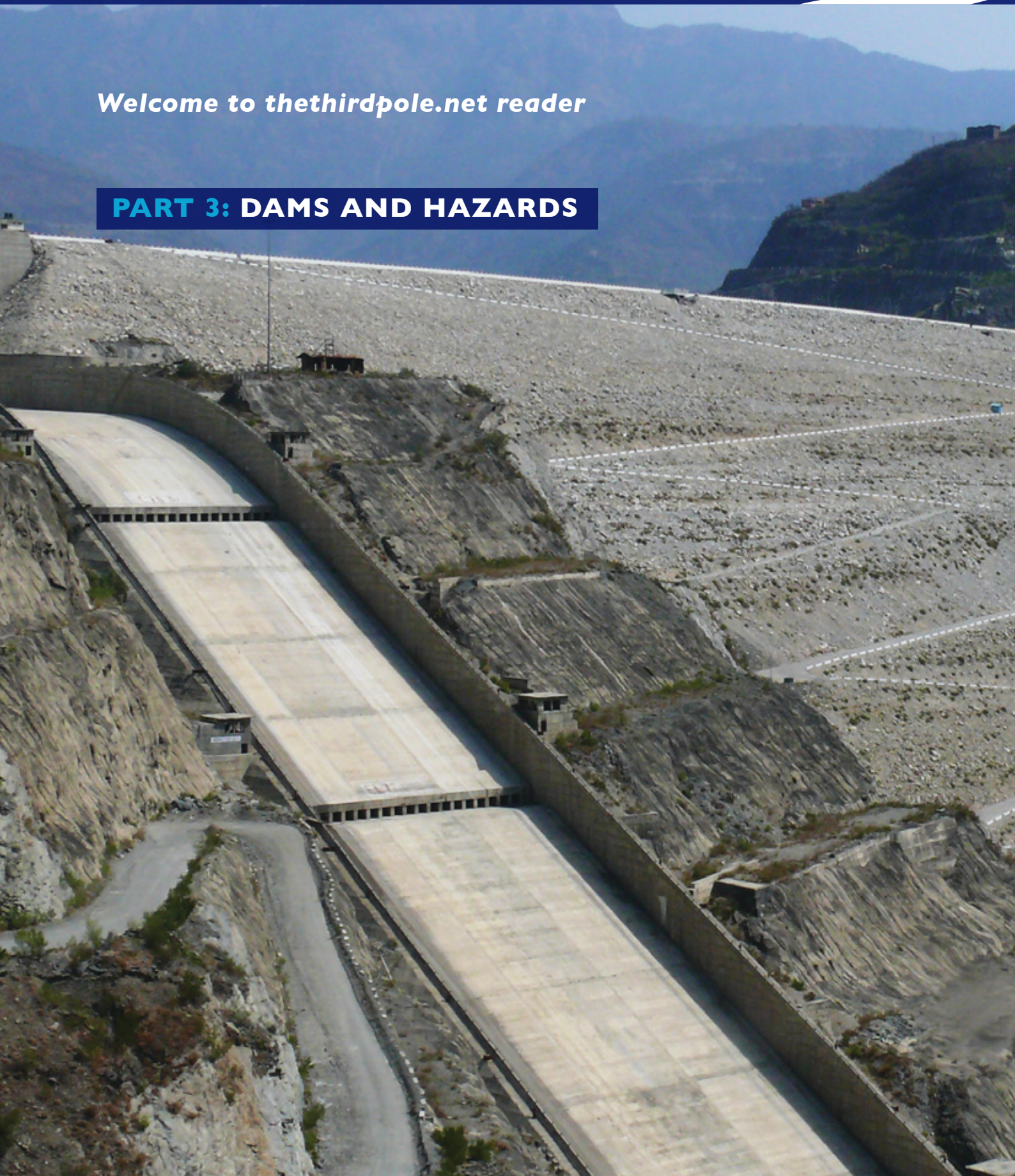
Exploring the third pole



Welcome to thethirdpole.net reader

PART 3: DAMS AND HAZARDS

Exploring the third pole
Editor's note

Welcome to thethirdpole.net reader

Since its launch in 2009, thethirdpole.net has provided a unique platform for information, reporting and discussion on the ecology, environment and climate of the Hindu Kush-Himalayas, the Qinghai-Tibet Plateau and the rivers that originate there. We aim to facilitate the free flow of accurate information and analysis and thereby support well informed policymaking in this region. Good governance is crucial to protecting ecosystems on which around 1.3 billion people depend directly or indirectly for their food, water and other vital services.

Using thethirdpole.net's unique reach across the region, we have been able to publish articles by journalists and experts from the various countries that share the benefits and risks of the world's highest mountain range and plateau, from Tibet to Bangladesh. Recognising the continued and pressing need for a regional perspective in a part of the world where access to accurate information is problematic, we are launching the first of a series of thethirdpole.net readers. These special publications will offer invaluable background material to policymakers, academics and other stakeholders.

Important articles are classified by theme and this reader is free to download. We hope that you find it useful and we encourage you to circulate the link. Please also help us to improve and develop this resource by sending your comments and feedback to joydeep.gupta@thethirdpole.net or beth.walker@thethirdpole.net.

Isabel Hilton and thethirdpole.net editorial team

June, 2012

Part 3:
Dams and hazards

The Himalayas – formed from the clash of two great tectonic plates – is one of the world's most active earthquake zones. With its powerful rivers and deep valleys, it is also extremely attractive to dam builders. The governments of the region have dramatic plans to transform the Himalayan rivers into the powerhouse of South Asia, ignoring the potential hazards and the cumulative and transboundary impacts of such projects.

In this section, Ann-Kathrin Schneider argues that climate change poses unprecedented challenges to hydropower development in the region and calls for a comprehensive review of dam building projects. Meng Si discusses the impending hydropower boom in western China. Zhou Wei gives voice to Chinese scientists' concerns about a radical proposal to divert Tibet's water. Daanish Mustafa and David Wrathall call for a new approach to river basin management in the wake of the destructive Indus flood of 2010. And Joydeep Gupta debunks an old myth that dam building in Nepal can prevent floods in India's Ganges basin.

Cover image shows Terhi Dam in India by Lingaraj G J

Dams and hazards
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February 23, 2009

Mountains of concrete?

The effects of climate change on the Himalayan glaciers pose unprecedented challenges to hydropower development in the region, writes Ann-Kathrin Schneider.

The warming climate is changing the environment in the Himalayas faster than any other region of the world. The mighty glaciers of the world's highest mountains – the source of most large Asian rivers, including the Indus, the Ganges and the Nu (Salween) – are melting.

Against these dramatic changes, the governments of India, Pakistan, Nepal and Bhutan are planning to transform the Himalayan rivers into the powerhouse of south Asia. They want to build hundreds of mega-dams to generate electricity from the wild waters of the Himalayas. With over 150,000 megawatts (MW) of additional hydropower capacity proposed in the next 20 years across the four countries, the Himalayan region could potentially have the highest concentration of dams in the world.

While a high concentration of large dams will challenge the integrity of river basins and the livelihoods that depend on them, a dam building boom in the Himalayas could have a range of unforeseen consequences due to climate change.

