Mountains of Concrete:

DAM BUILDING IN THE HIMALAYAS

INTERNATIONAL RIVERS
people • water • life

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About International Rivers

International Rivers is a non-governmental organization that protects rivers and defends the rights of communities that depend on them. International Rivers opposes destructive dams and the development model they advance, and encourages better ways of meeting people's needs for water, energy and protection from damaging floods.

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By Shripad Dharmadhikary

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Contents

Introduction . . . 3

Regional Paradox . . . 5

Dam Building in the Himalayas: Potential and Plans . . . 6

Table 1: Total Installed Capacity and Share of Hydropower . . . 6

Table 2: Ultimate Hydropower Potential and Exploited Potential . . . 7

Table 3: Existing, Under Construction, and Planned Hydropower Projects . . . 7

Drivers of the Hydropower Programs . . . 8

Funding Requirements . . . 11

Table 4: Funds Required For Himalayan Dams in the Next 10 Years . . . 11

Sources of Financing . . . 12

Box 1: 750 MW West Seti Project, Nepal: Funding Sources . . . 14

Table 5: Percentage of Contributions from Various Sources of Funds for the 11th Five Year Plan for the Indian Power Sector, 2007-12 . . . 15

Key Players . . . 17

Box 2: Some Public and Private Corporations in India and the Projects They Are Developing . . . 18

Box 3: Merchant Sale of Power and Windfall Profits for Private Companies . . . 19

Box 4: China "Goes Out" to Build Himalayan Dams . . . 20

Social and Environmental Impacts . . . 21

Box 5: Diamer-Bhasha Project, Pakistan . . . 25

Box 6: "Chicken's neck" area of India . . . 29

Dams in the Himalayas map . . . 22

Developmental Impacts . . . 30

Climate Change . . . 32

Box 7: Dig Tsho Glacial Lake Outburst Flood, Nepal . . . 34

Box 8: Some Likely Impacts of Climate Change and Glacial Lake Outburst Flood Risks in Specific River Basins . . . 35

Responses of Civil Society and Affected People's Groups . . . 37

Alternative Approaches . . . 39

Conclusions . . . 40

References . . . 41

Abbreviations and Acronyms

ADB	Asian Development Bank
BOOT	Build-Own-Operate-Transfer
CEA	Central Electricity Authority (India)
DoED	Department of Electricity Development (Nepal)
ECAs	Export Credit Agencies
ECBs	External Commercial Borrowings
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ENVIS	Environmental Information System (Indian Ministry of Environment and Forests)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLOF	Glacial Lake Outburst Flood
GWh	Gigawatt Hour
ICIMOD	International Centre for Integrated Mountain Development
IEX	Indian Energy Exchange
IFIs	International Financial Institutions
IIFCL	India Infrastructure Finance Company Limited
INPE	National Institute for Space Research (Brazil)
IPCC	Intergovernmental Panel on Climate Change
IsDB	Islamic Development Bank
IUCN	International Union for Conservation of Nature
KfW	Kreditanstalt für Wiederaufbau (German government-owned bank)
KWh	Kilowatt Hour
MAF	Million Acre Feet
MCM	Million Cubic Meters
MoU	Memorandum of Understanding
MW	Megawatts (One Million Watts)
NBA	Narmada Bachao Andolan (Save the Narmada Movement)
NEA	Nepal Electricity Authority
OECF	Overseas Economic Cooperation Fund (Japan)
PFC	Power Finance Corporation (India)
PFR	Preliminary Feasibility Report
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSPD	Public Sector Development Plan (Pakistan)
PTC	PTC India Limited (Formerly Power Trading Corporation of India)
REC	Rural Electrification Corporation (India)
RHEP	Ranganadi Hydro Electric Project (Arunachal Pradesh, India)
SANDRP	South Asia Network on Dams, Rivers and People
SEBs	State Electricity Boards (India)
TA	Technical Assistance Grant (lending instrument of the ADB)
T&D	Transmission and Distribution
WAFED	Water and Energy Users' Federation, Nepal
WAPDA	Water and Power Development Authority (Pakistan)
WCD	World Commission on Dams

Conversion tables for currencies

Currency	**Amount for US$1**
Indian Rupee (INR)	42
Pakistan Rupee (PKR)	73
Nepal Rupee (NPR)	69
Bhutan Ngultrum (BTN)	42

Exchange rates as of August 11, 2008, rounded off to zero decimals.

All figures are in US Dollars, unless otherwise noted.

These conversions have been used to convert local currencies to US dollars for uniformity, but this often does not capture the true sense of amounts in local contexts, especially in the current situation of steep changes in exchange rates. Hence, we have also given the estimates in local currency wherever possible, especially where it is the currency used in the primary reference.

Introduction

The Himalayas are the highest and among the most spectacularly beautiful mountains in the world. In the absence of a geographically precise definition, the Himalayas may be taken to mean the mountain ranges that separate the Indian sub-continent from the Tibetan Plateau. By extension, it is also the name of the massive mountain system which includes the Karakoram, the Hindu Kush, and a host of minor ranges extending from the Pamir Knot.[1]

The Himalayas consist of several parallel ranges running west to east, from the Indus River Valley to the Brahmaputra River Valley; they form an arc 2,400 kilometres long, which varies in width from 400 km in the western Kashmir-Xinjiang region to 150 km in the eastern Tibet-Arunachal Pradesh region.[2] The Himalayas stretch across six countries: Bhutan, Nepal, India, Pakistan, China and Afghanistan.

The Himalayas are undoubtedly a world heritage. All 14 of the highest peaks in the world, called the "eight-thousanders" (peaks with heights greater than 8,000 metres) are in the Himalayas. While UNESCO has declared the Sagarmatha National Park near Mt. Everest in Nepal as a World Heritage Site,[3] there are hundreds of such undeclared locations of equal magnificence and significance in the Himalayas.

The name itself literally means "the abode of snow," and the Himalayan region is sometimes called the "Third Pole," as it has the most highly glaciated areas in the world outside of the two Polar regions. It has huge stocks of water in the form of snow and ice, with a total area of 35,110 km^2 of glacier and ice cover, and a total ice reserve of 3,735 km^3.[4] Hundreds of small and large rivers originate and run through the Himalayan region. It is the source of some of the largest rivers in Asia – the Indus, Ganga, Brahmaputra, and Irrawaddy – the basins of which are home to millions of people. Glacial and snow melt is an important source of the flows of these rivers.[5]

The rivers that originate in the Himalayas provide sustenance, livelihoods and prosperity to millions of people living in a vast area that stretches from the Indus Basin plains of Pakistan in the west to Bangladesh in the east. With their high slopes and huge quantities of fast-moving waters, the Himalayan rivers have always been looked upon as having large potential to generate hydroelectric power. Some of the earliest and largest hydropower stations in the countries of the Indian subcontinent have been built on Himalayan rivers; for example, the Bhakra Nangal project in India and the Tarbela project in Pakistan.

Recent years have seen a renewed push for building dams in the Himalayas. Massive plans are underway in Pakistan, India, Nepal and Bhutan[6] to build several hundred dams in the region, with over 150,000 Megawatts (MW) of additional capacity proposed in the next 20 years in the four countries. If all the planned capacity expansion materialises, the Himalayan region could possibly have the highest concentration of dams in the world.

The Seti River near the planned West Seti Dam site in Nepal, 2007. The 750 MW West Seti project is set to begin construction even as the affected people are strongly opposing it. Photo: Yuki Tanabe

This dam building activity will fundamentally transform the landscape, ecology and economy of the region and will have far-reaching impacts all the way down to the river deltas. Submergence of lands, homes, fields and forests on a large scale will displace hundreds of thousands of people. Damming and diversion of rivers will severely disrupt the downstream flows, impacting agriculture and fisheries and threatening livelihoods of entire populations. Degradation of the natural surroundings and a massive influx of migrant workers will have grave implications for the culture and identity of local people, who are often distinct ethnic groups small in numbers. As the entire region is seismically active,

> The rivers that originate in the Himalayas provide sustenance, livelihoods and prosperity to millions of people living in a vast area that stretches from the Indus Basin plains of Pakistan in the west to Bangladesh in the east.

these dams face high risks of catastrophic failures due to earthquakes.

By far the most serious issue, however, is that of climate change and its impact on the Himalayas. The impact of global warming is already being felt much more in the Himalayas than in other parts of the world. This is resulting in the accelerated melting of glaciers and the depletion of the massive water store of the region. There are real fears that the "abode of snow" would no longer be left with any, turning "the snow-covered mountains into bare, rocky mountains" and "dynamic glaciers…into lifeless rubble."[7] This would have tremendous impacts all the way to the Indo-Gangetic Plains. The impact of climate change will be aggravated by the construction of hundreds of dams. As glaciers melt, water in the rivers will rise, and dams will be subjected to much higher flows, raising concerns of dam safety, increased flooding and submergence. With the subsequent depletion of glaciers there will be much lower annual flows, affecting the performance of such huge investments. Climate change will also increase the threats of Glacial Lake Outburst Floods (GLOFs) and possible cascading failures of downstream dams.

Unfortunately, dam construction is being planned and carried out with hardly any assessment of these impacts. Most importantly, even when some impact assessment is done for individual projects, there is no evaluation of the cumulative impacts of construction of so many dams in one river basin or region; this will lead to disastrous consequences for the people and ecology of the region. Ironically, while the people of the region face these huge risks, little of the benefits of the projects would accrue to them. Most of the dams are being constructed to deliver electricity to load centres far away; and in the case of Nepal and Bhutan for electricity exports to India.

There are also questions about whether the power generated from these projects would help increase access to electricity for the poor and the vulnerable sections of society, as the location of these projects in remote and difficult terrains, privatization, and the incentives offered will result in a high cost for the electricity generated.

Given all this, there is an urgent need to understand the extent, nature and impacts of this dam building program. With this in mind, this report examines the Himalayan hydropower program in the four countries of Pakistan, India, Nepal and Bhutan. It looks at the social, political and economic contexts for the dam building programs in the four countries, as well as the similarities and differences across the region. It outlines the issues at stake, the actors involved, the responses of civil society and affected people's groups and the likely developmental impacts of these projects.

This study does not look at the dams in China. Insufficient resources, difficulty in access to information and the issue of language are some of the reasons.

The Regional Paradox

The Himalayan mountain ranges that stretch across a 2,400 km arc form an ecological system whose diverse elements are interlinked together in many complex ways. The highest Himalayan mountains influence the lives of people several thousand kilometres away on the plains. Rivers originating at one point in the region traverse across long distances, unifying and connecting areas far apart. There is little doubt that this is a highly diverse yet cohesively interlinked region.

The most important links between the countries of this region are its rivers. Almost each and every one of the major rivers is a trans-boundary one. The Indus River originates in Tibet, travels through India and then into Pakistan, where it descends from the mountains onto the plains to eventually meet the sea. The Satluj River, too, rises near Mansorovar in Tibet, and then, after traversing through India and Pakistan, eventually meets the Chenab and the Indus rivers. The major rivers of Nepal, like the Mahakali and Karnali, originate in the Himalayas, run through Nepal and then into India to meet the mighty Ganga. The Ganga River itself flows on to Bangladesh. The Tsangpo River originates in Tibet, flows into Arunachal Pradesh in India as the Siang (Dihang) River, then into Assam as the Brahmaputra River after receiving the waters of many other rivers, and finally flows onto Bangladesh, where it is called the Jamuna River. Thus, the rivers of the region form vital links from the high mountains to the sea.

Political boundaries cut sharply through the region, dividing it into areas that have many common geographical, topographical and eco-climatic features but starkly different political and economic contexts.

While Nepal and Bhutan continue to be primary production economies with low industrialization and large parts of the populations dependent on agriculture, Pakistan and India are much more industrialized. As a result, developmental policies, priorities and constraints also differ in each of the four countries.

Relations between the different countries are also mixed. Nepali and Indian citizens can move freely between the two countries without a visa. On the other hand, even though Pakistan and India were one country about 60 years ago, the history and legacy of partition has led to strained relations between them. Notwithstanding this, India and Pakistan negotiated and signed the Indus Water Treaty in 1960 and have successfully implemented the sharing of the Indus Basin river waters since then.

Whatever the relationships are at the official levels, the people of India and Pakistan share deep social, cultural and familial ties as well as friendships. While similar relationships exist between the people of India and Nepal, and notwithstanding the open borders, there is deep resentment amongst many Nepali people with the rulers in New Delhi that stems from the feeling that many of the bilateral water-sharing agreements have favored India. Bangladesh is downstream of all the Himalayan rivers of Nepal and India, but has little say in the dam building program that is planned in these areas.

Thus, the Himalayan region is a remarkable combination of an area with strong ecological, geographical, cultural and social links fractured by political divisions, hostility and differing economic and political contexts. These commonalities and differences, the links and the fissures, significantly influence the dam-building programs, their features and even the likely outcomes. We will examine some of these important features where relevant.

Dam Building in the Himalayas

Potential and Plans

In the last few years, Pakistan, India, Bhutan and Nepal have prepared plans for massive dam building in the Himalayas. Several hundred dams are now proposed for the region, which could lead to capacity additions of over 150,000 MW in the next 20 years.

All these countries have built dams in the Himalayas in the past to generate hydropower and to store water for irrigation and other needs. Among India's earliest multi-purpose projects was the Bhakra Nangal Dam, a rim station project[8] on the Satluj, a tributary of the Indus, with an installed capacity of 1,200 MW, completed in 1962. Pakistan built the 1,000 MW Mangla and the 3,478 MW Tarbela dams, completed in 1967 and 1977, respectively.[9] Bhutan undertook the construction of the 336 MW Chukha project (1986-88) with the Indian government's help, while Nepal also built several small and medium projects in the 1960s-70s. The construction of big dams has slowed due to a variety of reasons, including the tremendous opposition they faced from affected people and strong critiques of their development effectiveness. Today there is a renewed and aggressive push for these projects, several of which are already under construction.

Hydropower constitutes an important source of power for all four countries, but the significance differs. Table 1 shows total installed capacities and the share of hydro for each country. Note that for India and Pakistan the hydropower stations include non-Himalayan hydro stations.

Each of these countries has huge hydropower potential. Much of this potential lies in the Himalayan region. Table 2 gives the estimated hydropower potential in each country along with the potential exploited so far.[11]

It should be pointed out that the basis for the estimation of "potential" and the assessment of "feasibility" are unclear. In particular, whether social, environmental and cultural costs are included in determining if the potential is economically feasible is not clear. Given the established procedures of dam building and the gross neglect of these factors in the process, it is highly likely these factors have not been considered.

Table 1: Total Installed Capacity and Share of Hydropower[10]

	Total Installed Capacity (MW)	Capacity from Hydro (MW)	Hydro Capacity as a % of Total
Bhutan	1,505	1,488	98.9 %
Nepal	615	561	91.2 %
Pakistan	17,369	6,444	37.1 %
India	143,311	35,909	25.1 %

Construction of the 600 MW Loharinag-Pala Hydropower Project on the Bhagirathi River in Uttarakhand, India, 2008. Photo: Matu People's Organization

These countries are creating massive plans for additional hydro capacity based on these assessments of potential.

Bhutan is planning a capacity expansion of about 10,000 MW in the next 10 years. Among the projects being planned for the near future are the 1,095 MW Puntansangchu-I and the 600 MW Mangdechhu projects.

