables poor farmers, whose only communication device may be a village phone, to connect to the wired world for information on crop prices, weather forecasts, plant diseases, and more.

The potential uses of information technology to enable smarter water decisions are extensive and have only begun to be tapped. Using GIS (geographic information system) technology, for example, the World Wildlife Fund (WWF) recently identified more than 6,000 traditional water tanks (small reservoirs to capture rainfall or runoff) in a single sub-watershed in western India. WWF determined that if the tanks were restored to capture just 15-20% of local rainfall, they could hold some 1.74 billion cubic meters of water – enough to expand irrigated area in the region by 50% and at a cost per hectare just one-fourth that of an irrigation dam-and-diversion project proposed for the region.

Resetting the Signals

Most of the world's water shortages have arisen because the policies and rules that motivate decisions about water have encouraged inefficiency and misallocation rather than conservation and wise use. Without big dams and river diversions subsidized by taxpayers, for example, rivers and streams in the western United States would not be so severely depleted today. And without low, flat rates for electricity, India's groundwater would not be so severely over-pumped.

Allowing markets to do what they can do well – send a price signal about water's value –is critical for encouraging investments in water efficiency and more sensible uses of water. Most governments in rich and poor countries alike, however, continue to send the wrong signal by heavily subsidizing water, especially for irrigation, the biggest consumer. While better pricing is essential, it doesn't automatically account for the many important benefits of rivers, lakes, wetlands, and streams that are not recognized in the marketplace. It is the job of governments, as custodians of the public trust in water, to protect these important but often unrecognized values, and it is the job of citizens to demand that their elected officials get busy crafting creative solutions

Current pricing and policy signals are deeply misaligned with the realities of our water predicament, but this means that there are untold opportunities for improvement. For example, a cap on groundwater pumping from the Edwards Aquifer in south-central Texas has motivated farmers, businesses, and citizens to conserve. San Antonio has cut its per capita water use by more than 40%, to one of the lowest levels of any western US city.

It is critical that policy-makers begin to grapple with the inconvenient truth that supplying water takes energy and supplying energy takes water. Energy and water are tightly entwined, and all too often public policies to "solve" one problem simply make the other one worse. For example, the 2007 mandate of the US Congress to produce 15 billion gallons of corn ethanol a year by 2015 would annually require an estimated six trillion liters of additional irrigation water – a volume exceeding the annual water withdrawals of the state of Iowa. Even solar power creates a demand for water, especially some of the big solar-thermal power plants slated for the sunny Southwest. Clearly any action we take to build local renewable energy sources must be careful not to add additional strain to our already-stressed rivers and aquifers.

The win-win of the water-energy nexus, of course, is that saving water saves energy, and saving energy saves water. The more a community lives on water, energy, and food produced locally, the more options arise for solving multiple problems simultaneously, building resilience through resourcefulness, and preparing for future uncertainties. ●

Sandra Postel directs the Global Water Policy Project and is a fellow of the Post Carbon Institute. She is the author of several books, including Last Oasis: Facing Water Scarcity, *and a member of International Rivers. A longer version of this article, including references, appears in the* Post-Carbon Institute Reader.

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Jocie Bartlett

Volunteer of the Month

Jocie Bartlett is an International Rivers Ambassador. She began volunteering in 2009 and has been helping make our public events amazing ever since. In her time with us, she has also worked on our Patagonia and Africa programs. Jocie was originally drawn to International Rivers' work, she says, because of our efforts "to strengthen civil societies and faciliate the cultivation of agency within disempowered communities." She is currently pursuing a Master's Degree at the California Institute of Integral Studies in San Francisco.

Brazilian Dam Plan Threatens Peruvian Amazon

by Monti Aguirre

Brazilian President Luiz Inácio Lula da Silva signed an energy agreement with Peruvian President Alan Garcia in June that includes building six hydroelectric dams in the Peruvian Amazon. The plan, expected to cost more than US$15 billion, would supply more than 6,000 MW of power to Brazil,

The projects were designed by the Brazilian electric utility Eletrobrás in conjunction with Brazilian multinational construction giants Odebrecht and Andrade Gutierrez, all of which would be directly involved in dam construction with funding from the Brazilian national development bank, BNDES.

"This accord will not guarantee clean and renewable energy for Peru. On the contrary, it will impose a series of negative environmental and social impacts such as displacement of indigenous people and deforestation in at least five regions of Peru, putting at grave risk the future of the Peruvian Amazon," said Mariano Castro, a lawyer with the Peruvian Society of Environmental Rights.

One of the first projects to be built under the accord would be the Pakitzapango Dam on the Ene River, which would impact close to 17,000 Ashaninka indigenous people and threaten Otishi National Park.

The Inambari Dam on the Madre de Dios River is also on the list of dams to be built under the bilateral agreement. Inambari would flood more than 46,000 hectares of land, which would leave more than 15,000 people without agricultural lands. The project would also flood portions of the Inter-Oceanic highway, for which Peruvians already paid a massive price.

Ruth Buendia is leading the Ashaninka people in fighting Pakitzapango Dam. Photo: Jonathan McLeod

"Peru does not need these dams, we have close to 50,000 MW of renewable energy potential, such as wind, solar and geothermal, that does not include large dams. This deal will only benefit Brazil, and we are not going to let this happen," said Engineer Alfredo Novoa Pena, the founder of Peruvian environmental organization Pro-Naturaleza.