Global warming will cause glaciers to melt, river waters to rise and increase the risks of storms and floods. The water situation in the Himalayas will change drastically: past seasonal and regional trends will no longer be a good measure to predict future water flows; these flows will change in each and every Himalayan river.

What does this mean for dam building in the region? When planning hydropower projects, some of the most crucial data is about river flow. However, with melting glaciers in the Himalayas, historical river flows are no longer a good measure for future flows. Climate change has destroyed the certainty that future river flows will be similar to past flows.

> *Climate change has destroyed the certainty that future river flows will be similar to past flows. This uncertainty makes it incredibly risky to build dams.*

This uncertainty makes it incredibly risky to build dams. The extent of the predicted storms is not known, the seasonal distribution of waters is no longer certain. Nobody can predict when the waters in the rivers will rise, how much they will rise and for how long. Moreover, no one knows when the glaciers will eventually have melted – and no longer can provide any water to the rivers at all. We only know that the melting of the glaciers in the Himalayas will result in an initial increase and then a decline of water flows in the Himalayan rivers.

The data needed to build hydropower projects in the Himalayas is not available. It is not clear how often the dam gates of any planned dam in the Himalayas will have to be left open in order to allow for extremely high floods to rush through its gates (all the while not generating any power). Storms, strong rains and floods, which are predicted to increase with the warming climate, can also threaten the very existence

of dam walls and can destroy even the most robust mountains of concrete planned in the Himalayas.

Shripad Dharmadhikary, in his report "Mountains of Concrete: Dam Building in the Himalayas", has shown that the plans for most dams in the Himalayan region do not take the likely impacts of climate change on the Himalayan rivers into account. Dharmadhikary says: "Unfortunately, none of these risks are being considered in the dams planned for the Himalayas – neither for individual dams, nor cumulatively".

The governments of the region, eager to make the dam-building boom happen, focus on the expected benefits while turning a blind eye to the uncertainties of global warming. "Hydro-dollars" are on the minds of the governments of Nepal and Bhutan, who want to build the large dams to earn revenues from the sale of electricity to India. India itself is eager not only to buy hydropower from its neighbours, but also to generate it in the mountainous regions of the country.

Nepal currently finds itself in a severe energy crisis, with a shortage of petroleum fuels and only 40% of the rural population with access to electricity. However, most of the large dams in the country are planned for the export of electricity to India. Among the big projects planned for the immediate future, West Seti, Upper Karnali and Arun III are all meant to sell electricity to India, with only a small percentage of that power being set aside for Nepal.

It comes as no surprise that these large dams face opposition from the residents they will displace. But some in Nepal also explain that the country will not even gain "hydro-dollars" from projects such as West Seti. Ratna Sansar Shresthar, a Nepali lawyer and financial analyst, explained that since the project is being built by foreign corporations, Nepal will not see much of the expected profits. "Since most of the project's equity comes from overseas – except for the government's 15% share – only 15% of the dividend will come to Nepal," said Shresthar. "Another major outlay is the repayment of a part of the principal and interest. As the project is borrowing from foreign agencies, these payments will never enter Nepal." The promises of high revenues for Nepal are therefore likely to remain unfulfilled.

In India, the basic driver for hydropower is the demand for electricity. The country continues to be plagued by power and energy shortages. Overall, peak power demand over 2007 was 108,886 MW, of which only 90,793 MW were met – a shortfall of over 16%.

Moreover, a large portion of the Indian society does still not have access to electricity. The government says that in 2006, one in four Indian villages was still without access to electricity.

However, it is not clear that a lack of access to electricity can be blamed solely on the country's lack of generation capacity. India's electricity grid is known for its huge transmission and distribution losses of between 35% and 45%. Recent increases in electricity costs for private consumers, as well as the reduction of subsidies, have further reduced poor people's access to the grid.

More hydropower capacity will not necessarily increase people's access to electricity. Since most of the projects are planned at high altitudes, they will be costly and so will the electricity that they generate.

The 4,500-MW Diamer-Bhasha Dam on the Indus in Pakistan, with a price tag of US$12.6 billion, is the most costly dam planned for the Himalayan region. While the government of Pakistan has been working for more than two years to find funders for the project, its finances are still on shaky grounds. In November 2008, Pakistan's National Economic Council approved US$1.5 billion toward the construction of the dam, and Pakistan's minister for water and power declared that Chinese companies would build the dam and "some Arab countries" would provide part of the financing. Around the same time, the World Bank refused to provide any funding for the project, dealing a severe blow to the government's attempts to find foreign backers. In response to this decision, the minister was quoted as saying that several alternative avenues for funding the project would have to be

sought, including private sector loans and a surcharge on electricity.

The Diamer-Bhasha Dam is not the only project that lacks clear funding commitments and forces the government to try to find alternatives to traditional funders that used to provide the bulk of the funds for hydropower.

In India, traditional funders are also taking a back seat and Indian financial institutions, as well as Indian public sources, are playing larger roles. But the financial gap is still huge; with the current global financial crisis, the appetite for funding large dams might be further diminished. Dharmadhikary shows in his report that over 40% of the funds needed for the Indian government's Eleventh Five-Year Plan for the power sector are still lacking.

Global warming might be the most serious challenge to the safety and efficiency of the proposed dams in the Himalayan region, but the funding gap appears to be hampering India and Pakistan moving ahead with the largest planned dams for the region, including the Diamer-Bhasha project. It also appears that strong local opposition to some of the major projects, including the West Seti project and the 3,000-MW Dibang project in Arunachal Pradesh, India, constitute larger obstacles for the project planners than anticipated. Planned public hearings for the Dibang project have had to be cancelled several times due to strong opposition, and the government of Sikkim has announced it will scrap four planned projects on the Teesta River, in response to local opposition.

Opposition to the projects testifies the low degree of participation of affected people in the relevant decision-making processes – and the lack of consideration for the social and environmental impacts of the planned dams. Dharmadhikary's analysis also testifies to the lack of consideration for climate-change issues in the planning processes. He writes: "Pushing ahead such a massive dam-building program in the fragile Himalayan region without proper social and environmental assessments and safeguards, and ignoring the likely impacts of climate change, can have severe consequences.

"All of these things point to the need for a comprehensive review of the dam building program in each of the river basins in the Himalayas."

Ann-Kathrin Schneider is South Asia programme director and policy analyst at International Rivers. Schneider holds a Master's degree in Development Studies from the School of Oriental and African Studies in London. Her work focuses on monitoring and challenging the activities of international financial institutions such as the World Bank and private banks.

Image by International Rivers

February 14, 2011

Hydropower's green excuse

Seven years ago, public pressure brought plans to dam China's Nu River to a halt. But top officials, bolstered by clean-energy targets, are backing the scheme once again, reports Meng Si.

"Hydropower development is a must," said a senior official from China's top economic planners, the National Development and Reform Commission (NDRC), effectively breaking seven years of silence on hydropower exploitation on the Nu River – China's last great waterway without large-scale dams – and dashing the hopes of campaigners who successfully halted development in 2004, after a public outcry.

Feeling the pressure from energy-efficiency and emissions-reduction targets in China's 12th Five-Year Plan, due to be published next month, the government and state-owned electricity enterprises are ramping up their hydropower ambitions. Bets are rising on a "Great Leap" in hydropower exploitation.