Nepal is planning to install hydropower capacity of 22,000 MW in the coming years. Interestingly, Nepal has a dual capacity addition plan in place – one for capacity addition for domestic needs and another, more massive one for electricity export to India. For its own needs, Nepal plans to add 1,750 MW by the year 2020-2021, mostly through small and medium projects.[13] Much of the rest, mainly from the bigger projects, is planned for selling power to India. The 750 MW West Seti project is set to begin construction even as the affected people are strongly opposing it. Memorandums of Understanding (MoUs) have also

Sign of the planned Diamer-Bhasha Dam in Pakistan, 2007. The government is pushing for the immediate implementation of the massive 4,500 MW Diamer-Bhasha project in Pakistan. Credit: Naeem Iqbal

been signed for the 300 MW Upper Karnali and 402 MW Arun-III projects.

Pakistan has plans to add 10,000 MW through five projects by the year 2016.[14] Another 14 projects totalling about 21,000 MW are under study for construction by 2025.[15] The government is pushing for the immediate implementation of the massive 4,500 MW Diamer-Bhasha project.

India declared its intentions with the launch of the "50,000 MW Initiative" by then Prime Minister Atal Bihari Vajpayee on May 24, 2003. This initiative fast-tracked hydropower development by taking up time-bound preparation of the Preliminary Feasibility Reports (PFRs) of 162 new hydroelectric schemes totalling around 50,000 MW.[16] India has plans to build this capacity by 2017 and then, in the 10 years following, to add another 67,000 MW of hydropower.[17] Construction is ongoing for many of the projects including the 2,000 MW Lower Subansiri project, the 400 MW Koteshwar project and the 1,000 MW Karcham Wangtoo, to name a few.

Thus, the hydropower capacity addition planned in just the next 10 years in this region is close to 80,000 MW. This can be compared to the planned additions in the whole of Latin America (60-64,000 MW) or Africa (27-99,000 MW).[18]

Many of these projects are already under construction. Table 3 shows the number of existing, under construction and proposed hydropower projects in each of these countries. Note that the proposed projects are not limited to those planned for the next 10 years. A full list of the names and capacities of all projects can be found on www.internationalrivers.org/himalyasreport/list.

Table 2: Ultimate Hydropower Potential and Exploited Potential [12]

	Total Claimed Potential (MW)	Capacity Already Developed (MW)	% Capacity Remaining to be Developed
Bhutan	23,760	1,488	93.74
Nepal	44,000	561	98.73
Pakistan	41,722	6,444	84.55
India (Himalayan)	118,210	26,376	77.69
India (Rest)	30,491	19,641	35.58

Table 3: Existing, Under Construction, and Planned Hydropower Projects

	Nepal		Pakistan		Bhutan		India (Himalayan Region)	
	No. of Projects	Capacity (MW)	No. of Projects	Capacity (MW)	No. of Projects	Capacity (MW)	No. of Projects	Capacity (MW)
Existing	15	545	6	6,385	5	1,480	74	15,208
Under Construction	2	84	7	1,405			37	17,765
Planned	37	26,324	35	33,769	16	15,693	318	93,615
Total	54	26,953	48	41,559	21	17,173	429	126,588

Drivers of the Hydropower Programs

While these hydropower projects are being justified on the grounds of economic development and electricity needs – and there are real and growing needs of electricity in these countries, even energy crises in several – the real drivers for building these projects are quite different.

For Bhutan and Nepal, the total hydropower potential is far in excess of their power requirements.[19] Both countries see possibilities of earning huge revenues from the sale of surplus electricity to India – the so called hydro-dollars on the lines of petro-dollars. Hence, the major projects in these countries are planned for exporting electricity to India, with the attraction of large incomes being the key driver of the hydropower programs.

NEPAL

Nepal is suffering from a power deficit situation, and the Nepal Electricity Authority (NEA) had to resort to load shedding[20] in 2006-07.[21] At the same time, about 60% of the rural population did not have access to electricity. Nepal also has a severe energy crisis with a shortage of petroleum fuels, yet most of the big projects in Nepal are planned with the intent to export electricity to India. The NEA estimates the energy and power demand in 2018-19 to be 8,333 Gigawatt Hours (GWh) and 1,788 MW, while for 2024-25 the estimates are 13,099 GWh and 2,779 MW.[22] Thus, most of the planned capacity addition of 22,000 MW is clearly slated for exporting power to India. Among the big projects planned for the immediate future, West Seti, Upper Karnali and Arun III are all meant for selling electricity to India, with only a small percentage of that power being set aside for Nepal.

BHUTAN

With Bhutan's own power needs expected to be around 1,000 MW by 2020,[23] it already has more installed capacity than this to date. Most of the electricity generated in Bhutan is exported to India. Between April 2007 and March 2008, Bhutan exported 5,300 GWh, or about 70-75% of its generation, to India.[24,25] It is significant that even after deducting this export, the per capita annual electricity generation in Bhutan is about 1,800 Kilowatt hours (KWh), by far the highest among all four countries, and almost three times higher than India. But electricity coverage in Bhutan was 60% in 2007, and only 40% in rural areas.[26]

Hydropower is the single biggest revenue earner for Bhutan. Revenue from the sale of electricity provided 45% of national revenue before the 1,020 MW Tala project was commissioned and is expected to account for about 60% with the full commissioning of Tala.[27] Most of this is from the sale of power to India. Bhutan wants to increase this income many fold; this is the biggest driver of its hydropower program.

In July 2006, India and Bhutan signed an agreement for long-term cooperation in the field of hydropower development. Under this umbrella agreement, valid for 60 years, India will import a minimum of 5,000 MW of power from Bhutan by 2020. Bhutan is now urging India to push this up to 10,000 MW. Its recently announced "Bhutan Sustainable Hydropower Development Policy," endorsed by the Cabinet in the last week of June 2008, approves this target and mentions the projects that will be pursued to meet this target.[28]

PAKISTAN

In Pakistan, the first and primary driver for large storage dams appears to be irrigation and agriculture, while power generation is secondary. This is not surprising since agriculture, while contributing about 25% to the Gross Domestic Product (GDP),[29] accounts for an overwhelming 66% of the county's employment and over 80% of its exports.[30]

Agriculture and irrigation in Pakistan are in a severe crisis. The country has one of the world's oldest and most extensive irrigation systems based on the Indus Basin rivers, but it is now facing massive problems. Waterlogging and soil salinity have affected vast areas, and ameliorative measures have aggravated the problems. River flows have fallen drastically as enormous quantities of water have been diverted. The lowest riparian state, Sindh, has been the worst affected, including agriculture and fisheries in the mangrove areas. Many of the problems are inherent to big dams and canal-based systems. Yet the same solutions are being suggested for addressing the problem – more water, and for that, more big dams and storage capacities. These solutions are politically appealing, even though they are likely to aggravate rather than address the problems, because the proposed storage projects are in remote areas of the Himalayas.

Former President Musharraf in his address to the nation in 2006 said that "constructing two to three dams is inevitable" and "urgently needed" for Pakistan by the year 2020 as "the development of [the] agriculture sector is the only and effective way to check poverty…More water will help us irrigate more land along with the construction of canals and it will help increase our agriculture production and Pakistan's economy will Inshallah prosper further…"[31]

> **Several observers have noted that the "reforms" in the power sector initiated at the behest of the World Bank and the Asian Development Bank (ADB) since the 1990s have led to a number of people losing access to electricity as tariffs have risen sharply and subsidies have been cut back.**

While Musharraf is no longer the president, this view is well entrenched, both with the national technocracy and the World Bank. The World Bank's "Pakistan Country Water Strategy" argues strongly that there is "the urgent need for construction of major new storage on the Indus."[32]

It is ironic that a major argument for the necessity of new big dams is that heavy sedimentation has led to the loss of storage capacity of the biggest existing dams like Tarbela and Mangla, and so new dams are needed as replacements. This ignores the fact that the proposed new reservoirs in the Himalayas would face the same sedimentation problems, as these rivers carry heavy silt loads.

Thus, even for the largest hydropower dams like Diamer-Bhasha, agriculture continues to be the primary justification. Consider this excerpt from the former President's website on the Diamer-Bhasha Dam:

> **NEED OF THE PROJECT**
> Agriculture is the backbone of Pakistan's economy. Pakistan today is among one of the World's fastest growing populations, now estimated at over 150 million. Due to the lack of large river regulation capability through sizeable storages, the country is already facing serious shortages in food grains. Given the present trend, Pakistan could soon become one of the food deficit countries in the near future. Therefore, there is a dire need to build storages for augmenting agriculture production.[33]

This is a key emotional and political driver for many of the new dams. One of the reasons why irrigation and agriculture have been the main political arguments used to promote dams could be that until 2005, Pakistan seemed to have surplus power even during peak demand times.[34] The situation has now changed with rampant power cuts and power shortages. The power deficit is predicted to grow to 5,500 MW by 2010 unless new power projects are brought online. Furthermore, about 40% of firms in Pakistan identified electricity as a major constraint for the operation and growth of their businesses; a quarter of the Pakistani population has no access to electricity at all.[35]

Thus the need to meet increasing electricity demands is also becoming an important justification for the big dam plans in Pakistan.

INDIA

In India, the basic driver for hydropower is the demand for electricity.

India continues to be plagued by power and energy shortages. Overall for the country, peak power demand in the year 2007-08 was 108,886 MW, while the peak power demand met was 90,793 MW; there was a shortfall of 18,093 MW or 16.6% of peak demand.[36] The energy demand in the same year was 737,052 GWh, towards which energy availability was 664,660 GWh. This was a deficit of 72,392 GWh, or 9.8%.

A large portion of Indian society does not have access to electricity. According to the Working Group on Power for the 11th Five Year Plan, 154,567 villages, or a full 26% of the inhabited villages in the country, were without access to electricity in 2006.[37] The household-level picture is worse; according to the 2001 Census, 44.2% of households in India did not have access to electricity.[38]

Shortages affecting urban centres are also leading to demonstrations, violence and riots in some parts of the country. At the same time, vulnerable sections of society, like the poor, and small and marginal farmers, are finding access to electricity more and more difficult due to a lack of physical access or increasing tariffs.

The government of India also argues for an increase in power generation capacity in order to meet some declared social objectives. These, as articulated in the National Electricity Policy of February 2005, include:

- Access to Electricity – Available for all households in the next five years;
- Availability of Power – Demand to be fully met by 2012 with energy and peaking shortages to be overcome (the "Power on Demand" policy);
- Per capita availability of electricity to be increased to over 1,000 units (1,000 KWh) by 2012;
- Minimum lifeline consumption of 1 unit (1 KWh)/household/day by the year 2012.[39]

The changing policy framework in India has introduced mechanisms that make it easier for private companies to make profits from hydropower projects.

Of course, it is a moot question whether these villages and households lack access because of scarcity of electricity or because of the heavy transmission and distribution losses and the inequitable distribution of available electricity.[40] Several observers have noted that the "reforms" in the power sector initiated at the behest of the World Bank and the Asian Development Bank (ADB) since the 1990s have led to a number of people losing access to electricity as tariffs have risen sharply and subsidies have been cut back.[41]

However, the push for hydropower in India mainly comes from the need to meet the power demands of the 9% plus annual growth rate. This high rate of growth needs similar high growth rates of inputs; on the other hand, sharply rising disposable incomes in a portion of society have also meant increasing consumption of goods, services and energy. Electricity is a vital part of both the inputs and the consumption. Thus, authorities are projecting rapid escalation in power demand. This is a key driver for the planned capacity expansions, both hydro and thermal.

There is also another reason for the spree of hydropower projects; a large part of the undeveloped hydropower potential is located in the Himalayan states of Arunachal Pradesh, Uttarakhand, Himachal Pradesh and Sikkim, states which have relatively low industrial development. These states see their rivers and the hydropower potential as the proverbial goose that lays the golden egg. For example, a Government of Arunachal Pradesh Cabinet note of April 2005 talks about how, if the hydropower potential of the state could be harnessed and the power sold to the rest of India, "the state would float in hydro dollars like the Arab countries are floating in petro dollars."[42] The state governments are signing MoUs with various developers at breakneck speed, prompting India's Minister of State for Power, Shri Jairam Ramesh, to remark that the hydropower sector has been afflicted by the "MoU virus."[43]

A third driver of the push for hydropower is private companies looking for profits. The changing policy framework in India has introduced mechanisms that make it easier for private companies to make profits from hydropower projects. These policies include open access and the freedom to sell power on a merchant basis, the transfer of hydrological risks to the public, and the cost-plus approach to tariff.[44] This has seen a large number of private companies, many without any previous experience in the sector, jumping in to sign MoUs for building hydropower projects.

Funding Requirements

The funds required by these projects are huge, and acquiring this financing is going to be a big challenge. Pakistan's Water and Power Development Authority (WAPDA) estimates that it will need about $20.3 billion for the five projects that it wants to build by 2016.

The Diamer-Bhasha Dam alone is expected to cost $8.5 billion, around 72% of the Pakistani government's annual revenue.[45] The 14 projects planned for the next phase are expected to cost $32.15 billion.

There does not seem to be any consolidated estimate for all the dams planned in Nepal, but we can use the costs of some of the key projects already underway or in an advanced stage of planning as a broad indicator. These 11 projects – Arun III, Upper Tamakoshi, Upper Karnali, West Seti, Middle Marsyangdi, Chameliya, Kulekhani-III, Upper Trishuli-3A, Rahughat, Upper Seti and Upper Trishuli-3B – are likely to cost about $3.8 billion for a total of 2,134 MW of capacity. The actual costs are likely to be even higher as some of the estimates are quite old; for many projects the estimates were from the early and mid-1990s. Already, the cost of the West Seti project has been revised from $1.2 billion to $1.6 billion. The annual revenue of the government of Nepal is about $1.2 billion. With Arun III estimated to cost $859 million (1995 estimate) and Upper Karnali $454 million (1998 estimate), many of these dams will each cost anywhere between half to more than the total annual revenue of Nepal.

Construction of Teesta V Dam, Sikkim, India, 2008. India, with a huge planned capacity expansion of 50,000 MW in the next 10 years, will require funds to the tune of US$31 billion just in the next five years. Photo: River Basin Friends, India

While there are no cost estimates available for many of the projects in Bhutan, with a rule of thumb of about Indian Rs. 5 crores per MW ($1.2 million per MW),[46] we can estimate that Bhutan will need $12 billion in the next 10 years for a capacity addition of 10,000 MW. The 1,095 MW Puntasangchu project is expected to cost around $900 million in 2006 prices.

India, with a huge planned capacity expansion of 50,000 MW in the next 10 years, will require funds to the tune of $31 billion in just the next five years.[47] If we use the same rule of thumb, India is likely to need around $60 billion over the next 10 years for these projects.[48]

Most of the project costs mentioned above do not include the cost of laying the transmission lines, which will be high given the remote locations of many of these projects. Table 4 summarizes the likely finances required for dam building in the Himalayas in the next 10 years. For Nepal, we have included only the projects that are likely to come up in the immediate future, but the capacity additions planned are much greater.

Table 4: Funds Required For Himalayan Dams in the Next Ten Years

Country	Capacity Considered (MW)	Funds Required (Billion US$)
Pakistan	10,000	20.3
Nepal	2,134	4.2
Bhutan	10,000	12
India	50,000	60

Sources of Financing

The financing sources of these dams are likely to differ from country to country, as the four countries have differing economic situations. In general, the private sector is expected to play a more significant role than in the past in all four countries, with governments hoping that it will help meet the huge requirements of funds. International Financial Institutions (IFIs) like the World Bank and the ADB are likely to play an important role in Nepal and Bhutan, as are the government of India, Indian companies and some bilateral donors. In Pakistan, IFIs, China and domestic resources are the likely sources of funds. In India, the government, public and private developers, Indian banks and Indian financial institutions are likely to be the biggest players, although given the size of the program there will also be a host of national and international players.