On January 28, Shi Lishan, deputy head of the New Energy and Renewable Energy Division of China's National Energy Administration, set out his views on the Nu River (also known as the Salween): "My belief is that development is a must. Because the Nu's upper and lower reaches are already built up, in the past some people have said that it is necessary to leave a stretch of free-flowing river. I believe that putting that theory into practice is not realistic.

"We expect that, on the basis of strong evidence, and after seeking the opinions of all parties, that we can press ahead with hydropower construction on the Nu River."

A journalist who has long reported on hydropower issues in China is Liu Jianqiang, chinadialogue's Beijing editor. He believes that hydropower development has caused so much controversy in the past in China because of the negative impact on ecology and displaced people – but that now hydro interest groups are using the need for energy and emissions saving as an excuse to promote a new round of frenzied hydropower development.

> *Hydro interest groups are using the need for energy and emissions saving as an excuse to promote a new round of frenzied hydropower development.*

In 2004, under pressure from environmental groups and the media, the prime minister, Wen Jiabao wrote in the State Reform and Development Commission report on the Nu River hydropower development project that "given the high level of social and environmental concerns over the large scale hydro project, further careful research is required in order to reach a scientific decision".

In the years following this event, the hydropower developers on the Nu kept a low profile, studiously avoiding doing anything to draw public attention. But the high-sounding sentiments from authorities in recent weeks have led Chinese NGOs to believe this time, the problem is serious.

The Nu is one of south-west China's great rivers, starting high up on the Qinghai-Tibetan plateau and flowing down to the Indian Ocean. Its water resources

are rich and it is currently China's only large river without any large-scale dams.

According to the first plan for dam construction on the Nu, a string of 13 hydropower stations would produce annual output of 102.96 billion kilowatt hours. When completed, the value of the electricity generated could reach 36 billion yuan. Every year, it would generate 8 billion yuan in tax revenue for the government and local government coffers would also grow by 2.7 billion yuan.

"It's true that hydropower exploitation can bring economic development, but not necessarily to the benefit of local people," says Ma Jun, director of Chinese NGO the Institute of Public and Environmental Affairs (IPE). He believes that today's insufficiently transparent policymaking mechanisms are maximising the interests of hydropower industry, officials and a small number of experts, while driving ecological destruction, affecting local livelihoods and increasing the risk of geological disasters.

Back in 2003 and 2004, proposals to build a string of dams on the Nu River provoked a fierce debate. A journalist from China Economic Times reported seeing a report on a meeting to assess hydropower projects on the middle and lower Nu, which said: "Hydropower development on Nu river is unstoppable. Preparatory work of next stage will be carried out as soon as the state approves."

Today's "hydropower is a must" has something of the flavour of that report's "unstoppable". But, back then, central government ultimately backed the voice of the people. Today's government is more worried about how "clean" hydropower energy can help the government fulfil its low-carbon promises.

The Chinese government has committed, by 2020, to getting 15% of its power from renewable sources. By 2020, it is also bound to reduce the carbon-intensity of its emissions by 40% to 45%, based on 2005 levels. However, to hit the energy-saving and emissions-cutting targets in the 11th Five Year Plan period, electricity supplies were cut off in some places. And, in the first half of 2010, energy consumption per unit of GDP jumped, showing just how difficult it will be for China to achieve the energy targets.

At the end of 2010, Zhang Boting, vice secretary of the China Society for Hydropower Engineering, told reporters that the 12th Five Year Plan called for hydropower development to be prioritised. For various reasons, two thirds of the hydropower projects detailed in the 11th Five Year Plan had not been completed and would be revived in the 12th Five Year Plan.

In November last year, the waters of the Yarlung Zangbo (which becomes the Brahmaputra downstream) were dammed for the first time as part of a project to build Tibet's first large-scale hydropower station, at Zangmu. Immediately afterwards, the developers commenced the plant's main construction stage. Geologist Yang Yong told Southern Weekend that this event marked the "start of a hydropower age in Tibet". Four of China's "big five" electricity companies have already made their way into the region.

It is not only the future of the Nu River that is at stake. In January 2011, in order to boost hydropower construction, a proposal was submitted to shrink a reserve for rare fish on the upper reaches of the Yangtze River, threatening the existence of many species. At the end of 2010, China's oldest environmental NGO, Friends of Nature, requested a public meeting with the environmental authorities, but their request was denied.

In the past, the Ludila, Jinanqiao, Long Kaikou and other hydropower projects were stalled due to obstruction by environmental groups and the pressure of public opinion. But now, one by one, the embargo on these projects has been lifted.

Ma Jun says: "Environmental groups are not completely against dams. We approve of appropriate development. But China's present speed of

development is excessive." He says that, by 2004, China had overtaken the US to become the country with the world's largest hydropower capacity. At that time, the target was to reach a capacity of 300GW, equivalent of tripling capacity within 16 years. After another 15 years, China's hydropower resources will reach their limit. "Now there is no way to undo the destruction and this will becomes a historic regret," he says.

Ma Jun says that if hydropower exploitation on Nu River gets going again, it will very likely trigger a new wave of high energy-consuming industrial development in south-west China, due to local government plans to use the newly generated electricity to exploit the area's rich mineral resource. This is difficult to square with the national goal of low-carbon development.

Ma Jun's research shows that in many areas of Yunnan province, to adjust the unstable electricity generated from hydropower, coal-fired power plants of the same scale are built up as back up. The Nu River could face the same situation, given its unstable water flow in different seasons. And this is difficult to square with national goals on low-carbon development.

The National People's Congress (NPC) and Chinese People's Political Consultative Conference (CPPCC) – two top government bodies – will meet in March this year. And the elements of the 12th Five Year Plan concerning energy efficiency, emission reduction and hydropower exploitation will be at the heart of their discussions. At the same time, Friends of Nature has been calling on local green groups to write open letters to NPC and CPPCC representatives, urging them to reconsider plans to shrink the national-level nature reserves on the upper Yangtze River.

Meng Si is a Beijing-based freelance journalist who formerly worked at chinadialogue.

Image by SunnyBada

September 20, 2011

Divided waters in China

Chinese scientists troubled by radical proposals to divert Tibet's water are making their voices heard. Zhou Wei listened in at a seminar about the Shuotian Canal.

One of the boldest engineering concepts to emerge in China in recent years is a plan to "save" the country by transferring water from Tibet to the parched north. Among the schemes put forward, bringing water from Shuomatan point in Tibet to the city of Tianjin on China's east coast – the "Shuotian Canal" – has received particular attention. It is said to have the backing of military figures and academics, but at a seminar last month scientists from a number of different disciplines were merciless in their criticism of the scheme.

The early August gathering, organised by Chinese NGO Green Earth Volunteers, brought together experts in geology, meteorology and wetlands conservation with the man behind the proposal, Guo Kai. Guo is convinced the Yarlung Zangbo River (known as the Brahmaputra once it crosses the border into India) is the solution to water shortages in some of China's driest parts. (See chinadialogue article "Diversion debate" for more detail on proposed water transfer schemes from western China.)

Sometimes referred to as a modern day Guo Shoujing, a Yuan Dynasty water expert, Guo Kai comes from a family of hydraulic engineers and is a retired technical cadre. His business card lists a number of titles: originator and chief designer of the Shuotian Canal, author, professor, economist, vice-director and secretary of the Shuotian Canal Preparatory Committee and chairman of the Beijing Shuotian Consulting Development Company.