BHUTAN

The Indian government will be a major funder of dams in Bhutan. The Chukha (336 MW), Kurichhu (60 MW) and Tala (1,020 MW) projects have been financed entirely by the government of India with 60% of the money coming as grants and 40% as loans with interest rates from 5-10.75%. Indian cooperation also extends to the construction of transmission lines to bring the power to India. The proposed Punatsangchu-I project (1,095 MW) will also be financed entirely by India as per the Indo-Bhutan Punatsangchu-I Agreement of July 28, 2007, but with terms changed to 40% as a grant and 60% as a loan.[49]

Bhutan estimates that it will need Nu 123 billion ($3 billion) in the 10th Plan period (2008-2013) for the first stage of the 10,000 MW development.[50] The government of Bhutan is proposing to use Nu 40 billion ($950 million) of the Nu 100 billion ($2.4 billion) committed by India towards the 10th Plan. It is not clear whether this includes assistance for the Punatsangchu-I project or not. There is also no clarity about the source for the remaining funds, except that they will come from loans. Even if we assume that the Indian contribution will pay for Punatsangchu and another Nu 40 billion, this comes to about $1.85 billion, leaving a shortfall of more than one billion dollars. And this is only the first stage, which accounts for a mere 25% of the total funds. Bhutan will need to bring in over $9 billion in the second stage. This is where IFIs are likely to play a role.

While the World Bank is not directly involved in financing hydropower in Bhutan at the moment, the ADB is directly supporting it. According to the ADB's "2008 Fact Sheet on Bhutan," the "ADB and the Government have agreed to focus assistance on transport, power (including rural electrification), urban development, and financial and private sector development."[51] The ADB also provided a Technical Assistance grant (TA), "Preparing the Bhutan Power Development," in 2007.[52] Among the objectives of the TA are the acceleration of hydropower development and private sector participation,[53] including preparations for the 114 MW Dagachu project. This TA will also devise financial packages from "public and private investors and lenders, including bilateral and multilateral banks, or export credit agencies." A related grant and loan are expected to follow this TA. The ADB has also recently approved a TA entitled "Promotion of Clean Power Export Development" that will result in, among other things, a "strategy and action plan to broaden financing avenues for future large hydropower projects."[54] Thus, the ADB is set to mobilize a set of international financiers, private and public, for hydropower projects in Bhutan. The ADB has also provided a $62.24 million private-sector loan for laying the transmission lines from Siliguri to New Delhi in India to transport power from the 1,020 MW Tala Hydroelectric Project in Bhutan.[55]

Bhutan hopes to build projects totalling about 7,000 MW through joint ventures with the government of India. It hopes to pull in private capital for the remaining 3,000 MW on a build-own-operate-transfer (BOOT) basis, and the new hydropower policy is a step in this direction. Apparently, Indian companies like Tata, Reliance, GMR, Lanco, Jai Prakash, Green Infrastructure Development, and even a few companies from Norway and South Korea, have expressed interest.[56] Tata Power of India has become the first private company to invest/have ownership in a hydropower project in Bhutan, with the company having taken a 26% share in the 114 MW Dagachu Power Project in January 2008.[57]

NEPAL

Nepal is following a two-pronged approach to fund its hydropower program. The relatively modest program for its internal requirements would be funded by NEA's internal resources, funds raised from the domestic market, and bilateral and multilateral aid agencies. The projects that are meant for power exports to India will be executed by public or private companies under Public-Private Partnerships

(PPPs), or through privatization where they would raise their own money, backed by the promise of the Indian power market. Nepal would get some free power and possibly some equity in these projects.

Thus, the NEA plans to issue power bonds to the tune of NR 3 billion ($43.5 million) to fund the Chameliya, Kulekhani-III and Middle Marsyangdi projects. It is also planning to raise domestic financing for the Upper Tamakoshi project.[58]

The German government is partially financing the Middle Marsyangdi project through the Kreditanstalt für Wiederaufbau (KfW), a German government-owned bank that supports economic, social and ecological development worldwide. Soft loans from China are expected to support the 60 MW Trishuli-3A project and the Nepalese government has recently requested support from China for the 122 MW Upper Seti project.

On the other hand, MoUs have been signed with corporations to build projects like the 750 MW West Seti (SMEC), 300 MW Upper Karnali (GMR Consortium) and 402 MW Arun-III (Satluj Jal Vidyut Nigam Ltd.) projects, primarily to export power to India; these companies will raise their own funds. The sources for these funds could be diverse, including Indian and international banks, financing agencies, bonds, export credit agencies, and even IFIs as the West Seti case shows. [See Box 1, page 14] The Indian market will be the ultimate backer of these funds, and thus, the policies and incentives associated with the sale of electricity in India, discussed further on in this report, will influence the funding of these projects in Nepal, too.

Recent developments suggest that Nepalese-Indian cooperation in the field of water resources could pick up pace. If this happens, there could be direct Indian government funding for projects like the 207 MW Naumure and the massive 6,480 MW Pancheswar multi-purpose projects.

The ADB is likely to be a very important source of funds for hydropower projects in Nepal. It is considering supporting the West Seti project in multiple ways – a Private Sector Loan of $50 million, a Political Risk Guarantee of $68.5 million and an Equity Investment of $40.8 million.[59] There is also a $45 million loan proposed to the Nepali government for it to invest in the project. The ADB has a TA, "Transmission and Distribution Project" that will facilitate the preparation of transmission and distribution expansion and reinforcement projects. The ADB has also approved a TA, "Promoting Private Sector Participation in the Power Sector," that will develop policy and regulations to encourage private participation in Nepal's domestic and export-oriented hydropower programs.[60]

PAKISTAN

Internal resources like the PSPD – Public Sector Development Plan (government finances) and special charges like surcharges on power sold (e.g. a 10 paisa per

The Karnali River downstream of the planned Upper Karnali project, 2008. Upper Karnali is estimated to cost $454 million (1998 estimate) which is about half the total annual revenue of Nepal. Photo: Shripad Dharmadhikary

KWh surcharge for the Neelum Jhelum project), support from China, and IFIs like the World Bank and the ADB are likely to be the main sources of funds for projects in Pakistan. Foreign private banks, Export Credit Agencies (ECAs) and external commercial borrowings could also play a role in Pakistan.

The ADB has funded virtually all the large hydropower projects in Pakistan to date – Tarbela, Mangla and Gazhi Barotha.[61] Key priorities for the ADB in Pakistan now include reforms and investment in major infrastructure – two of three key sectors being power and energy, and water and irrigation. This will likely mean the institution will support future big dam construction. Currently active ADB projects in the power sector include support for investments in power transmission and promotion of the private sector.

The World Bank has been involved in supporting the Tarbela, Mangla and the Gazhi Barotha projects. The World Bank's "Pakistan Country Water Strategy" argues strongly for large storage dams in the country and also says that "the very large hydropower potential [offers] possibilities for raising substantial amounts of private financing."[62]

The $38 million "Water Sector Capacity Building and Advisory Services Project" (WCAP) was approved on June 6, 2008 by the World Bank. The objectives of this project include:

BOX 1: 750 MW West Seti Project, Nepal: Funding Sources

Promoter:
SMEC Developments Pty. Ltd., a member of the SMEC Group of Australia

Other Equity Holders:
China Machinery Import-Export Company

Infrastructure Leasing and Finance Corporation (IL&FS) India

Government of Nepal (Equity Contribution to be funded through an ADB Loan of $45 million)

Asian Development Bank ($40.8 million)

Financiers:
China Export Import Bank

The Industrial and Commercial Bank of China

Bank of China

Asian Development Bank (Private Sector Loan $50 million)

Guarantees:
Asian Development Bank (Political Risk Guarantee $68.5 million)

PTC India Limited (PPA to purchase all the power exported to India)

> …(ii) sediment management studies for the Indus system and [the] possibility of flushing sediments through the Tarbela reservoir and its impact basin wide; (iii) preparation of a power investment plan with [a] focus on hydropower development in the upper Indus and conjunctive operation of dams and infrastructure; and (iv) feasibility studies and preparation of designs for quickly/easily implementable hydropower plants suitable for financing by international financial institutions.[63]

While Pakistani media reports suggest that the World Bank will not finance the massive 4,500 MW, $8.5 billion Diamer-Bhasha Dam, this water sector capacity-building project indicates that this may not entirely be true and the World Bank could play a role in the Diamer-Bhasha project. It is also clear that the Bank is preparing to support, or at least help raise support for, some of the other projects that are at advanced stages of preparation; one such likely project is Akhori. The Bank may also want to push for privatisation of some of these projects.

There are indications that China will support the Diamer-Bhasha project. Reports say that the Chinese government has offered to provide skilled labour from the Three Gorges Dam site.[64] Chinese companies are already involved in several projects in Pakistan, including Allai Khwar, Khan Khwar, and Neelum Jhelum.

Several bilateral agencies and foreign financial institutions and banks have also been involved in supporting Pakistan's dam-building program. For example, the Ghazi Barotha project was supported by the Overseas Economic Cooperation Fund (Japan), KfW, European Investment Bank (EIB) and Islamic Development Bank (IsDB), plus the World Bank and the ADB. KfW has been supporting feasibility studies for the 621 MW Lower Palas Valley project (Chor Nallah) and the 122 MW Keyal Khwar project. The Abu Dhabi Fund has provided loans for the Khan Khwar, Allia Khwar, Duber Khwar and Gomal Zam projects.[65] The Kuwait Fund is supporting the Golen Gol Hydropower project.[66] Some of these agencies are likely to be involved in Pakistan's future hydropower program.

INDIA

The funding of large hydropower projects in India has undergone important changes in the last decade or so. Earlier, governments provided the bulk of the funds and IFIs such as the World Bank played a significant role. The relative role of IFIs is now declining, and funds from non-government sources and funds raised on the market are becoming more important. Indian domestic financial agencies are emerging as major sources of financing. Another important change has been the increased role of the private sector as project developers.

Given the huge size of India's hydropower program and its massive requirements of funds, a number of diverse sources are expected to emerge. Among them are internal public sector dam developers like NHPC, government budgetary support, borrowings from domestic banks, bonds, other instruments for raising money from the market, External Commercial Borrowings (ECBs), i.e., borrowings from foreign private banks or markets, specialised financial institutions for power like the Power Finance Corporation (PFC), private developers, etc.

The World Bank, the ADB, export credit agencies and some bilateral institutions are expected to continue their support for hydropower in India, though their involvement will be relatively small. However, they could still play a "beacon role"; while the contribution of their own funds would be relatively small, their involvement or approval would be a signal for many of the other financing agencies, especially international agencies, to provide funds to these projects.

An indication of the contributions from different sources is given by the estimates of funds required and available for the power sector in the report of the Indian Ministry of Power's Working Group on Power for the 11th Five Year Plan.[67] It is cautioned that these estimates are for the entire power sector, including thermal generation, transmission and distribution, but they do offer an idea of the magnitude of contributions from the key sources. Table 5 summarises these estimates.

Thus, domestic banks and financial institutions are among the biggest sources of funds for the power sector. Their share would be more than the 10.3% as suggested in Table 5, since agencies like the PFC also raise some of their resources from these banks. The PFC and the REC are also major sources, but they have been lending mainly to the thermal generation sector, with limited contribution to the hydro sector. In the case of the PFC, hydropower generation projects account for about 13% of the total cumulative sanctions while thermal generation projects account for 55%.[68]

Table 5: Percentage of Contributions from Various Sources of Funds for the 11th Five Year Plan for the Indian Power Sector, 2007-12

Particulars / Source	% of Total Outlay
Total Funds Required With Equity to Debt Ratio of 30:70)	100%
Equity Available	
Promoters including Foreign Direct Investment for Independent Power Producers	2.47%
Internal Resources	6.10%
Others	3.86%
Total Equity Available	**12.43%**
Additional Equity to be arranged (EQUITY DEFICIT)	**17.56%**
Debt Available	
Direct Market Borrowing	2.42%
Banks and All India Financial Institutions (AIFIs)	10.30%
Power Finance Corporation (PFC)	7.87%
Rural Electrification Corporation (REC)	5.73%
India Infrastructure Finance Company Limited (IIFCL)	1.45%
Multilateral/Bilateral Credits	2.68%
ECA/ECB/Syndicated Loan, etc.	5.57%
Total Debt Available	**36.02%**
Additional Debt to be arranged (DEBT DEFICIT)	**33.97%**
Total Deficit including Equity and Debt	**51.53%**
Special Funds (Government Funds under special programs for rural electrification and others)	7.8%
Total Deficit	**43.73%**

THE FUNDING GAP

However, the most significant fact that stands out from Table 5 is that even with all these available sources, almost 44% of the funds still remain unsecured. Thus, funds are going to be a severe constraint for the power sector as a whole. In terms of accessing funds from the market, it should also be kept in mind that the power sector has to compete with other infrastructure projects; within the power sector, hydro also has to compete with thermal power projects.

A number of steps have been suggested to meet the funding gap in the power sector, including a relaxation of the norms for how much banks can lend to the power sector, higher ceilings for total borrowings and interest rates for ECBs, special financial support grants in the form of viability gap funds for generation and transmission schemes in remote areas like the northeastern region, and the state of Jammu and Kashmir.

While these high energy prices may ease the availability of funds for power projects, they will push electricity out of the reach of the poor. The fast expanding markets of those who can pay high energy prices beg the question – what about those who cannot?

At the fundamental level, however, as the hydropower sector turns increasingly to funds from outside government budgets, the availability of funding becomes more and more dependent upon the ability of the sector to pay these back, and hence on its ability to recover its investments. This is true for funds raised for equity or debt, from local or foreign markets, from banks or through bonds, indeed, for any funds that don't come from governmental sources, and for many that do. The need for recovery of investment is especially critical for private developers.[69] Thus, being able to raise funds will critically depend on whether the projects will be able to sell power at the appropriate tariffs in the market. The key will be to achieve both high enough tariffs and the creation of a market with enough paying capacity to buy power at the desired rates. This is precisely the aim of the power sector "reforms" in India.

The reforms consist essentially of transforming the power sector to operate on a commercial basis. Key elements of the reform program include full cost recovery measures, an increase in tariffs, the elimination or phasing down of direct and cross subsidies, and the development of an electricity market with open access and merchant sale.

Even with over 12 years of these reforms so far, the uncertainty of recovery of payments for electricity sold remains. As the Working Group on Power for the 11th Plan points out:

> The off takers of power are mostly SEBs [State Electricity Boards] and almost all of them (and their successor DISCOMS[70]) continue to make cash losses. The lenders are extremely concerned over this and continue to seek a credible payment security mechanism that often entails suitable credit enhancement as may be required.
>
> However, till the time these entities start making cash profit, the concerned Governments may need to provide suitable comfort to the lenders by signing/operationalising satisfactory escrow agreements or required changes in other project documents (PPA, etc). It must be re-emphasized that the utilities in the power sector need to generate profits through levy of adequate user charges/recovery…[71]

Mechanisms like escrow[72] and guarantees have serious implications in that precious government and public resources can end up being effectively mortgaged for private profits. Also, the escrowable capacities and guarantees that the government can extend are limited. Thus, it is not assured that the projects, especially hydropower projects, will necessarily be able to raise the required money from the markets, as the reforms have made limited progress.