Guo explained that he originally planned to bring water from the Yellow River to Beijing – but then the Yellow River dried up. He also thought about the Yangtze River, but its western reaches didn't hold enough water either. "But the Brahmaputra has plenty of water; it won't make any difference to India," he said.

> *"Even shouting can cause an avalanche in these steep snowy valleys, said Xu, let alone the blasting, artificial landslides, dyke-building and river-blocking required by the Shuotian scheme."*

Promotional material from the Shuotian Canal Preparatory Committee shows the canal cutting across China from west to east, crossing five different rivers on its journey from the Brahmaputra to the north-east and requiring construction of 10 separate reservoirs. Were it to go ahead, on its way to the Yellow River the canal would take water to more than 14 provinces and municipalities in the west and north of China, including Qinghai, Gansu, Inner Mongolia, Xinjiang and Beijing – and generate electricity en route. The proposal claims the canal would in one fell swoop solve China's shortages of water, electricity, grain and oil, relieve pollution and even ease the rural-urban wealth gap. Examples of support from senior levels of government over the years are also provided.

Before the seminar, Xu Daoyi, a retired researcher from China Earthquake Administration's Institute of Geology had scrutinised the book How China will Save the World, published this year, which sets out the case for Guo Kai's scheme. Xu pointed out that the proposal barely touches on the seismic and environmental risks, even though the canal would cross several earthquake-prone areas. Its tunnels would also pass through the high mountains of the south west, where devastating landslides are possible. There is no way to route the project without passing through these geologically unstable areas.

Xu listed 10 major earthquakes that have struck the south-west over the last 60 years. Pointing to a table of earthquake data, he asked Guo Kai: "What impact will an earthquake have on your canal? You don't seem to have thought about that. If one of your tunnels collapses, what then?" Xu pointed out that reconstruction following an earthquake could be more expensive than the original build.

Even shouting too loudly can cause an avalanche in these steep snowy valleys, continued Xu, let alone the blasting, artificial landslides, dyke-building and river-blocking required by the Shuotian scheme. The map of the proposed canal also indicates that Qinghai Lake will be used as a reservoir – but it is a saltwater lake. The proposal says salinity will be reduced by the water from the canal, when in fact the water of the canal will become salty, argued Xu. The proposal is poorly thought through, he concluded: if the Shuotian team really wants to do this, then they should be prepared to do the necessary scientific research.

Chen Kelin, head of Wetlands International's Beijing office, expressed concern about protecting wetlands on the Tibetan Plateau. The Yellow River dries up almost every year now – in 1999, the dry patch continued for more than seven months – and the ground in many areas along its banks has become salty, he said. The 490,000-hectare Zoige wetland on the upper reaches of the Yellow River has plenty of capacity to store water, but is suffering from over-grazing, pest infestations and the impacts of mining, all man-made issues. "If we looked after it properly, there wouldn't be any need for wasteful water-transfer projects," said Chen.

In his speech, Guo Kai described the Tibetan Plateau as an area of permafrost, with huge quantities of water resources in the form of ice – as the climate warms and that ice melts, that water should be used, he said. Meanwhile, the Shuotian team's solution to Chen Kelin's concerns about the Zoige Wetlands was another water transfer scheme: "bringing in water from Sichuan's Dadu River".

But Guo Kai's arguments received short shrift from the assembled scientists. Tao Zuyu, a retired professor from Peking University's Department of Atmospheric Physics, was next to jump in. He started by criticising the map the Shuotian Canal team had provided to the seminar's participants: beautifully made, with a detailed explanation of the project in the back, but lacking scale or contour lines, it looked more like a tourist map than a scientific document, making the project seem like a mere fantasy, he said.

We're all entitled to our dreams, Tao said, but if you want to turn dreams into reality, you have to put the work in. How much water is there to transfer, and will moving it change the climate? Desert formation is linked to atmospheric circulation, which in turn is connected the layout of the land and ocean, he said – the implications need to be worked through.

Geologist Yang Yong has been researching water diversion in western China for the past four years. He had four major concerns: first, he said, there is still vigorous debate over the risk of triggering earthquakes and geological disasters on the Tibetan Plateau with such schemes. Second, the points identified for water diversion into the Shuotian Canal would not actually be able to supply the quantity of water claimed in the proposal. Third, the canal would change the entire distribution of water across China, particularly in the south-west: there are already many hydropower stations in this region, but the transfer and damming of rivers for the Shuotian Canal would

result in existing dams and power stations lying idle: a massive waste.

Finally, Yang questioned whether the project had the necessary mechanisms and systems to respond to situations such as drought, or climatic changes caused by the scheme, as well as earthquakes and mudslides. He pointed out that China's water authorities had previously proved themselves to be slow or incapable of reacting adequately to drought in the south-west.

Tao Zuyu urged the Shuotian team to take heed of international lessons: the former Soviet Union once transferred water to Kazakhstan, but ended up turning the local soil salty. The colonisers of America planted grain on land once used for grazing – and caused desertification. "We must respect nature," Tao said.

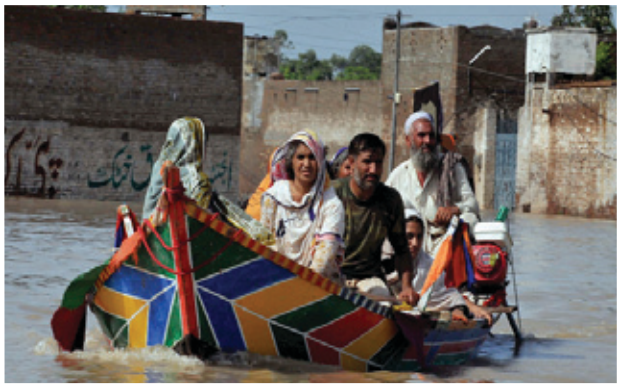
Zhou Wei is assistant editor in chinadialogue's Beijing office.

Image by Nasa Images

March 11, 2011

Lessons from the flood

Human error played a key role in last year's devastating floods in Pakistan, write Daanish Mustafa and David Wrathall. They call for a new approach to the Indus basin.



Editor's introduction: *In July and August 2010, abnormally heavy monsoon floods hit the Indus River in Pakistan, causing unprecedented damage. The floods deluged a fifth of the country, affecting 21 million people and destroying homes, farmland, health clinics, power stations, schools, roads and water-supply systems. The scale and damage of the floods is greater than that of the Asian Tsunami, the Kashmir earthquake and the Haiti earthquake combined.*

The government deployed at least 20,000 troops to lead rescue operations, while its civilian officials attempted to distribute cash handouts to flood-affected people. However, in a country prone to disasters, and where extreme weather patterns such as the current floods are becoming more and more frequent, the state should have been better prepared to deliver a response.

Pakistan and the international community will have to learn lessons from this disaster. Was it natural or man-made? What kind of flood management will help prevent or mitigate future floods? Why did the brunt of the impact fall on the poorest people?

Daanish Mustafa, a water expert from Pakistan who teaches at King's College in London, explores the causes of the current disaster and draws on the lessons that can be learnt. He argues that mismanagement of river systems by building dams and embankments along the Indus has major long-term costs. A new paradigm of water management that adjusts to the natural rhythms of the river, rather than vain attempts to control and harness its water is required.