On the other hand, whatever progress has been achieved by the reforms raises questions about the impact of these measures on the poor. India's Hydropower Policy 2008 states: "Lately, financial institutions have become more flexible…in financing power projects, particularly hydro projects. High energy prices in a fast expanding power market have diluted their insistence on water-tight PPAs backed by Government guarantees….there would be no dearth of funds for projects with viable tariffs…"[73]

While these high energy prices may ease the availability of funds for power projects, they will push electricity out of the reach of the poor. The fast expanding markets of those who can pay high energy prices beg the question – what about those who cannot?

The important question then becomes the impact of these measures (reforms) on the tariffs of the electricity generated, and the implications for access to electricity for the poor. The reforms, and many of the incentives being offered to the hydropower sector, are likely to lead to higher tariffs. In the case of the Himalayan projects, distance from load centres, difficult terrain and other factors will add to the high capital costs of hydropower projects. There is a real danger that these projects will then end up generating high-cost power supplied only to consumers with a high paying capacity. This is an important concern. The National Tariff Policy 2006 says: "Consumers, particularly those who are ready to pay a tariff which reflects efficient costs, have the right to get uninterrupted 24 hours supply of quality power."[74] Is this a recognition and a pre-emptive defense of the fact that these policies are likely to lead to higher tariffs, which only a certain segment of consumers will likely be able to afford?

It is important to note that as the major hydropower projects in Nepal and Bhutan are linked into the Indian power system, these issues apply equally to them. The ability to raise finances for projects being built by private developers in Nepal and Bhutan will be dependent on finding markets in India at sufficiently high tariffs and with high levels of reliability of payments. In turn, the same issues of access for the poor will become important.

Key Players

Key players in the massive dam building programs in all four countries include the central and provincial governments and the respective energy or power ministries, public corporations set up to build hydropower projects, financial institutions – national and international, and contractors and equipment supply companies.

Recent privatization trends and reform processes have brought in a number of new players and institutions. These include the various electricity regulatory commissions, power trading companies and power exchanges, and of course the large number of private companies emerging as developers of hydropower projects.

Some of the key financial agencies have already been discussed above. Among the public sector developers of the projects are the WAPDA in Pakistan, the Nepal Electricity Authority in Nepal and several publicly owned corporations in India like NHPC Limited, North Eastern Electric Power Corporation Limited (NEEPCO), and NTPC. Private developers are also emerging as important players in all four countries. Box 2 (page 18) lists some of the public and private corporations in India and the projects they are developing. Box 4 (page 20) explains the interests of Chinese companies in dam building in the Himalayas.

Water and Power Development Authority (WAPDA), Pakistan, 2007. WAPDA is a key public sector developer of hydropower projects in Pakistan. Photo: Ann-Kathrin Schneider

Many big and small players want to enter the hydropower business, as can be seen from the large number of private players who have shown interest in hydropower projects in Nepal. There are about 160 companies, individuals and combinations thereof who have submitted License for Survey applications – which are currently under review – to the Department of Electricity Development (DoED) at the Ministry of Water Resources in Nepal. Included are major Indian companies like Lanco, GMR, Larsen and Toubro, Jindal and Satluj Jal Vidyut Nigam Limited (SJVNL). Also on the list are several well-known former bureaucrats, politicians, businessmen and their relatives.

Among the new institutions emerging from the power sector reforms that will play a major role in hydropower development are the electricity traders.

Trading of electricity has gained immense importance after the introduction of the power sector reforms. This is especially true for private project developers, as it is power trading that holds the key to viability; or rather, the key to the confidence that developers and financiers seem to have in getting assured returns from these projects. In particular, it is the provision of open access and merchant sales (sale of electricity directly to consumers, mostly bulk consumers without a long term PPA) of a large part of the generated electricity that seems to be an important attraction for these developers. In the case of a hydropower plant, in the later years when the cost of production decreases after debt repayment is complete, developers have the chance to make huge profits by selling the power at prevailing high prices in the open market. [see Box 3, page 19] India's hydropower policy notes this when it says that "…from the point of view of the private sector the major incentive is the scope for trading – particularly in the later years when cost of generation goes down and the market price of power is high."[75]

> In the case of a hydropower plant, in the later years when the cost of production decreases after debt repayment is complete, developers have the chance to make huge profits by selling the power at prevailing high prices in the open market.

While some of the open access and merchant sales are likely to take place through direct deals between the generator and either the distributor or the

BOX 2: Some Public and Private Corporations in India and the Projects They Are Developing

	Name of Company	Existing or Under-Construction Projects	New Projects
Public Sector			
1	National Hydroelectric Power Corporation Ltd. (NHPC)	Dibang, Subansiri Lower, Chamera-III	Pakal Dul (Drangdhuran), Teesta IV, Kotli Bhel 1A, 1B and II
2	North Eastern Electric Power Corporation Limited (NEEPCO)	Kameng Hydro Electric Project	Kameng-I HE (Bhareli-I), Tipaimukh, Kynshi Stage I
3	Tehri Hydro Development Corporation (THDC)	Tehri	Tehri PSS, Koteshwar, Vishnugadh Pipalkoti
4	Sutluj Valley Jal Vidyut Nigam Ltd. (SVJNL)	Nathpa Jhakri	Rampur, Devasari, Khab, Arun III (Nepal)
5	National Thermal Power Corporation Ltd. (NTPC)	Kol Dam, Loharinagpala, Tapovan Vishnugadh	Attunli, Etalin
6	Uttaranchal Jal Vidyut Nigam Ltd.		Pala Maneri
7	Himachal Pradesh Electricity Board		Kashang, Sainj, Shongtong Karcham,
Private Sector			
8	Bhilwara Group		Nyamjunchhu-I, II, III
9	D S Constructions Ltd.		Kutehr, Naying
10	Gati Infrastructures Ltd., Hyderabad		Sada Mangder, Bhasmey, Chujachen
11	Jay Pee Group	Baspa-II, Karcham Wangtoo, Vishnuprayag	Hirong, Lower Siang, Kynshi Stage II, Umngot
12	KSK Group		Dibbin, Dikri, Dimijin, Dinchang, Kameng Dam, Nazong, Utung
13	Mountain Falls (India) Ltd.		Hutong-II, Kalai-I, Kameng-II (Bhareli-II)
14	Reliance Energy (Reliance Power)		Tato-II, Siyom, Kalai II, Urthing Sobla
15	GMR Group		Badrinath (Alaknanda), Talong, Upper Karnali (Nepal)
16	Tata Power		Dagachhu (Bhutan)

BOX 3: Merchant Sale of Power and Windfall Profits for Private companies

India's new Hydropower Policy allows developers to sell 40% of their saleable electricity on a merchant basis.

In the case of hydropower projects, the main component of production costs is financial – repayment of capital, principle and interest. (The social and environmental costs are often externalized, and thus not paid for by the projects themselves).

After 7-10 years, when full repayment of capital costs is complete, the cost of generating power can fall sharply. However, in the open market, electricity can fetch a very high price. Thus, allowing a private company to sell power in the open market can lead to windfall profits. As an example, consider the 300 MW Baspa-II Project. According to the Tariff Order by the Himachal Pradesh State Electricity Regulatory Commission, in 2006, if company profits are left out, 89% of the generation cost went to capital recovery and 11% to operating expenses. Thus, as soon as repayment is complete, the cost of generation will drastically decrease by 89%. The company will be paying just 11% of the previous costs of production, but the price of electricity on the market will remain the same. Thus, the company stands to make sudden, huge profits.

In the case of a public company, when the cost of generation goes down in later years, the result is a decrease in the pooled cost of electricity generation; it can then sell the power at lower tariffs. The benefit will go to the public at large. But in the case of a private developer, this benefit goes directly to shareholders.

consumer, and mediated by the rules set by the regulatory commissions, other agencies are also likely to play a key role. One such agency is PTC India Limited (formerly Power Trading Corporation of India).

PTC India Limited was set up for trading power and encouraging the development of a power market. An important role that PTC has been asked to play by the government of India is that of the nodal agency for trading power with the neighboring countries of Bhutan and Nepal. Among the projects whose electricity is being or will be traded by PTC are Malana-II and Karcham Wangtoo in India, West Seti in Nepal, and Chukha, Kurichu and Tala in Bhutan. Several other trading companies are also in the process of being created.

Another important development in this context is the launch of the Indian Energy Exchange Limited (IEX), on June 27, 2008. The IEX "…is India's first-ever, nationwide, automated, and online electricity trading platform. It has been conceived to catalyse the modernisation of electricity trade in the country by ushering in a transparent and neutral market through a technology-enabled electronic trading platform."[76]

BOX 4: China "Goes Out" to Build Himalayan Dams

One of the biggest changes to occur in big dams in the past 20 years is the rise of Chinese dam builders and financiers. China's dam industry has gone global, building hundreds of dams throughout Africa and Southeast Asia, but also Central Asia, South America, and the Himalayas. To date, some 10 different Chinese companies have built or are building at least 13 dam projects in Nepal and nine in Pakistan. While there are no Chinese-built or financed dams in Bhutan, possibly due to long standing and unresolved border disputes between the two countries, Chinese dam builders have taken their business to nearby countries such as Burma, Uzbekistan, Tajikistan, and Kyrgyzstan. China is also beginning a long-term program of domestic hydropower expansion in the headwaters of the many rivers that originate in the Tibetan Plateau, including the upper Brahmaputra (Yarlung Tsangpo), which could have impacts on populations living downstream in India and Bangladesh.

The increased number of Chinese companies involved in dam development in Nepal and Pakistan is a product of two recent trends. First, since the year 2000 China's central government has advanced a "Going Out" campaign in an effort to boost China's economy, which includes incentives for companies to expand their overseas business. These incentives include the promise of "tied" concessionary loans and export credit insurance. Second, China's domestic dam industry is now arguably the most prolific in the world, with technical skills on par with those of industrialized nations. While the playing field is becoming crowded within China, there is huge external demand for the technology, capacity, and financial backing that Chinese dam building companies can bring, particularly in countries like Pakistan and Nepal, where there are few domestic resources and leaders are eager to exploit rich hydropower resources or boost irrigation capacity.

Chinese dam companies have shown some interest in working within India as well, but so far none have been awarded contracts. This may be in part due to the fact that India seeks to bolster its own overseas dam industry rather than helping China gain footing in the region. China's ability to not only construct but also finance projects may give it a slight advantage over India, as suggested by recent media reports regarding competition for dam contracts in Nepal. It may be noted however that many Indian thermal power projects are sourcing equipment from China and Chinese companies.

Though many of the dams Chinese companies have built in Nepal and Pakistan are relatively small, trends suggest that Chinese dam builders and financiers are setting their sights on larger projects. For example, the 750 MW West Seti project, which will be the largest dam in Nepal, is being built by China Machinery Import-Export Company and is financed in part by three Chinese banks: China Export Import (Exim) Bank, the Industrial and Commercial Bank of China, and the Bank of China. The project has been the subject of intense debate within Nepal not only because it will displace thousands of subsistence farmers and destroy Seti River fish habitat, but also because 90% of the power the project produces will go to India.

Another controversial project, the 4,500 MW Diamer-Bhasha Dam in northern Pakistan, may have gotten the green light in August 2008 when it was reported that the Chinese government (presumably, China Exim Bank) agreed to finance the $8.5 billion dollar project. While China's involvement in the Diamer-Bhasha Dam has yet to be confirmed, another large dam in Pakistan's north is already being constructed by Chinese companies. In February, 2008, the cornerstone for the 969 MW, $1.5 billion Neelum-Jhelum Dam was laid by China Gezhouba Company and China National Machinery Import and Export Corporation. Several smaller projects built by Chinese companies and financed by Chinese banks are in the works throughout Pakistan.

Nicole Brewer, International Rivers

Social and Environmental Impacts

The World Bank says that "the Himalayan hydropower sites are, from a social and environmental perspective, among the most benign in the world."[77] This is a patently false assertion. Dams in the Himalayas will have social and environmental impacts similar to dams in other parts of South Asia, which have proven very harmful. The low population density in these areas is sometimes put forward to argue that the projects are benign from a social impact point of view. Indeed, this very fact can mean that the populations are actually more vulnerable to displacement and that the impacts of displacement would thus be more severe. In fact, due to the peculiar geographical and cultural circumstances, dams in the Himalayas will have some serious impacts not seen elsewhere.

DIRECT SUBMERGENCE

Direct submergence of a large number of houses, villages, cultivated lands and forests remains a serious issue. For example, the Tehri project in Uttarakhand, India has led to the direct submergence of the town of Tehri, 37 villages fully and 88 partially. More than 10,000 families have been displaced.[78] The Tipaimukh project in Manipur, India, is going to submerge an area of 292 km^2. The Environmental Impact Assessment (EIA) of the project boasts that it will have a "meagre impact," as it will submerge a population of only 2,027 in 313 households in 12 villages.[79] Although it does note that lands and farms of 91 villages will be submerged by the reservoir, they are inexplicably not considered to be "impacted" by this project.

Protest in Bangladesh against the environmental clearance of Tipaimukh Dam in India, 2008. The dam will submerge 292 sq km, affecting 91 villages in India, and people in Bangladesh are concerned that the project will drastically and adversely alter river flow in the downstream region in Bangladesh, with severe social and environmental consequences. Photo: Angikar Bangladesh Foundation

In Pakistan, the reservoir of the Diamer-Bhasha Dam will spread over 130 km^2 (32,000 acres) and 24,500 people will be affected.[80] [See Box 5, page 25] Given the size of the reservoir, the resettlement figures seem to be an underestimate.

The 600 MW Akhori project is expected to have a submergence area of 240 km^2 (59,200 acres), and will displace 49,300 people.