This is not the first disaster that Pakistan has experienced and it will not be the last. But the crisis can be used strategically to build better and to address the problematic social and physical factors that contributed to the disaster in the first place. The central government's current approach of cutting development budgets in half and focusing on the cash disbursement scheme will leave many underlying issues unresolved.

> *Pakistani water managers have kept a sharp eye on the benefits that they could extract from the Indus basin rivers, without regard for the hazards.*

Pakistan's great Indus flood of 2010, and the unprecedented devastation it caused, cannot be understood or mitigated against in isolation from the "routine" river management in the Indus basin. The cultural, economic and social geographies of water use, distribution and regulation in the basin are integral links in the causal chain of events that led to the disaster. The disaster therefore is deeply human in its genesis, even to the extent that the irregular monsoonal pattern that triggered the floods may be linked to anthropogenic climate change. After all, the weather anomaly observed in 2010 has recurred in a milder form about three times in the past decade – in the previous century, it was seen once every 10 years.

We hope that this article will serve as an invitation to Pakistani water managers and their colleagues globally

to critically re-evaluate their basic assumptions and procedures for river management and perhaps lead to greater integration of flood hazard and issues of social vulnerability in water-resources management. Vulnerability here is understood as a socially determined state of being, where people are more likely to suffer damage from an environmental extreme and are less able to recover from those extremes.

Last year's floods have been declared to be the worst calamity to have hit Pakistan in its history – and the world in the twenty-first century. Although the death toll of more than 1,700 lives at the time of writing this article is relatively modest in comparison with other disasters such as the Asian Tsunami, the Kashmir earthquake or the Haiti earthquake, the scale of inundation and the material damage from the floods seem to be greater in scale than the three major disasters of the twenty-first century combined. Furthermore, with stagnant water in inundation zones a major disease vector, the final indirect toll – especially on children and the elderly – is likely much higher.

Our core argument is that the Pakistani water managers have kept a sharp eye on the benefits that they could extract from the Indus basin rivers, without regard for the hazards that are also integral to living in river basins. Pakistanis – as the proverbial Faustus – bargained with the devil of technocratic vanity to pretend that they could ignore the river system's natural rhythms in return for the agricultural productivity and prosperity (for some) that it could deliver. The gains from the river have been realised: now it is time to pay the price.

Approaching the river with a view to controlling and taming it is bound to fail. A better tactic would be to learn to adapt to the Indus basin's hydro-meteorological regime, particularly in view of the looming uncertainties from climate change. An adaptive flood strategy will not only involve different behaviour towards the physical system but also towards the social systems that depend on it. Greater attention to issues of differential vulnerability to floods, and equity in distribution of the irrigation system's benefits will be an integral part of a resilient adaptive flood-management strategy.

Last year's flooding stems from a confluence of events possibly associated with a warming planet. In July, when monsoon rain began in Pakistan, 2010 was already the hottest year on record and high glacier runoff had already filled rivers to capacity. Evaporation rates over the hotter-than-average Indian Ocean soared, leading to especially active monsoon weather, and oceanic phenomenon La Niña is thought to have exacerbated the severity of monsoon activity. As Michael Blackburn from the United Kingdom's University of Reading explains, both the fires in Russia and the precipitation activity in Pakistan were globally linked through an unusually strong polar jet stream, which stalled unprecedented levels of moisture over the Himalayas, pouring into the Indus valley a quantity of water equivalent to the entire land mass of the United Kingdom.

Although evidence of climatic changes cannot be deduced from a single meteorological event; nevertheless, the number of exceptionally heavy monsoons over India has doubled in the last 50 years, while at the same time moderate and weak precipitation has decreased. South Asia is becoming more arid during dry seasons, and wetter during monsoons. In the Arabian Sea, data from the 1880s to the present indicate that in past decades severe cyclonic events have increased three-fold during intense cyclone months. In the past 15 years, Pakistan has directly received four considerable low pressure cyclonic systems, of similar orders of magnitude to this year's, in 1993, 1999, 2004 and 2007, as well as other lesser systems in 1998 and 2001. Weather variability like we have witnessed this year may be part of long term trends for the Arabian Sea.

By July 22 last year, record levels of rainfall had begun falling across Punjab, Khyber Pakhtunkhwa and Balochistan. Tens of thousands were displaced

immediately, and up to a million more in the following week as flash flooding surged through riverbeds and canals. Flooding started along major tributaries, overwhelmed flood barriers and spread through canals, generally overwhelmed water-management capacity, and eventually inundated large swaths of farmland.

By early August, flooding had reached the lower Indus valley and red alerts were announced for Sindh and Balochistan provinces. According to Pakistan's National Disaster Management Authority, one fifth of the entire area of Pakistan was submerged at the high water mark, affecting 84 out of 121 districts. By August 31, Punjab, Sindh, Khyber Pakhtunkhwa, Balochistan provinces along the Indus river valley were still flooded, and some 800,000 people were still physically cut off. Some levee surfaces, already saturated for nearly a month, began to deteriorate and burst, which exacerbated the crisis in several notable instances, as in the case of historic Thatta city, where 95% of the population – some 170,000 persons – were displaced.

By the first day of September, though the rain had largely ceased, contaminated flood waters continued to rise in the southern provinces, and roughly one million people in Sindh province alone were in the process of migrating away from submerged villages to higher ground, urban areas and Internally displaced person (IDP) camps. While some of the flooding was caused by the overwhelming of levees and flood barriers, a considerable amount was the result of deliberate breaching of the embankments by irrigation authorities to keep regulatory infrastructure from suffering damage. This has been a cause of considerable controversy in the country.

Around 21 million people have been affected; at least 1,700 people had perished due to flooding – probably more; and 1.8 million homes destroyed or damaged. According to the World Health Organization, 10 million people have been left with unsafe drinking water, a figure that will likely increase as time goes on, increasing the potential spread of water- and vector-borne diseases. From mid-August, cholera outbreaks were confirmed, raising the alarm of a secondary health crisis.

The floods affected 17 million acres of Pakistan's most fertile land, causing total damages estimated at over US$7 billion (47 billion yuan) with US$2.9 billion (19.26 billion yuan) to the agricultural sector and US$4 billion (26.6 billion yuan) to infrastructure. With agricultural production decimated, food-distribution systems disrupted, food prices spiking and household economies in tatters, the spectre of food insecurity is beginning to take physical shape. With 3.6 million hectares ruined, the results of winter wheat crop for 2011 are uncertain. Food shortages in the event of a below par wheat crop could further destabilise some of the most affected areas of the country.

Certainly, the brunt of the impacts has been borne by the most vulnerable and impoverished areas. For example, 90% of the 1.7 million refugees fleeing strife in Afghanistan currently reside in flood affected districts. These are people already at the margins of society. With farmland trapped beneath water and silt, and at least 1.2 million livestock dead, small-scale and subsistence agriculturalists and cattle herders are least able to cope with impacts. According to earlier research on flood hazard in Pakistan, livestock is a key asset used for recovery in the aftermath of floods, and the losses are likely to stretch the Pakistani rural livelihood and recovery systems to the limits.

According to the International Monetary Fund (IMF), the total economic cost of flooding to rural livelihoods, agricultural output, industrial input and infrastructure, including lost economic productivity, is expected to totalUS$43 billion (286 billion yuan), raising the possibility of financial insolvency. Already deeply indebted, Pakistan will have to make tradeoffs in order to recover from impacts, and inevitably discussions will occur around scaling back essential social services, including education, rural healthcare and poverty-reduction programmes. As government priorities drift toward flood response, rehabilitation

and reconstruction, many expect illusive development goals to slip still farther away.

The relationship between anthropogenic environmental degradation and catastrophic flooding in Asia, Latin America, Europe and other regions is well documented. Conversely, we know there is an established link between healthy watersheds with flow capacity – wetlands, marshes, estuaries and mangroves – and flood mitigation. Since disasters have been shown to be costly to long-term development goals, questions are raised about need to invest in risk reduction, and with the rising challenges of climate change, we must ask ourselves: can our engineered systems keep pace with climatic trends?

Past failures of flood control

Pakistan benefits from an extraordinary water supply, sourced mainly from swift-flowing glacial melt from the Himalayas in late spring, and monsoon activity between June and October. To take advantage of this tremendous resource, the country has been highly engineered in hydrological terms: irrigated areas represent 82% of all farmland and 43% of the 170 million-strong population is directly dependent on farming activities. However, irrigated areas are exposed to flooding hazards, and consequently the largest sector of the economy and the majority of Pakistanis are vulnerable.

> *“There are accusations in the Pakistani press that, in fact, some of the levees were breached to protect the lands of specific influential interests.”*

Additionally, many villages are situated on river terraces, or in low-lands, and urban migrants tend to informally settle in low-lying high risk areas. As the great flood of 2010 has illustrated in vivid detail, floods are typical in the five major rivers of the Indus River Basin. Twenty major floods, and many more minor floods, occurred in the 50 years from independence in 1947 to 1997. Thus Pakistan is exposed, susceptible and sensitive to regularly occurring flooding events which at times are exacerbated by the river engineering necessary to maintain the irrigation infrastructure.

The development of Pakistan’s flood-management system can be characterised by two dominating approaches and two corresponding periods: 1947 to 1973, a period of risk acceptance and limited risk management; and 1973 to the present, a period of comprehensive physical risk management. Although flood-irrigation techniques – where water is distributed across the soil by gravity – had dominated farming along the Indus River since pre-historic times, the original canal network, upon which the current system is based, was conceived and executed under British colonial rule, beginning with the Upper Bari Doab Canal in 1859. Throughout the colonial era, the system was maintained and expanded, such that, on the eve of independence, there were 150 major canals extending thousands of kilometres through the country.

The colonial approach to flood management depended on a network of “bunds” (linear levees along rivers and ring levees around cities), which the army could strategically breach when waters approached flood stage. During periods of high water, barrages and cities with bunds were protected, but massive flooding would occur in breach areas and regions without protection. The general public had little influence on flood management, though public opinion in affected areas fell decidedly against risk acceptance. The bund system of flood management was carried forward after independence.

In 1960, the Indus Basin Development Programme (IBDP), a colossal engineering project signed into existence with the Indus Waters Treaty between India and Pakistan, further fashioned much of Pakistan’s countryside into an extensive network of canals and reservoirs. The focus of flood planning – shaped through the lens of the Indus Waters Treaty – was

on drainage procedures to avoid damage to recently constructed critical infrastructure.

The IDBP was part of a wider trend in modern flood management, born out of the experiences of inundations that beset the Tennessee Valley and the Great Plains of the United States early in the twentieth century. Armed with the vanity of modern engineering techniques and the doctrine of economic growth, international financial institutions and donor countries began to promote and incentivise mega-projects, like the IDBP in Pakistan and the Helmand-Arghandab Valley Project in neighbouring Afghanistan, offering enormous loans to developing countries. This international one-size-fits-all engineering approach to hydrological mega-project spread to developing countries around the globe, in spite of important regional peculiarities.

These water projects, while credited for transforming developing countries into the world's producers and exporters of commodities like wheat and cotton, are also widely criticised for their environmental impacts. Biodiversity plummets in the face of habitat destruction, soil erosion increases, grazing land disappears and water-borne disease proliferates. In addition, the changing nature of river aggradation and erosion processes can result in accentuated flood events. Some of these consequences in the case of the Indus were even recognised under the British Colonial administration – but were generally considered to be the price of development.

Questions also arise about the relevance of large-scale projects to goals of poverty reduction. Engineering projects can exclude and marginalise the vulnerable poor, whose livelihoods are already sensitive to shocks. So much of rural, subsistence agriculture in developing countries is based on flood recession irrigation. Famous examples from Africa, both the Kainji Dam in Nigeria and the dams on the Lower Omo River in Ethiopia, have resulted in massive disruptions to flood recession agriculture livelihoods, on which hundreds of thousands of vulnerable poor depend.

Moreover, developing countries like Pakistan, whose rural livelihood systems, infrastructure and economies are utterly transformed by these projects, suddenly become vulnerable not only to flooding events but also to fluctuations and shocks in international commodity markets. Market-led growth in the absence of social programmes has another consequence: growing disparity between the haves and have-nots, who incidentally became the most vulnerable to river flooding.

Upon completion of IBDP in 1970, Pakistan's agricultural production expanded substantially. However, shortly thereafter, in 1973, when massive flooding generally overwhelmed the canal network, the risk-management paradigm shifted. Vulnerability of the system was revealed, as well as the resource and experiential constraints of regional flood managers in dealing with newly engineered canals and reservoirs.

In 1978, the Federal Flood Commission was established to implement a comprehensive risk-management strategy, the National Flood Protection Plan. The tool kit of the new strategy included greater resources for reservoir operations, including procedures, inspections and training; schedules for bund maintenance and reinforcement and bund breaching plans; expansion and modernisation of data-collection techniques, including satellite monitoring, run-off modelling and flood forecasting; as well as the implementation of a flood-warning system. In spite of these improvements to the flood-management system, weaknesses remained evident and flooding events disastrously re-occurred, most notably in 1988 and in 1992.

Scholars have noted several institutional limitations to adequately addressing the fundamental issue of flooding. First, a failure to adapt the system to natural processes like aggradation and erosion was causing a mismatch between river flow measures and actual hazards. Most water entering the system is withdrawn for irrigation purposes, leaving little water in the system to flush the channels and carry the highest silt loads in the world to be flushed out to the sea.

This long term reduction in channel capacity to carry floods was one of the key reasons for exacerbating the effects of the exceptionally high floods in 2010.

Secondly, monitoring stations were, in some instances, unable to take measurements and report them in a timely fashion due to their own physical location relative to flooding. Even when measurements were taken and alerts were issued, public warning, evacuation and safety measures, in some cases, were ineffective and haphazard. On the flood-management side, canal and reservoir operators were not empowered to make important split-second decisions about flow adjustments that would ease flood hazards, and in some cases reservoir managers, for lack of system coordination, released waters exacerbating deadly down-stream flows.

Besides the systemic weaknesses at the macro scale, the negative consequences of flood hazard at the local scale are often disproportionately experienced by the poor and most powerless segments of the population. Because of hierarchical canal policies practiced by the British colonial administration and then the post-independence Pakistani government, the small farmers were often disadvantaged by virtue of being at the tail end of canal commands.