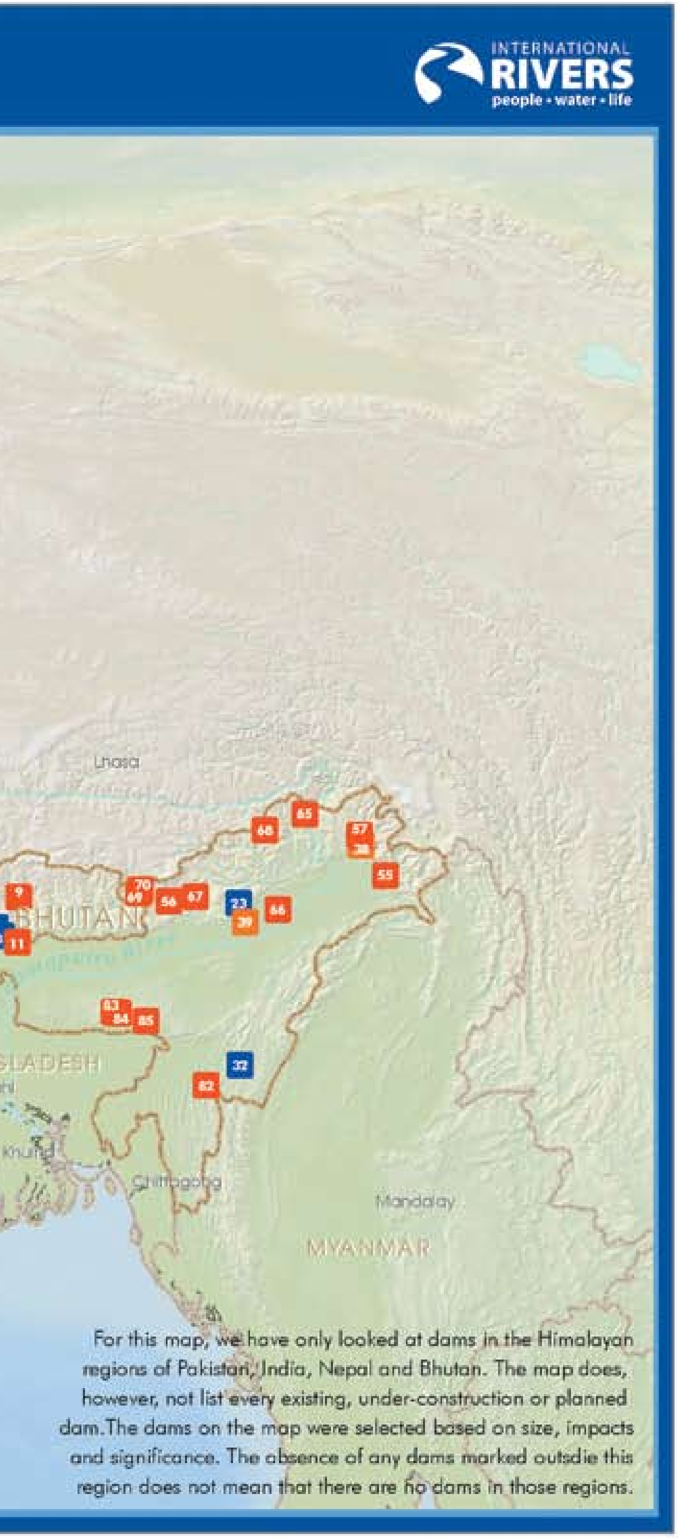
The website of the West Seti project in Nepal says that "2,322 ha [23 km^2] of land will be acquired for permanent project features and 678 ha [7 km^2] for the transmission lines."[81] It also says that 1,383 households will need to be resettled from the project site, and another 186 households for the transmission lines. However, it does not mention the total land submerged or the total number of people affected, as in many cases people severely affected are not necessarily slated for resettlement. Other estimates put the number of people affected by this project at 15,000.[82]

Indeed, the impact of Himalayan dams is likely to be much greater if the totality of the impacts of the destruction of the resource base, including rivers, fisheries and forests, is taken into consideration.

LOSS OF THE RESOURCE BASE

Most of the people living on the banks of rivers in the Himalayan region derive their sustenance from their natural resource base. Agriculture provides food and other needs. The river gives fish, and also provides water for daily use and irrigation. It can also provide transportation routes. Forests provide a variety of things including fruits, vegetables, timber, fodder and in many areas they are also an integral part of the *jhum*, or shifting cultivation, cycle.[83] This richness and multi-dimensionality of the resource base is often not understood nor taken into account by planners when considering the impacts of projects.

DAMS IN THE HIMALAYAS



For this map, we have only looked at dams in the Himalayan regions of Pakistan, India, Nepal and Bhutan. The map does, however, not list every existing, under-construction or planned dam. The dams on the map were selected based on size, impacts and significance. The absence of any dams marked outsdie this region does not mean that there are no dams in those regions.

No.	Project	Country	Capacity (MW)	Status
3	Diamer-Bhasha	Pakistan	4,500	Proposed
4	Dasu Hydropower	Pakistan	4,000	Proposed
5	Bunji Hydropower	Pakistan	5,400	Proposed
9	Punatsangchhu-I	Bhutan	1,080	Proposed
11	Sankosh Multipurpose Project	Bhutan	4,060	Proposed
14	Arun-III	Nepal	402	Proposed
15	Upper Karnali	Nepal	300	Proposed
16	West Seti	Nepal	750	Proposed
17	Trishuli Upper-3A	Nepal	60	Proposed
18	Trishuli Upper-3B	Nepal	44	Proposed
19	Barakshetra (Kosi High Dam)	Nepal	3,300	Proposed
20	Pancheswar	Nepal	6,480	Proposed
55	Demwe	India	3,000	Proposed
56	Dibbin	India	125	Proposed
57	Etalin	India	4,000	Proposed
65	Siang Upper (Upper Siang)	India	11,000	Proposed
66	Siyom	India	1,000	Proposed
67	Talong	India	160	Proposed
68	Tato-II	India	700	Proposed
69	Tawang-I	India	750	Proposed
70	Tawang-II	India	750	Proposed
71	Kashang-II	India	65	Proposed
72	Kashang-III	India	48	Proposed
73	Khab	India	340	Proposed
74	Kutehr	India	260	Proposed
75	Reoli / Dugli	India	715	Proposed
76	Shongtong Karcham	India	402	Proposed
77	Thopan Powari	India	480	Proposed
78	Bursar	India	1,020	Proposed
79	Pakal Dul (Drangdhuran)	India	1,000	Proposed
82	Tipaimukh	India	1,500	Proposed
83	Kynshi Stage I	India	450	Proposed
84	Kynshi Stage II	India	450	Proposed
85	Umngot	India	270	Proposed
86	Jorethang Loop	India	96	Proposed
87	Teesta I	India	280	Proposed
88	Teesta II	India	330	Proposed
89	Teesta IV	India	495	Proposed
90	Devsari Dam	India	690	Proposed
91	Garba Tawaghat	India	630	Proposed
92	Kotli Bhel 1A	India	195	Proposed
93	Kotli Bhel 1B	India	320	Proposed
94	Kotli Bhel II	India	530	Proposed
95	Tehri PSS	India	1,000	Proposed
96	Urthing Sobla	India	400	Proposed
97	Vishnugad Pipalkoti	India	444	Proposed

No.	Project	Country	Capacity (MW)	Status
6	Neelum Jhelum	Pakistan	969	Under construction
21	Kulekhani-III	Nepal	14	Under construction
22	Marsyangdi Madhya (Middle)	Nepal	70	Under construction
38	Dibang	India	3,000	Under construction
39	Subansiri Lower	India	2,000	Under construction
40	Allain Duhangan	India	192	Under construction
41	Chamera-III	India	231	Under construction
42	Karcham Wangtoo	India	1,000	Under construction
43	Rampur	India	412	Under construction
44	Sawara Kuddu	India	110	Under construction
45	Baglihar-I	India	450	Under construction
46	Baglihar-II	India	450	Under construction
47	Kishanganga	India	330	Under construction
49	Teesta III	India	1,200	Under construction
50	Teesta VI	India	500	Under construction
51	Koteshwar	India	400	Under construction
52	Loharinagpala	India	600	Under construction
53	Shrinagar	India	330	Under construction
54	Tapovan Vishnugad	India	520	Under construction

No.	Project	Country	Capacity (MW)	Status
1	Tarbela	Pakistan	3,478	Existing
2	Mangla	Pakistan	1,000	Existing
7	Chukha	Bhutan	336	Existing
8	Tala	Bhutan	1,020	Existing
12	Kali Gandaki-A	Nepal	144	Existing
13	Khimti-1	Nepal	60	Existing
23	Ranganadi	India	405	Existing
24	Baspa II	India	300	Existing
25	Bhakra	India	1,325	Existing
26	Chamera-I	India	540	Existing
27	Chamera-II	India	300	Existing
28	Malana	India	86	Existing
29	Nathpa Jhakri	India	1,500	Existing
30	Dul-Hasti	India	390	Existing
31	Salal	India	690	Existing
32	Loktak	India	90	Existing
33	Teesta V	India	510	Existing
34	Maneri Bhali (Thilot or Tiloth) ST	India	90	Existing
35	Maneri Bhali II	India	304	Existing
36	Tehri	India	1,000	Existing
37	Vishnuprayag	India	400	Existing

Fisherman on the Indus River, Pakistan, 2007. The planned hydropower projects are likely to submerge forests, farms and grazing lands, impact fisheries, cut-off access roads, and degrade water sources impacting millions of people along the way. Photo: Ann-Kathrin Schneider

Consider the 2,000 MW Lower Subansiri project in Arunachal Pradesh, India, which is under construction. The people of Durpai Village, one of the affected villages, say that while two villages are shown to be losing land to submergence, many other villages and people will also be affected because their rice growing areas are affected by the project. They also say that the project requires 40 km^2 (4,000 ha) of forests, much of it for submergence. This forest area supports part of the *jhum* cycle of the local people, in addition to being a source of many other goods and services.

The people also say that the construction activities at the dam site have adversely affected their fishing and that once the dam is complete, all fishing opportunities will be completely destroyed. The people of the village transport construction material for their houses by rafts via the river. This practice has already been disrupted due to dam construction and once the project is complete will be entirely impossible. Thus they have already been badly affected on many levels by this project during its construction phase.[84]

These are likely to be major issues for almost every project in the area, as these projects are likely to submerge forests, farms and grazing lands, impact fisheries, cut-off access roads, and degrade water sources.

There are also several issues that are unique to the dams in the Himalayas, either due to its geography and topography, or due to the sheer extent of the dam building proposed. In many cases, impacts of individual dams are dwarfed by the cumulative impacts of several dams in an area or a river basin.

DOWNSTREAM IMPACTS

Some of the most serious impacts of dams in the Himalayas are going to be felt downstream of the projects as the dams affect the quantity, quality and pattern of water flows.

The experience of the 405 MW Ranganadi Hydro Electric Project (RHEP) Stage I in Arunachal Pradesh, India, shows the seriousness of the issue. The project, commissioned in 2002, involves a dam to divert the flow of the Ranganadi River into the Dikrong River. Tana Pinje of Upper Cher Village (District Papum Pare), downstream of the RHEP, describes its impacts:

> After the completion of the dam, water flows in the river have gone down drastically. Our fish are totally gone. Earlier even outsiders – like tourists – used to come here to fish, now there is no fish even for us. In fact, our village was considered so beautiful because of the flowing river that it was a very popular tourist spot and many tourists used to come here for picnic. But now all that has stopped because with the river gone, so have the tourists.
>
> Our fields are also affected badly as the channels we had made to take water to the fields have become dry. Horticulture, which is a very important source of livelihood for our village and includes banana, oranges, pineapple and spices like black pepper, cardamom – has almost finished along the river banks.[85]

As serious as the problem of diminished water flows are sudden high flows in the River. On several occasions the project has released large quantities of water into the river without any warning, leading to flash floods.

Downstream impacts can extend much further down a river. The Brahmaputra river system has intricate links with *beels,* the wetlands in the plains downstream that are an important source of livelihoods and fisheries. The changes in the flow regime are likely to seriously impact these wetlands.

With a high concentration of dams, cumulative impacts will become very important and can be greater than the sum of impacts of individual projects. For example, sudden releases of water from the Ranganadi project have aggravated floods in the downstream state of Assam and have raised fears about the cumulative downstream impacts of dams in Arunachal Pradesh on the state of Assam. On July 16, 2008 the Chief Minister of Assam announced in the State Assembly that he had moved the central government in Delhi to carry out a "cumulative impact study" of the construction of dams in Arunachal Pradesh. It is reported that India's Central Electricity Authority (CEA) has agreed to this.[86]

As many dams are built in the Himalayas, on every tributary and every river, the downstream impacts will extend from the mountains to the plains and all the way to the estuaries. A large number of dams in the basins would cause dramatic transformations in the patterns, quantity

BOX 5: Diamer-Bhasha Project, Pakistan

Dam: 281 meter-high, 990 meter-long concrete gravity dam

Reservoir Area: 129.5 km^2

Agricultural Land Submerged: 6.5 km^2

Population Affected: 24,500 people in 2,833 Households

Affected Villages: 32

Infrastructure Submerged: 110 km-long stretch of the Karakoram Highway

Land Required for Resettlement: 22.26 km^2

Cost of Resettlement Program: US$200 million

Source: Press Briefing by WAPDA on 16 Dec. 2005, from website of the President of Pakistan http://www.presidentofpakistan.gov.pk/media/Water/WAPDA%20Brief.pps. The same presentation gives two different figures for affected population in two different slides. (Slide 41 gives 23,700 people and 2,850 households as affected, whereas Slide 45 gives the figures quoted.)

and quality of flows. Rivers could run dry for a period and then suddenly flood. Hourly, diurnal, and seasonal flows would change. Dams would trap silt behind them, depriving downstream areas of nutrients. All this is likely to dramatically affect everything that depends on the river – daily water use, agriculture and irrigation, fisheries, wetlands and mangroves, livelihoods, cultures and identities.

The areas affected could range from the Indus Plains in Pakistan to the Indus Delta, from the plains of the Ganga in India to the whole of Bangladesh, and would impact millions of people. The impacts would be local, regional and trans-boundary, with the cumulative impacts of dams in Nepal and India being felt all the way to Bangladesh. In Pakistan, the combined effect of the existing storage and diversion projects on the rivers has already had a serious impact on the Indus Delta. According to a study by the International Union for Conservation of Nature (IUCN), the flow in the lower Indus River decreased from 105,000 million cubic meters (MCM) in 1932 to 43,000 MCM in 1970 as a result of the number of projects on the Indus and its tributaries. In the 1990s, the flow went down to 12,000 MCM. This led to a sharp reduction in the area of mangrove forests, declining fish production, degraded water quality, and severe encroachment of the sea into the delta area with a resultant loss of 4,856 km^2 of farmland.[87] New dams will aggravate such problems in the deltaic regions. Undoubtedly, the cumulative downstream impacts of dams in the Himalayas are going to be one of the most serious issues and needs to be urgently studied in detail. It may be mentioned here that dams planned in Tibet are likely to have many impacts for downstream areas in Nepal, Bhutan, India and Bangladesh.

Some of the projects in the Himalayas plan to divert large parts of river flows into tunnels. Such tunnels could empty the flows into the same river many kilometres downstream, or into another river. This will leave parts of the main stream virtually dry or with highly depleted flows. For example, the 300 MW Upper Karnali project on the Karnali River in Nepal will divert river flows through a tunnel, leaving a 60 km-long stretch virtually waterless. Such diversion projects can disrupt fisheries, agriculture and other livelihoods dependent on the river. The impact will be particularly severe when there is a cascade or series of such projects on a single river or in a single river basin. As Himanshu Thakkar of the South Asia Network on Dams, Rivers and People (SANDRP) points out, there are seven projects under construction and nine proposed on the Bhagirathi River and its tributaries in Uttarakhand, India.[88] As a result, in large stretches between Gangotri and Haridwar the river will flow through project-related tunnels, and there will be no recognizable free flowing river as we know it.

The same holds true for a number of other rivers like the Satluj, Teesta, and Alaknanda. Bharat Jhunjhunwala, an economist and a resident of Bhagirathi Valley, estimates that of the 270 km of the Alaknanda River between Badrinath and Kaudiyala, 116 km will be affected by tunnels and 179 km will be affected by either tunnels or reservoirs.[89]

Another dimension of the downstream impacts is the impacts of the so-called run-of-river projects. Technically, run-of-river projects are projects without any storage or pondage. They use the flow of the water in the natural river course, or sometimes through diversions like canals and tunnels, to generate electricity. They can have many of the typical structures such as dams, weirs, headraces, tailraces, and diversions tunnels.[90]

Many Himalayan dams are being classified as run-of-river and hence are touted as socially and environmentally benign; this is false. Many run-of-river projects can have serious impacts by disturbing downstream river flows. Some run-of-river projects divert the water into tunnels, leaving downstream sections dry, and thus cause even more severe impacts downstream. Many of the diversion projects discussed above are classified as run-of-river.