The canal administration system also has a strong colonial ethos in its legislation and bureaucratic practices, which discriminate against smaller farmers in terms of redressing complaints, water delivery and important levee-breaching decisions. All the infrastructure on the Indus basin rivers has a safe design capacity, which has been exceeded quite often in the past. To protect this infrastructure, upstream levees are often breached to relieve pressure. The operation of the breaching section is a decision taken by the local canal officer who is often influenced by local large-scale farmers. In such situations it becomes a question of which farmer has the most influence to either prevent a levee breach or to affect the breaching of an alternative levee. There are accusations in the Pakistani press that in fact, some of the levees were breached to protect the lands of specific influential interests. The veracity of the media claims is under judicial investigation but, suffice it to say, political influence in levee breaching decisions is a routine occurrence in Pakistan.

This historical perspective of Pakistan flood policy shows that, by ignoring the river's natural systems and marginalising the poor, engineers and water managers have exacerbated the country's physical and social vulnerability to floods. The relationship between anthropogenic environmental degradation and catastrophic flooding in Asia, Latin America, Europe and other regions is well documented. Conversely, we know there is an established link between healthy watersheds with flow capacity – wetlands, marshes, estuaries and mangroves – and flood mitigation.

Since disasters have been shown to be costly to long-term development goals, questions need to be answered about the need to invest in risk reduction. And, with the rising challenges of climate change, we must ask ourselves: can our engineered systems keep pace with climatic trends?

What will change?

So what can we expect to change in the aftermath of this mega-disaster in Pakistan? It is tempting to say that nothing will change given the more than a century and a half of institutional inertia from the Pakistani water establishment. But changes in the aftermath of a disaster of this magnitude are not always planned and deliberate and not limited to formal governmental institutions.

One fifth of Pakistan's population has been affected by this crisis and to pretend that, somehow, after a while, they can go back to normal would be foolish. The new normal is likely to be very different from the old normal, and whether that normal will be for the better or worse is something that the Pakistani and international decision makers can influence and need to be attentive to.

As documented before, in Pakistan the normal conditions for the rural poor are characterised by their virtual invisibility to decision makers, limited access to water, subjugation to larger landowners and fragile livelihoods. But those same normal conditions also have stories of adaptation to adversity and of social mobility. The point is to strengthen the latter in order to mitigate and undermine the former. Dispelling certain misconceptions and highlighting avenues for intervention might help to achieve that end.

In the post-flood scenario, the greatest urgency is dedicated to the usual basic needs such as food, shelter, clean drinking water and so on. But two key issues have not received sufficient attention – the first is of drainage, and the other is targeted assistance to small farmers and the rural poor.

First, the issue of drainage is going to be key – after all according to Pakistan's National Disaster Management Authority (NDMA) as of December 2010, more than four months after the river floods subsided, up to 4,210 square kilometres of land is still inundated in the southern Sindh province. Most of the flooding is from breaching, which typically occurs on the right bank of the rivers, to allow water to drain right back into the river once the flood peak has subsided. In Pakistan, the density of canal, road and levee development has prevented water in the inundation zone from draining back to the main-stem river, instead turning it into a cesspool of disease and delaying the return of affected populations.

Pumping water from such inundation zones should have been a high priority from the start, but there is no evidence to suggest it has been done. Delayed action could have consequences not just for livelihoods but also for the proliferation of diseases and mortality levels. The drainage of flood water should not just be an episodic reactive measure, but a higher priority in infrastructural design or redesign.

Second, the Pakistan government, like most other governments inevitably deals with aggregate numbers

when it comes to relief and rehabilitation aid. The need here is to specifically target small farmers who, with the loss of livestock and summer crop, are particularly vulnerable. There haven't been any systematic vulnerability assessments in Pakistan, except some piecemeal ones undertaken by a few NGOs. Systematic vulnerability assessments must be carried out using some of the insights from recent research.

> *"The priority for dam and barrage management has always been irrigation, power generation and then flood control as an afterthought."*

But in the interim, local level governance structures that used to exist may be resurrected, even if briefly in order to get the local level knowledge to national and international level agencies so that they can target the most vulnerable. There is a sufficiently robust moral economy in rural Pakistan to provide some level of support to the rural poor, but that moral economy has been strained to its limits and is in need of support.

On the institutional side, the government of Pakistan, as usual, received considerable criticism for its slow response to the disaster. While the government merits criticism on many, many counts, in the context of flood response much of the domestic and international attention has been unfair. First, the extent of the disaster is such that no government in

the world could have fulfilled the type of retrospective expectation that the press and the public seems to have attached to its response.

Second, local level is the first and the most appropriate level for responding to environmental disasters, not the national government. The present "democratic" government unfortunately and ironically has eviscerated local level representative government. Third, disaster response in Pakistan is constitutionally a provincial subject, and not a federal subject. The federal government has no constitutional basis to intervene in disaster response unless requested by the provincial government. And when it is requested, the only institution it has to offer is the armed forces – which, by all accounts, are effectively delivering services. So the criticism that the military is doing everything and federal government is not is incomprehensible.

Fourth, even at the provincial government level, populations and geographical areas are so enormous that the functionality of a federalist structure to ensure more efficient devolved government would not hold. Consider that just the Punjab province in eastern Pakistan has a population of more than 90 million. If it were a country by itself, it would be one of the 15 most populous countries in the world. In the absence of local government structures, which the present provinces themselves have eliminated, their efforts for flood relief were also inevitably inadequate.

Flood policy in Pakistan has been somewhat of a peripheral area for Pakistani water managers, and even then it has been limited to concerns with physical risk and exposure reduction. On the physical risk management side the priority for dam and barrage management has always been irrigation, power generation and then flood control as an afterthought. There is an urgent need for Pakistani water managers to be trained to do multi-criteria management of the system, where long term flood management is a priority on par with other priorities. The managers, if trained and given the necessary autonomy, could operate infrastructure in such a way as to flush channels and reduce the need for costly levee breaching during flood events.

Pakistani water managers must also be sensitised to the need for adapting to the rhythms of the Indus basin rivers, instead of maintaining the attitude of heroic engineering to control them. Allowing some inundation zones and restoration of wetlands could go a long way towards moderating high flood peaks, in addition to providing important ecosystem services such as groundwater recharge, carbon sequestration and bio-diversity benefits – which the poor tend to benefit from the most. People living in such inundation zones could be relocated to newer canal colonies after fair and just compensation.

Flood warning systems could also be improved. Pakistan has some of the highest cell phone penetrations in the world – 86% of men and 40% of women in Pakistan use a cell phone. This network could be effectively used as a conduit for emergency information and warning.

And the Pakistani public needs to be educated about flood response strategies and what is expected of them. Greater communication and trust between the flood managers and the people is the ultimate guarantee of safety. It is appropriate that the federal government of Pakistan should limit itself to undertaking technical assistance to the provinces – and then physical assistance if need be – through the National Disaster Management Authority (NDMA). But NDMA has very little budget during normal times and has dubious constitutional authority to intervene in disaster situations. Those constitutional and budgetary issues should be resolved.