Furthermore, often projects with pondage to store water for meeting daily or weekly peaking needs are wrongly classified as run-of-river. Consider the 510 MW Teesta-V Project in Sikkim, India. NHPC, the developer, classifies it as a run-of-river project; it has a 97 meter-high dam, with "diurnal storage for peaking during the lean season,"[91] and will divert the river through a 17 km-long tunnel.

It is therefore important to properly assess the impacts of run-of-river projects, both individually and cumulatively, rather than assume that they will be benign.

It would be useful to recollect that the Pak Mun project on the Mun River in Thailand, also classified as a run-of-river project, resulted in a dramatic decline in the fisheries and the destruction of livelihoods of thousands of people,[92] faced strong opposition, and became one of the most controversial projects in the world.

CULTURAL IMPACTS

One of the most severe impacts of dam construction in the region, which will be particularly severe in the Himalayas, will be on the culture and identity of the local people. Many places are inhabited by tribes with a distinct identity, language, customs and location. Often, the total population of these tribes is small in number and hence they are excessively vulnerable to the influx of new settlers that is likely to take place during the construction of such huge infrastructure projects, as staff and construction workers will be largely constituted of migrant populations.

For example, Idu-Mishmi is the major tribe in the 3,000 MW Dibang Project area in Arunachal Pradesh, India. Raju Mimi, a local activist and journalist from the lower Dibang Valley, says:

Ancient rock carvings of the Buddha near Diamer-Bhasha Dam site, 2005. A huge treasure trove of rock carvings of ancient times have been found in the area that will be submerged by the reservoir of the planned dam. Photo: Heidelberger Akademie der Wissenschaften - Felsbildarchiv

> The huge influx of outsiders will create a demographic problem. Totally Idu Mishmi population is 11,021. According to the EIA of the Dibang project about 5,800 workforce will come from outside. You can imagine how we will become outsiders in our own lands. As it is, our tribe has been declared as an endangered tribe by the United Nations.[93]

The traditionally distinctly demarcated location and areas of the various tribes also complicate the problems of displacement and resettlement, as attempts to resettle people of one tribe or clan into areas that belong to other tribes can lead to ethnic tensions.

The customs, traditions and the very character of local tribal communities are closely tied to the lands, rivers, forests and other elements of the natural ecosystem. According to a memorandum submitted by Kotige Mena and Ingore Linggi to the chairman of the state pollution control board of Arunachal Pradesh on January 29, 2008, regarding the Dibang project:

> The construction of the Talon/Dibang multipurpose project will completely displace our Idu people who are very much dependent on the river as a source of their livelihood. The Idu community's tradition, custom, faith and beliefs are greatly attached to the river Talon/Dibang…The construction of the dam will herald the end of our culture and tradition as the river Talon/Dibang is as sacred to us, as is the river Ganga to the Hindus…we believe that after death the Igu-myi (1st Order Priest) Sineru carries forward

Rock carvings of a Buddha group and stupas near the Diamer-Bhasha Dam site that will be submerged by the reservoir, 2005. Photo: Heidelberger Akademie der Wissenschaften - Felsbildarchiv our souls through this river…The hills, the rivers and the mountains are deeply embedded in our ethos. It is the life force of our community. Destruction or endangerment of these will be a threat to the community itself. Development at the cost of culture and tradition is not acceptable to us.

These two factors – the influx of large numbers of migrants and the destruction of the natural ecosystem that is integral to the tribal community – are therefore likely to threaten the very identity and culture of several communities who are already endangered due to small population size.

Dam building in the Himalayas will also lead to the submergence of places of religious or historical significance. The Shaligram Shila, a very important religious site for Hindus, now remains submerged quite often due to the Kaligandaki project in Nepal.[94] The Bhagirathi River, sacred in India, is threatened by the number of projects planned on it. A huge treasure trove of rock carvings, dating back from ancient times, has been found along the Indus where the Diamer-Bhasha reservoir is planned.[95] All of these will be submerged by the reservoir.

Such impacts are likely to be seen in many of the projects, as rivers have been the cradles of the earliest human civilisations and centres of religious and spiritual significance for most human societies.

ECOLOGICAL IMPACTS

The Himalayas are recognized not only as a hotspot of biodiversity but also for their fragility. Conservation International[96] lists the Himalayas among the biodiversity hotspots of the world and says that

> The abrupt rise of the Himalayan Mountains from less than 500 meters to more than 8,000 meters results in a diversity of ecosystems that range, in only a couple of hundred kilometers, from alluvial grasslands (among the tallest in the world) and subtropical broadleaf forests along the foothills to temperate broadleaf forests in the mid hills, mixed conifer and conifer forests in the higher hills, and alpine meadows above the treeline.[97]

Conservation International also says that of the estimated 10,000 species of plants in the Himalayas, about 3,160 are endemic, as are 71 genera. Furthermore, five plant families are endemic to the region.[98] About 300 mammal species have been recorded in the Himalayas, including a dozen that are endemic.

The Indian Ministry of Environment and Forests' Environmental Information System (ENVIS)[99] also talks about the rich and diverse ecology of the Himalayan region. For Arunachal Pradesh, it says:

> The state is situated in the Eastern Himalaya and is the richest biogeographical province of the entire Indian Himalayan zone. The province has been identified as one of the world's 18 biodiversity hotspots. The richness of life forms, i.e., the flora and fauna that occur in these forests presents a panorama of biological diversity with over 5,000 plants, about 85 terrestrial mammals, over 500 birds and a large number of butterflies, insects and reptiles. This diversity of topographical and climatic conditions has favoured the growth of luxuriant forests that are home to myriad plant and animal forms adding beauty to the landscape.[100]

Snow Leopard. Dam building in the Himalayas is a threat to animals and endangered species such as the snow leopard. Photo: Fritz Polking. Courtesy: Snow Leopard Trust.

In the case of Sikkim, it states that "Its unique geographical position, varied topography and high annual rainfall make the state a treasure house of flowering plants. The vegetation of tropical forests occurring up to 900 m consists of moist deciduous to semi-evergreen tree species. Sikkim is famous for its orchids and harbours about 45% of [the] orchid species found in the country."[101]

These two states are planning to build a huge number of dams. This is likely to have very serious effects on biodiversity due to the destruction of habitats, natural ecosystems, flora and fauna.[102]

Many aspects of dam building, like the submergence of forests, large scale river diversions, disruption of aquatic eco-systems – both upstream and downstream, blasting, digging, excavation, debris dumping and other construction-related activities, are likely to wreak havoc on the ecology of the Himalayan region.

Conservation International identifies the construction of big dams in the region as a threat to biodiversity and forests, along with habitat loss and degradation, mining and pollution from agrochemicals.[103]

SEISMICITY AND SEDIMENTATION

Much of the area in which the Himalayan dams are proposed is a high-risk seismic zone. This can have severe implications for both the safety of the projects and the surrounding areas.

WAPDA in Pakistan rates the seismicity at the Diamer-Bhasha Dam site higher than at other project sites.[104] In several places in Arunachal Pradesh, fear of the colossal destruction and loss of life and property in the case of a dam break haunts the people.[105]

Another possible threat from an earthquake is that the resultant landslides and land-shifting could block rivers and create "quake dams" – temporary dams created from earthquake loosened debris – which could pose risks of catastrophic failure. The floods resulting from such dams could have a cascading impact on the man-made dams with disastrous results. As a consequence of the 2008 Sichuan earthquake in China, "as of May 27, 2008, 34 lakes had formed in nine earthquake-affected counties due to earthquake debris blocking and damming rivers."[106]

While dam builders continue to play down seismic threats by saying that it is not a problem, given the current and past records of the dam building authorities, it is clear that the people do not have faith in these statements. It is therefore imperative that the issue of seismic risk be evaluated and studied by independent panels of experts who can convey the true risks to the people.

The problem of sedimentation in reservoirs is also going to be particularly severe in the Himalayas. The Himalayas are young mountains and are highly prone to erosion. Thus, most of the rivers carry heavy silt loads. Moreover, the region is prone to landslides that can increase siltation in the reservoirs, and can also trigger large waves and/or flash floods. Construction activities related to dam building can also lead to an increase in landslides and erosion. Siltation is a serious issue as it affects the performance and life of a project. In Pakistan, Warsak Reservoir on the Kabul River, built in 1960, has become fully silted and power generation is only achieved according to water inflows in Kabul River, much as would happen with a "run-of-river" project.[107] By 2004, the Tarbela Reservoir had lost 28% of its gross storage due to silt accumulation, and the Mangla and Chashma reservoirs had lost 22% and 45%, respectively. In actual terms, the total storage lost was 4.89 million acre feet (MAF). WAPDA predicts that by 2025, Tarbela will have lost 47% of its storage, Mangla 34% and Chashma 57%, totalling nearly 8 MAF.[108] Ironically, this loss of storage is also one of the key arguments presented for creating new storage projects, while conveniently forgetting that new dams would face precisely the same siltation problems. The accumulation of sediment behind these dams also deprives downstream plains of nutrients and silt deposits that have been the source of their fertility.

IMPACTS OF TRANSMISSION LINES

A unique feature of the Himalayan dams is that they are planned in areas that are far from major load centres. Hence, these projects will require construction of long transmission lines, which will push up the cost of energy from the projects. The transmission lines will require land and thus more people could be displaced. Furthermore, as these lines will traverse through difficult terrain and fragile ecosystems, they are likely to have significant impacts on the environment. Yet there seems to have been little assessment of these impacts.

Projects in Nepal seem to be the only ones to explicitly mention the amount of land required for transmission lines. As an example, the West Seti project plans to acquire 7 km^2 (678 ha) of land for transmission lines.

The impacts from transmission line construction will be an important issue in Pakistan, Nepal and Bhutan. A major impact will be felt in India in the Siliguri Corridor or "Chicken's neck" – the area between Siliguri and Bidhan Nagar in West Bengal – which is the only connection from the Indian mainland to the states in the northeast. This area is the only way to transmit power from Bhutan to India, and from India's northeast to the rest of the country; the transmission lines will have to be bunched together here. The Working Group on Power for the 11th Five Year Plan in India estimates that to transmit all the surplus power from northeastern India and Bhutan will require a set of transmission lines with a right of way about 1.5 km wide.[109]

Silt accumulation upstream of Teesta V Dam, 2008. Siltation is a serious issue as it affects the performance and life of a project, and also deprives downstream plains of nutrients that have been the source of their fertility. Photo: River Basin Friends, India

The impact on this ecologically sensitive area is a question that remains to be answered. Indeed, it has hardly been asked. (For a map showing the "Chicken's neck," see Box 6)

GREENHOUSE GAS EMISSIONS

Hydropower is often portrayed as an important weapon in the fight against climate change, claiming that it produces very small amounts of greenhouse gas (GHG) emissions.[110] However, it is now recognised that big dams can be significant sources of GHGs, including methane. The Inter-Governmental Panel on Climate Change's (IPCC) "Technical Report on Climate Change and Water" notes that "Hydrodams are a source of renewable energy. Nevertheless, they produce greenhouse gas emissions themselves. The magnitude of these emissions depends on specific circumstance and mode of operation."[111]

Calculations carried out by Himanshu Thakkar of SANDRP based on a study by Ivan Lima and colleagues from Brazil's National Institute for Space Research (INPE) show that the methane emissions from Indian big dams contribute 18.7% of the total GHG emissions in India.[112] This means that the claim that hydropower is climate friendly is a myth.

Although the net emissions from a dam depend on several site and design specific factors – and therefore need to be estimated on a case by case basis – this is not being done for most of the projects under construction and planning.

BOX 6

The red circle shows the "chicken's neck" through which all power from Bhutan and northeastern India will be transmitted to rest of the country. http://upload.wikimedia.org/wikipedia/en/d/d8/Chickensneckindia.jpg

DISASTROUS TRACK RECORD

While the social and environmental impacts of the proposed dams are likely to be severe, the record of these countries of assessing, avoiding, mitigating or compensating for past big dam projects does not inspire confidence.

In Pakistan, the refugees of Tarbela Dam were not resettled or compensated properly, even several decades after the dam was completed.[113] The oustees from Bhakra Dam in India, displaced in the late 1940s and early 1950s, are still fighting for proper rehabilitation. Indeed, the World Commission on Dams (WCD) notes that in India, over 75% of people displaced by big dams have not been rehabilitated and are impoverished.[114]

The record on the environmental front is no better. EIAs and other assessments for individual projects are often of poor quality, and cumulative impact assessments of several projects taken together are virtually absent. There is little attempt at planning projects in such a way as to avoid or minimise displacement and environmental impacts. Social and environmental criteria are minimally considered in decision making and planning processes related to dam projects.

In India, even the limited and flawed safeguards offered by the environmental clearance procedure have now been diluted through recent changes. The EIA Notification of September 2006 puts enormous discretion in the hands of authorities; they can now do away with a public hearing that was earlier mandatory. The right of participation in the hearing has also been restricted to "local people."

The continuing absence of proper safeguards and the exclusion of social and environmental criteria from the decision making process mean that current and proposed dams are likely to create massive social and environmental disruptions.

Developmental Impacts

One of the most important questions is whether these dams will perform as predicted. A serious drawback of dam building in the region has been the virtual absence of any official *ex post-facto* performance assessment of dams built to date, in which huge resources have been invested. However, studies carried out by independent experts point to the fact that these projects are delivering far less than promised.

Himanshu Thakkar of SANDRP has carried out performance assessments of hydropower dams in India. His findings point to severe under-performance of projects, and that performance has in fact been falling over the years.

In India, hydropower projects are approved on the basis of power generation at 90% dependable flows. This is the "design energy" generation. Thakkar's analysis of 208 projects (30,740 MW) of the 228 operational projects in India as of March 31, 2007, showed that power generation at 184 of them was below the design energy.[115] The total capacity of these 184 projects is 25,214 MW – thus, 82% of the total analysed capacity is under-performing. This conclusion was based on generation figures for 1985-86 through 2007-08 obtained from the Central Electricity Authority. What is most important is that the actual 90% dependable generation achieved by these 184 projects was less than half the design energy. This means that projects have been heavily over-designed, and river flows over-assessed.

Woman without access to electricity in rural Nepal, 2005. A key issue is that planned hydropower projects in Nepal are not likely to to rural areas of Nepal but will export most of the power to India. Credit: Alex Zahnd

This should be taken as a warning signal, especially for projects in India's northeast, where experts opine that there is much higher uncertainty in the flow data.[116] There is a high risk that projects in this region have been over-designed and that they will grossly under-perform, generating less electricity than promised.

In a related study, Thakkar also shows that the actual electricity generation from hydropower projects in India has been declining. His analysis shows that as of March 31, 2008, India had a total installed hydropower capacity of 36,468 MW. This generated energy at the rate of 3.39 GWh per MW during 2007-08. This was a sharp decline of 14.6% from a high of 3.97 GWh per MW in 1994-95. It should be noted that rainfall in 2007 was 105% of the long-term average, and that generation per MW has been showing a declining trend since 1994-95.[117]

Thus, there are serious questions as to whether the planned hydropower projects will actually generate as much electricity as promised. Lower generation means that the per unit cost of electricity becomes higher. This has grave implications for electricity tariffs, the overall cost/benefit ratio and the viability and desirability of the projects.

Even with this underperformance, hydropower projects in the Himalayas are likely to generate millions of KWh of electricity. However, this does not automatically and necessarily translate into addressing the priority and basic needs of the common people. The spate of dam building is unlikely to have an especially positive impact on the poor and vulnerable sections of society. Neither are the promises of huge revenues for countries like Nepal likely to be fulfilled.

In the case of Nepal, one of the main justifications for big hydropower dams is that the export of electricity to India will bring massive earnings and could wipe out the trade deficit with India of about 66 billion Nepali rupees ($957 million).[118] Claims are made that the West Seti project alone will slash this deficit by 25%.

As Ratna Sansar Shreshta, a lawyer and financial analyst, points out in his article "Pie in the Sky,"[119] these earnings are likely to be mythical. The projects are going to be built by foreign corporations with most of the capital coming from outside the country. Revenue will be earned, but by the companies who build the projects and the financiers who fund them, not by the country. Most of the revenue will go to loan repayment and shareholder profits. Much of the highly paid skilled workforce will come from outside the country. Thus money will flow largely to entities outside the country. Furthermore, in trying to create incentives to attract companies, Nepal is likely to forgo taxes and levies. Shrestha analyses the case of the West Seti project and concludes that

> …only about Rs 297 million out of the total export revenue of Rs 10.33 billion will enter the Nepali economy. This comes to about 2.88 percent of the total export earnings. And by exporting electricity from this project, the country's Rs. 66 billion trade deficit with India will be reduced by all of 0.45 percent. Thus the claim that this project alone will take care of 25 percent of the deficit is a myth.

In another article, Shrestha points out that these big hydropower projects will not create forward and backward linkages in the Nepalese economy. Looking at the backward linkages of the West Seti project, he says: "In this manner, of the total initial investment of $1,097 million, about $39 million will be spent in Nepal – amounting to 3.56% percolation into the domestic economy. Therefore, the employment generation, level of industrialization, capacity enhancement and capital formation will be limited by this percentage…"[120]

He also points out that as most of the electricity from the project will be exported, there will be limited forward linkages in the economy that stem from the use of power. He says that "foreign investment in [an] export oriented project is a deadly combination which deprives Nepal of both forward and investment [backward] linkage."[121] The West Seti project is not only a prime example but is typical of the bigger projects planned in Nepal, as well as many of the projects in Bhutan.

A key issue is that these projects are not likely to create enough and appropriate employment opportunities in countries like Nepal and Bhutan. The ADB points out for Bhutan that "Hydropower and its related industries have low employment elasticity, leaving the labour market unlikely to be able to absorb the 50,000 youth and 20,000 rural migrants expected to enter the workforce by 2008."[122]

In the case of Bhutan, there is also the issue of overdependence on one revenue source. Thus, in Nepal and Bhutan, the promises of high revenue earnings are likely to be unfulfilled, and revenues that do accrue are unlikely to lead to local employment or an optimal level of development for the local economy.

A key issue is that these projects are not likely to create enough and appropriate employment opportunities in countries like Nepal and Bhutan.

Equally important is the issue of whether these hydropower projects would increase access to electricity for poor and vulnerable populations. The answer seems largely in the negative.

The likely under-performance of the projects due to over-designing means that the cost of electricity generation will be higher than planned. Moreover, the various incentives offered to hydropower projects, especially private sector ones, are likely to lead to increased tariffs. Further, as the hydropower sector depends increasingly on non-government funds, paying them back and hence fully recovering investments will become critical. This again means the elimination of subsidies, and an increase in tariffs.

With higher tariffs and the need to recover construction costs, power companies will seek out customers who have higher paying capacities; new policies have been designed specifically for this.

In India, prior to the reforms, electricity generated had to be sold to the government-owned State Electricity Boards (SEBs), who were the sole distributors. The SEBs had a social obligation to supply electricity to all sections of society, including those with low paying capacities like the poor and small and marginal farmers. They did this using direct subsidies from the government and cross-subsidisation among the various users.

Distribution is now being opened up to the private sector, and the Open Access policy means that the generator can sell power generated not just to the SEBs but to anyone, including directly to the consumer. Clearly, private companies will hope to find their own customers with high paying capacities, as will the state-owned companies, who have to show full recovery of costs. In other words, there is a real danger that the power sector could end up with high-cost electricity generation supplied only to high paying-capacity consumers; this would result in an enclave type formation with the rich producing for the rich, and no place for the poor in the system.[123] Given that the cost of production of hydropower is considerably higher in the initial period means that new hydropower projects are likely to end up meeting the needs only of the better-off sections of society.

As much of the dam building program of Nepal and Bhutan is integrated into India's power sector, the above will apply to these projects also.

Climate Change

Climate change is likely to be the one phenomenon that will have the most serious implications for dams in the Himalayas. It is likely to fundamentally alter the basic assumptions on which the dams are planned – especially water flows – and has consequences for dam performance and safety. The entire climate of the region, including rainfall, temperatures, and geographical phenomena such as erosion and landslides, will change dramatically, and the region's ecology, agriculture, economy and livelihoods will also be affected. Yet, none of the dams being built or planned in the Himalayas has taken this aspect into consideration. Climate change has introduced huge uncertainties in the basic parameters affecting dam projects, and has made these projects unpredictable and financially risky.

LIKELY CONSEQUENCES

While there are several uncertainties as to the impacts of climate change, especially for predictions at the local or basin level, the direction is clear.

According to the report "The Melting Himalayas" by the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, much of the annual precipitation in this region falls as snow, and the "snowfall builds up from year to year to form glaciers that provide long-term reservoirs of water stored as ice."[124]

Significant portions of the river flows of Himalayan rivers come from these reservoirs through snow and glacial melt. "The Melting Himalayas" notes that the contribution of snow and glacial melt to the major rivers in the Himalayan region ranges from less than 5% to more than 45% of the average flows. The contribution in lean season can be much higher. For example, snow and ice melt contribute about 70% of the summer flows of the main Ganga, Indus and Kabul rivers before and after precipitation from summer monsoons. Also, the contribution of glacial melt to the tributaries, especially in the higher reaches, could be much greater. Climate change is resulting in the melting of the Himalayan glaciers, which will have profound long term impacts.[125]

The warming effect in the Himalayas appears to be higher as compared to other parts of the world. Glaciers are already shrinking and retreating at rates higher than historical ones. According to "The Melting Himalayas":

> The Himalayan region, including the Tibetan plateau, has shown consistent trends in overall warming during the past hundred years. Various studies suggest that warming in the Himalayas has been much greater than the global average of 0.74 degrees Celsius over the last hundred years…
>
> Many Himalayan glaciers are retreating faster than the world average and are thinning by 0.3–1 m/year. The rate of retreat for the Gangotri glacier over the last three decades was more than three times the rate during the preceding 200 years. Most glaciers studied in Nepal are undergoing rapid deglaciation…in the last half-century, 82 percent of the glaciers in western China have retreated. On the Tibetan plateau the glacial area has decreased by 4.5% over the last 20 years and by 7% over the last 40 years.[126]

This trend is likely to continue and the result will be that flows of glacial and snowmelt-fed rivers will increase initially and then decline. "The Melting Himalayas" states:

> Various attempts to model changes in the ice cover and discharge of glacial melt had been made by assuming different climate change scenarios. One concludes that with a two degree Celsius increase by 2050, 35% of the present glaciers will disappear and runoff will increase, peaking between 2030 and 2050.
>
> Under the uniform warming scenario of +0.06 degree Celsius per year, impacts of declining glacier area on river flow will be greater in small, more highly glaciated basins in both the western and eastern Himalayas. Flow for the most glaciated sub-catchments (glaciation greater than or equal to 50 percent) will attain peaks of 150 and 170% of initial flow around 2050 and 2070 in the west and the east respectively before declining until the respective glaciers disappear in 2086 and 2109.[127]

Apart from these long-term trends of an initial increase and subsequent decline in flows, the annual seasonal distribution of flows is also likely to undergo a shift. The chapter on *Freshwater Resources and Their Management* of the "Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (IPCC), published in 2007, states that:

> More than one-sixth of the world's population live in glacier- or snowmelt-fed river basins and will be affected by the seasonal shift in streamflow, an increase in the ratio of winter to annual flows, and possibly the reduction in low flows caused by decreased glacier extent or snow water storage.

> A very robust finding of hydrological impact studies is that warming leads to changes in the seasonality of river flows where much winter precipitation currently falls as snow…This has been found in projections for the European Alps…[and] the Himalayas…[128]

Apart from the glacial and snow melt, climate change will also affect precipitation. The most recent (June 2008) IPPC "Technical Paper on Climate Change and Water" states that:

> Increases in precipitation at high latitudes in both the winter and summer seasons are highly consistent across models. Precipitation increases over the tropical oceans and in some of the monsoon regimes, e.g., the South Asian monsoon in summer (June to August) and the Australian monsoon in summer (December to February), are notable and, while not as consistent locally, considerable agreement is found at the broader scale in the tropics.[129]

Thus, to the extent that the Himalayan system is fed by the South Asian monsoon, this could mean increased precipitation, though caution is called for before reaching any conclusions. As "The Melting Himalayas" notes, "[I]ntensification of the Asian monsoon is predicted by most climate models. On a regional scale this could result in increase in precipitation, although local effects are poorly understood."[130] It appears from the predictions about river flows that the impact of glacial melting is likely to dominate the effects of any increases in precipitation resulting in eventual decline in flows of glacier and snowmelt fed rivers.

Heavy precipitation events are also predicted to increase. The IPPC's "Technical Paper on Climate Change and Water" says that "It is very likely that heavy precipitation events will become more frequent. Intensity of precipitation events is projected to increase, particularly in tropical and high-latitude areas that experience increases in mean precipitation…In most tropical and mid- and high-latitude areas, extreme precipitation increases more than mean precipitation." [131]

Other reports also support this prediction of an increase in extreme events. For example, a report by ICIMOD on the impact of climate change on Himalayan glaciers says:

> On the Indian subcontinent, temperatures are predicted to rise between 3.5 and 5.5°C by 2100. An even higher increase is predicted for the Tibetan Plateau (Lal 2002). Climate change is not just about averages, it is also about extremes. The change in climate is likely to affect both minimum and maximum-recorded temperatures as well as triggering more extreme rainfall events and storms.[132]

Extreme precipitation events are likely to lead to an increase in the intensity and frequency of flash floods.

To summarize, the picture that emerges in the Himalayas is that of:

- An increase in the intensity of precipitation, leading to higher flows and floods
- An increase in glacial and snow melt leading to an initial increase in river flows and floods
- Subsequent disappearance or significant depletion of glaciers and snow leading to depleted flows
- Change in the seasonal distribution of total flows

IMPLICATIONS OF CLIMATE CHANGE FOR DAM SAFETY

The likely implications for the region in general and hydropower projects in particular are serious.[133]

Most dams are designed based on historical data of river flows, with the assumption that the pattern of flows will remain the same as in the past. Climate change has effectively destroyed this assumption. It is likely that dams will be subjected to much higher flows, raising concerns of dam safety, increased flooding and submergence, or much lower flows, affecting the performance of such huge investments. A changing seasonal balance in water flows could even eliminate the rationale for storage dams.

The increased rate of glacial and snow melt is likely to lead to higher river flows in the short-term. Also, one of the more robust predictions for climate change is an increase in the frequency of extreme events; extreme precipitation events and other phenomenon can lead to large floods. The safety of dams in view of these increased flows/floods is a major cause of concern. Even if a dam is able to survive higher flows, bigger floods are likely to lead to higher backwaters, increasing the areas affected by submergence.

Another major cause for concern are glacial lake outburst floods (GLOFs). As glaciers melt, they can form large lakes behind temporary dams of ice and moraine. When these dams fail, the water is released resulting in massive flash floods. The Dig Tsho GLOF in Nepal is a good example. [See Box 7, page 34] The chapter on *Freshwater Resources and Their Management* of the "IPPC Fourth Assessment Report" states that "Rapid melting of glaciers can lead to flooding of rivers and to the formation of glacial melt-water lakes, which may pose a serious threat of outburst floods…"[134]

This threat of a GLOF is intensified by global warming as glacial melt increases. A paper by Shaun D. Richardson and John M. Reynolds states that "As glaciers recede in response to climatic warming, the number and volume of potentially hazardous moraine-dammed lakes in the Himalayas is increasing. These lakes develop behind unstable ice-cored moraines, and have the potential to burst catastrophically, producing devastating Glacial Lake Outburst Floods (GLOFs)."[135]

The IPCC's "Technical Paper on Climate Change and Water" points out that there has been an increase in the

BOX 7: Dig Tsho Glacial Lake Outburst Flood, Nepal

"On 4 August 1985…the terminus of Langmoche Glacier in the Dudh Kosi River Basin of Nepal collapsed into Dig Tsho Glacial Lake. The resulting displacement wave traveled along the lake, overtopped the lake's moraine dam and initiated a period of accelerated erosion that ultimately led to dam failure. Initial discharge rates of the ensuing flood may have been as high as 2,000 m^3/second, with an average discharge of 500 m^3/second over 4 hours, draining a total volume of 610 million m^3 of water… Five people were killed and a small run-of-river hydropower scheme was completely destroyed shortly before its commissioning. Environmental degradation was severe, with the loss of cultivated land and destabilisation of valley sides and river channels for 90 km downstream."

Source: Richardson, Shaun D. and John M. Reynolds. *An Overview of Glacial Hazards in the Himalayas*. "Quaternary International" 65/66. 2000. Pages 31-47

Photo:©Matthieu Paley/www.paleyphoto.com

frequency of GLOFs in the Himalayas in Bhutan, Nepal and Tibet from 0.38 events/yr in the 1950s to 0.54 events/yr in the 1990s.[136] GLOFs are already a threat; climate change is aggravating it. The cascading effect of a GLOF leading to a dam failure can only be imagined. Apart from the dangers of GLOFs, climate change may impact other cryogenic (very low temperature related) processes like avalanches and debris flow. The melting or shrinking of permafrost is likely to impact slope stability and erosion processes. All of these have implications for the safety and performance of dams and other infrastructure projects.

IMPLICATIONS FOR DAM PERFORMANCE

In the longer term, increased temperatures and glacial melt will lead to diminished river flows – total flow, low season flow, or both. This will certainly impact the performance of a hydropower project, in terms of the total power it can generate as well as the seasonal pattern of power generation.