But for long term flood hazard mitigation, there is no alternative to being attentive to issues of vulnerability reduction. At the national level, this flood could provide the impetus for the government to undertake some painful but necessary tax reforms to bring larger segments of the privileged Pakistani's income into the tax net. With a tax to GDP ratio of

only 10.2%, the long term ability of the government to invest resources in reducing vulnerability and development is likely to be very limited.

Lastly, representative and accountable local level governance structures are a must to tap information about vulnerable populations and then to target them. International donors and Pakistan's government could fruitfully engage the Pakistani provincial governments to restore local level governance structures so as to facilitate local level development as well as vulnerability mitigation.

The 2010 floods were a disaster, but the disaster can be used strategically to build better and to address better the problematic social and physical factors that contributed to the disaster in the first place. Climate change may not have been a top priority for the Pakistanis but with anomalous meteorological events becoming alarmingly frequent, it is important that Pakistani managers start being attentive to a future world where their past experience of average conditions will not hold. That will mean reworking their operating procedures and managerial outlook. Vulnerability reduction is the best defence they can have against future uncertainty and that is where they need to focus. Hopefully, this intervention – coming in the aftermath of a disaster – will serve as a reminder to focus on vulnerability, adaptation and even some humility in the face of river systems like the Indus.

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First Image by DVIDSHUB
Second image by Oxfam International

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World Bank: Nepal dams won't stop Indian floods

Indian planners need to radically rethink flood prevention strategies in the Ganges basin, as a new World Bank study debunks old myths. *Joydeep Gupta* *reports.*

For decades, Indian planners working to harness the waters of the Ganges and its tributaries have believed building dams in Nepal will save Bihar and eastern Uttar Pradesh from the floods that occur almost every year. A recent comprehensive study led by the World Bank says this belief is no more than a myth.

The belief was that there were substantial upstream reservoir storage possibilities in the Ganges basin that straddles India, Nepal and Bangladesh. But the Ganges Strategic Basin Assessment (SBA) coordinated by the World Bank and carried out by experts in the region has found that the largest 23 dams that have been conceived would only hold an additional 13 percent of the annual flow of water.

The preliminary findings of the SBA have been presented to government officials in all three countries and were unveiled in public at the World Water Week in Stockholm.

The experts working with the South Asia Water Initiative (SAWI) coordinated by the World Bank found that in terms of flood control, there would be little basin-wide effect of upstream storage, and that effects were unlikely at the sub-basin level either. The models – developed by the Institute of Water Management in Bangladesh, the Indian Institute of Technology, Delhi and RMSI, a consultancy firm in India, and vetted by SAWI experts – showed that at the sub-basin level, the dams would reduce peak flows, but would not necessarily reduce floods. Most rivers in the basin are largely embanked, and local rainfall and embankment failures cause the most flooding, the study found.

Looking specifically at flooding in the Ganges delta, most of which is in Bangladesh, the experts found that the dams in the Himalayas would have a negligible impact on the main stem of the Ganges.

> *"Every monsoon when there is a flood in Bihar, including this year right now, local politicians blame Nepal and the lack of dams there."*

And in a finding that definitely counters the majority view in India, the study found that upstream water storage was not a robust strategy for flood control in Bihar, the Indian province immediately downstream of Nepal for most of the tributaries of the Ganges. Every monsoon when there is a flood in Bihar, including this year right now, local politicians blame Nepal and the lack of dams there.

But the experts found that most of the flooded area in Bihar is outside the basin of the Kosi river, the main Ganges tributary flowing from Nepal to Bihar in India. They also pointed out that most major tributaries of the Ganges in Bihar are embanked, and most floods are from direct rainfall and embankment breaches. In fact, experts have earlier pointed out that repeated embanking since the 1950s and silting of the rivers has created a situation in Bihar where most of the rivers actually flow at an altitude above the surrounding

land. The result is that when the water overflows during the monsoon rains or when there is a breach in an embankment, the land acts like a bowl and is flooded, because the water has nowhere to drain out.

Supporters of building large dams in the Himalayas have also said that the reservoirs behind these dams can be used to augment low season flows. They have pointed out that there is huge seasonal variation of water flow in the Ganges basin, since South Asia gets around 85%of its annual rainfall during the four monsoon months of June to September.

But the SBA has cautioned against this line of argument. It points out that redistributing a small portion of the flood waters would make a big difference to low flows, but the appropriate use and economic value of this water is unclear. Current agricultural productivity in the Ganges basin is low anyway. In waterlogged areas additional low season water could actually be harmful, while the stress on ecosystems and municipalities that would have to cope with the extra water could be high.

So are there good alternatives or complements to reservoir storage in the Ganges basin? The perceived wisdom has been that there is not, but the SBA says yes. The experts say that natural underground water storage, strategically and sustainably managed, could be used in the basin on a scale comparable to the full suite of dams considered in the models. They say there are additional sustainable groundwater resources available in the Ganges basin, in contrast to other parts of India.

Specifically, they point out, there are significant opportunities for additional groundwater use in the basin, in conjunction with a well-managed surface water system in eastern Uttar Pradesh, Bihar and West Bengal. In the Ghaghra-Gomti basin – a sub-basin of the Ganges in eastern Uttar Pradesh – 2.5 million new tubewells can utilise additional groundwater storage of 20 billion cubic metres. There are around 1.75 million tubewells in this sub-basin now, used mostly for irrigation but also for drinking water.

There is another myth that the SBA has punctured. It has often been said that water stored in Himalayan reservoirs can be used to dilute pollution downstream. But the experts point out that any such release would join the Ganges downstream of its most polluted stretches.

There is yet another myth, which says watershed management and upstream storage can control sediment loads. But the experts point out that most dam engineers would want to pass the sediment through, as their reservoirs would get silted up otherwise. Hydroelectric stations also filter out as much of the sediment as they can, because it affects turbine operations.

But after all this, there is one big advantage of building dams in the Himalayas. They would generate a substantial amount of hydroelectricity, the study confirmed. The preliminary finding is that the 14 largest of the dams planned have an installed capacity of around 25,000 megawatts, valued at US$4-5 billion a year. The Ganges basin, with 650 million people the most populous in the world, suffers a chronic power shortage.

Climate change has arrived as an additional complicating factor in the Ganges basin, as elsewhere. Temperatures will increase, glaciers will melt faster, the sea level will rise, rainfall and snowfall scenarios vary widely. The SBA says there are great uncertainties on the scale of the effects, but opportunities to act now. Pointing out that a focus on managing current variability is a no-regrets strategy, the authors say more knowledge and coordination are needed to handle the effects of global warming.

The preliminary findings have four takeaway messages:

- For regional floods, focus on warnings, not just water storage. Upstream storage infrastructure cannot protect the basin. Real, immediate benefits can, however, come from cooperative regional monitoring and warning systems, coupled with localised flood responses.

- For water storage to enhance low flows, look underground, not just upstream. Groundwater storage in the Ganges basin can provide the same scale of effective storage as upstream dams in Nepal, more immediately and at lower costs.
- Hydropower development and trade in the basin remain very promising. There is significant potential to deliver clean peaking power and improve trade imbalances.
- Climate adaptation can begin now, with enhanced and shared information, forecasting and warning systems; flood and drought management; and a major push to the use clean energy.

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Image by Satish Somasundaram