Most of the projections about the impacts of climate change are at the broader level [See Box 8, page 35], with few that predict specific impacts on individual rivers or projects. One paper that does attempt this for the Bagmati River in Nepal finds that:

> Mean yearly flow and monsoon season flow in the Bagmati River is decreasing significantly. Post-monsoon and pre-monsoon seasonal flows are more or less constant. If the current trend continues and no other management systems were adopted then it is likely that the power production from the Kulekhani hydropower plant is going to be reduced by 4% every 10 years. Production of rice, which is directly related to the monsoon season flow, is going to be decreased, but the production of the wheat may slightly be increased.[137]

The implications for hydropower should not be seen in isolation but in the context of other demands on water. If there is a conflict in allocation of water between different end-uses (as is possible in a multi-purpose scheme), it is likely that the water needs of domestic use and irrigation will be given priority. Climate change is likely to exacerbate water shortages and could shift the allocation of water away from hydropower (where a conflict exists). The chapter *Freshwater Resources and Their Management* of the "IPPC's Fourth Assessment Report" points out that:

> With more than one-sixth of the Earth's population relying on melt water from glaciers and seasonal snow packs for their water supply, the consequences of projected changes for future water availability, predicted with high confidence and already diagnosed in some regions, will be adverse and severe. Drought

BOX 8: Some Likely Impacts of Climate Change and Glacial Lake Outburst Flood Risks in Specific River Basins

BHUTAN

Twenty-four lakes were identified as potentially dangerous based on a set of criteria such as water level rise, the associated mother glacier, and the conditions of the dams and topographical features of the surroundings… Considering these criteria, five lakes in the Mo Chu Sub-basin, eight lakes in Pho Chu Sub-basin, seven lakes in the Mangde Chu Sub-basin, three lakes in the Chamkhar Chu Sub-basin and one lake in the Kuri Chu Sub-basin were identified as potentially dangerous.[1]

NEPAL, BHUTAN AND TIBET

The frequency of glacial lake outburst floods (GLOFs) in the Himalayas of Nepal, Bhutan and Tibet has increased from 0.38 events/yr in the 1950s to 0.54 events/yr in the 1990s.[2]

PAKISTAN

While the science is still in its infancy, best estimates are that there will be fifty years of glacial retreat, during which time river flows will increase. This – especially in combination with the predicted flashier rainfall – is likely to exacerbate the already serious problems of flooding and draining, especially in the lower parts of the [Indus] basin, in the next few decades. But then the glacial reservoirs will be empty, and there are likely to be dramatic decreases in river flows… conceivably by a terrifying 30% to 40% in the Indus basin in one hundred years time.[3]

1 Bajracharya, S. R., P. Mool and B.Shrestha: "Impact of Climate Change on Himalayan Glaciers and Glacial lakes, Case Studies on GLOF and Associated Hazards in Nepal and Bhutan," 2007, ICIMOD and UNEP-ROAP, Kathmandu

2 Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp. Available at http://www.ipcc.ch/ipccreports/tp-climate-change-water.htm

3 World Bank: "Pakistan: Country Water Resources Assistance Strategy, Water Economy: Running Dry November 14, 2005 Report No. 34081-PK," 2005, South Asia Region, Agriculture and Rural Development Unit, South Asia Region, World Bank

problems are projected for regions which depend heavily on glacial melt water for their main dry–season water supply.[138]

Another cause for concern is the potential increase in the sedimentation in the rivers due to climate change. As it is, sedimentation is a severe problem in the rivers and dams in the Himalayas as these are young mountains and erosion rates are very high. The Warsak Dam in Pakistan is completely silted and the 21 MW Trishuli project in Nepal barely generates 2 MW.[139] Climate change is likely to exacerbate the problem of high silt load in the rivers in three ways: 1. due to higher temperatures, a higher proportion of precipitation will fall as rain rather than snow, leading to higher erosion; 2. as extreme events and intensities of precipitation increase, so will erosion; and 3. the melting of permafrost will also likely lead to increased erosion.

IMPLICATIONS FOR DAM BUILDING AND ADAPTATION

One argument often presented is that since the variability of precipitation is likely to increase, an increase in storage capacity is needed to smoothen out availability constraints. The argument is also presented in the context of possible changes in river flows: if flows are likely to increase, greater storage capacity is needed to take advantage of this; if flows are likely to decrease, more storage to carry over occasional high flows is needed. All this translates to a justification for building new big dams. However, this is an unsound argument and is likely to result in disastrous consequences, all the more so in the Himalayan region.

Creation of more storage as an answer to fluctuating flows ignores the fact that climate change is going to increase the threats to dam safety, including the risks of catastrophic events like GLOFs. Hence, building more dams is likely to be a high risk policy choice. Indeed, given that the glacial melt feed to the rivers is likely to decline over the longer term, the very logic of building new and bigger dams is questionable, as they may not deliver the designed benefits. Building huge storages to catch occasional high flows will be an expensive measure. This is in addition to the series of other problems that such dams entail, including displacement, biodiversity loss, impacts on livelihoods, destruction of cultures and identities of indigenous populations, and seismic risks.

Another important issue is the uncertainties involved in the predictions of impacts of climate change. While the general direction and broad predictions are fairly robust, there are many uncertainties: in the time frames – when would the flows peak and when would they decline, when would the point of inflection be reached; in the magnitudes – how much would the flows increase, how much would they fall; and in terms of impacts in specific areas and river basins. "The Melting Himalayas" cautions:

> We speak of uncertainty on a Himalayan scale in recognition that our science and information systems are no match for the complexity and diversity of regional contexts, quite apart from the lack of studies and basic data…It seems certain there will be appreciable changes in the volumes and/or timing of river flows and other freshwater sources. There is, however, great uncertainty about the rates and even the direction of the changes, because so little is known about the dynamics of Himalaya topoclimates and hydrological processes and their responses to changing climatic inputs. The global circulation models used to model climates capture global warming on a broad scale, but do not have adequate predictive power even for large Himalaya drainage basins.[140]

Thus, we are confronted with a situation where dramatic changes are likely to occur in the Himalayas that will affect the fundamental basis of the proposed dams including the water flows, and yet there are many uncertainties in these predictions. Building big dams – hugely expensive structures with massive impacts that concentrate valuable resources in few locations – in the face of such uncertainties is possibly the worst course to follow. This could also lead to massive financial losses as investments underperform and cannot deliver the planned benefits.

The chapter titled *Freshwater Resources and Their Management* of the IPPC's "Fourth Assessment Report" correctly points out that given the uncertainties involved in the predictions, future planning should be accommodative and flexible; "A rather different way of coping with the uncertainty associated with estimates of future climate change is to adopt management measures that are robust to uncertainty…Integrated Water Resources Management, for example, is based around the concepts of flexibility and adaptability, using measures which can be easily altered or are robust to changing conditions."[141]

When faced with uncertainty, concentrating investment into a few large structures is like putting all our eggs in one basket. Instead, what is required is a set of many measures – both structural and institutional – that are decentralised, spread the risk and allow flexibility. The institutional aspect of such measures is also emphasised in the chapter *Freshwater Resources and Their Management* of the IPPC's "Fourth Assessment Report," which highlights the importance of a consensus-based decision making processes, a primary recommendation of the WCD.

Unfortunately, none of these risks are being considered in the dams planned for the Himalayas – neither for individual dams, nor cumulatively. What is urgently needed is a comprehensive assessment of the likely impacts of climate change on dam building in the Himalayas – a climate based critique of the program. This should not only assess the risks in terms of safety and performance, but should also recommend alternative approaches in the region in the face of these risks, and do so not just looking at the hydropower aspect but at the larger role of rivers in meeting needs of energy, water supply, agriculture, irrigation, food security and livelihoods.

Responses of Civil Society and Affected People's Groups

Pakistan, Nepal and India all have a very active and vigilant civil society and media, though the intensity of their work related to big dams differs. (The same cannot be said for Bhutan.) In all three countries, there are organisations of dam affected people, advocacy and research groups and others that have been raising important issues related to dams in the larger context of just and sustainable development. As a result, there is a rich critique of dams and development in these countries. There have been several attempts, especially in India, to locate a critique of big dams in the larger context of electricity and energy planning of the country.

Dams are highly controversial and contentious and the debate around them has often been polarising. There is a vocal population in these countries who do support big dams; this support is often expressed in the media. This view equates dams with development and argues that dams are necessary for meeting electricity needs. These arguments are often presented as assertions and viable alternatives are overlooked. Social and environmental impacts are ignored or categorized as the necessary price to be paid for development. Severe electricity shortages in these countries reinforce the case for large dams in the public discourse.

While all this has been replicated in the context of the Himalayan dams, these projects have also presented new issues and new challenges. Cultural issues have become very important. For example, several organizations of affected people are strongly protesting dams in Sikkim and Arunachal Pradesh in India on the issue of identity and culture. On June 12, 2008, the government of Sikkim announced the scrapping of four projects – 90 MW Ringpi, 33 MW Rukel, 120 MW Lingza and 141 MW Rangyong project – in response to the struggle of the Affected Citizens of Teesta.[142]

Projects being built for exporting electricity from Nepal to India have prompted people to raise the issue of rights to resources and to challenge the export of water and energy resources when the country itself faces severe energy and electricity shortages.

Some experts argue that the idea that Nepal has surplus electricity to export to India is itself fallacious. It is a myopic vision that makes Nepal import oil and export electricity. If Nepal increasingly uses electricity for transportation, production processes and other uses, replacing oil, then not only will Nepal become self-sufficient in energy but will not have any surplus power to sell to India.

Of course, this does not necessarily imply that Nepal should build big dams, for they have serious social, environmental and other impacts. The point made here is that Nepal needs its energy sources for meeting its own requirements. The development of these sources should be through small and medium projects, and based on comprehensive assessments of all costs and benefits for choosing the optimal solutions, as groups like WAFED,[143] a national network of water and energy project affected people and local concerned groups in Nepal, are demanding. Even in these projects, they are calling for the involvement of local people, making them partners and ensuring that they have first rights to benefit sharing. All of this should be in place before projects are considered.

In general, civil society groups and affected people have been raising several important issues and questions. Will these dams meet the energy needs of the countries, especially the needs of people without electricity access, the poor, the vulnerable? Are these dams the best or the optimal solution? This is by no means established and is a fundamental question being raised.

Various groups are calling for assessments to understand the full impacts of this massive dam building, especially the cumulative impacts. Some other key demands of civil society groups and affected people include the incorporation of social and environmental impacts as equal criteria in decision-making, and making local people, especially affected people, meaningful participants in the dam-related decision-making processes.

One of the most interesting features of the region is that such groups are forming links and networks across boundaries. This is an important recognition of the fact that the region is highly interconnected, both geographically through its shared rivers, and culturally and socially through the many interactions between common citizens. Groups from all the countries have expressed the desire to strengthen such links and networks. This is very important for countries like Nepal and India, where the Indian government and Indian companies are building dams in Nepal for the export of electricity to India. Ordinary citizens in Nepal often harbour deep resentment toward the Indian government, believing that it has pressured the Nepali government into accepting treaties preferential to Indian interests. Under such circumstances, it is the links between civil society groups that can bring trans-boundary water issues into proper perspective and create a healthy discussion.

There are a number of such important trans-boundary issues. Apart from importing electricity, several Indian dam proponents are calling for big storage dams to be built in Nepal to control floods in the downstream Indian states of Bihar and Uttar Pradesh. Indeed, some commentators in Nepal say that India is not interested in the electricity from these projects as much as it is in the regulated releases of water to meet irrigation needs within its borders. It should be kept in mind that some dams in Nepal and Bhutan – for example the 4,000 MW Sankosh Multipurpose project in Bhutan - are likely to be an integral part of India's ambitious Inter-Linking of Rivers project that aims to build as many as 30 inter-basin transfer projects.[144]

These and other trans-boundary water issues in the whole region will benefit tremendously from such network-building between civil society and affected people's groups from all the countries in the region.

Protest against the Teesta Dams in Sikkim, India, 2007. In 2007, the Affected Citizens of Teesta staged a relay hunger strike against the projects for more than 500 days. Photo: Affected Citizens of Teesta (ACT)

Alternative Approaches

One of the most important contributions of civil society has been in evolving alternative visions and approaches to meet the needs of water, energy, livelihoods and revenue. Several elements of such approaches have already been put forward by various groups. Some of these suggestions minimize the need to build large hydro and thermal projects, while some claim that they can be totally eliminated. Combinations of demand-side management, efficiency in generation, supply, transmission and energy use, and renewable sources of energy are at the core of most of these suggestions.

Simply reducing transmission and distribution (T&D) losses can provide significant additional electricity. The "11th Plan Document" for India states that "T&D losses in India continue to be among the highest in the world and are the main concern in the development of power sector…T&D losses for the country as a whole are estimated to be in the range of 35%–45%."[145]

The International Energy Agency's "Statistics for Pakistan for 2005" show that distribution losses were 25%.[146] The World Bank says that in Pakistan "the transmission and distribution networks are over-loaded, underinvested, and under-maintained, with technical and commercial losses significantly above the norm. Reducing losses from such levels are generally more cost-effective measures for reducing the demand-supply imbalances than adding generation capacity."[147]

Prayas Energy Group, based in Pune, India, calls for a new paradigm of power and energy planning that demands "an integrated view towards planning for all inputs that are necessary for livelihood security – water, land, energy and biomass." They call for an integrated least-cost plan to be carried out in a participatory manner, expanding the choices of technologies and fuels, and implementing supply-side efficiencies and demand-side measures.[148]

Several analysts also point out that one cannot talk about alternative approaches until one looks at demand. Supply cannot be increased indefinitely and no system can plan to meet unlimited demands.

Some of the most important ideas and contributions to this discussion are the many elements of alternative approaches emerging from popular struggles of affected people against big dam projects. One activist involved in supporting such movements has noted: "I believe that resistance movements result in alternate visions and development policy since the struggling peoples' vision becomes the focal point. Every resistance movement and community struggle has its own options and visions; they exist; only the policy makers are blind to them."[149]

One of the most fascinating examples of alternatives emerging from people's struggles around dams is that of Sulgaon Village in the submergence area of the 400 MW Maheshwar hydropower project on the Narmada River in India. The people of this village have been strongly opposing the project as a part of the Narmada Bachao Andolan (NBA – Save the Narmada Movement). Guided by experts from the Prayas Energy Group, Sulgoan citizens carried out a comprehensive survey of energy consumption and energy sources in their own village. Based on this, they demonstrated that using demand-side measures to conserve energy, along with local energy sources, mostly renewable biomass, to generate electricity, they could not only meet their own energy and electricity needs, but could also export significant amounts of it.[150] Scaling this up could lead to a large source of sustainable and renewable energy without many of the serious social and environmental disruptions that come from other projects.

There is a need to strengthen efforts to evolve such visions, plans and approaches for the entire region and within each country.

Meeting to discuss the potential impacts of the planned West Seti Hydropower Project, in Nepal, 2007. It is estimated that 15,000 people will be adversely affected by this project. Photo: Yuki Tanabe.

Conclusion

The Himalayas store vast amounts of water, and with their high slopes, the fast-moving rivers present huge potential for generating hydropower. India, Pakistan, Nepal and Bhutan have initiated massive plans to build several hundred dams to realize this potential.

These countries have growing needs of energy and electricity, and some of them suffer from severe shortages and even crises. All of them face very real and very difficult questions of how to meet these needs. Hydropower dams in the Himalayas are being advanced as a solution to meet a substantial part of these requirements.

Yet there is little evidence to establish that big dams are the only, the best or the optimal solution to the electricity question. In particular, while these projects will undoubtedly generate many thousands of units of electricity, it does not follow automatically that they will help improve access to power for the poor and the vulnerable sections of society.

Indeed, the way the hydropower programs are structured, the high cost of these projects, their long distances from load centres, privatization of many of them, and incentives and tax breaks being offered to attract private companies, are all likely to result in high costs of electricity and hence most of the benefits will accrue to sections of society with a high paying capacity.

At the same time, the projects are likely to have huge social, environmental and cultural impacts, impacts that will be especially harsh on locals, tribal people, farmers and others living in the remote valleys of the Himalayas. These projects threaten not only livelihoods but often the very identity and culture of these people. The downstream impacts of the proposed projects will also be serious, and could be felt in areas from just downstream of the projects all the way to the plains and the deltas. Projects are being pushed forward, unmindful of these social, environmental and cultural impacts, impacts that have not been fully and properly assessed and are often downplayed. Of particular concern are the cumulative impacts of what is likely to be the highest concentration of dams in the world, in a region that is ecologically fragile.

Unfortunately, the people who will be most severely affected have had little say in the planning, design and implementation of these projects, and even now have no place in the decision-making structures. Similarly, social, environmental and cultural issues are not even important considerations in the decision-making process, let alone being on the same footing as financial and economic ones.

Against this background, climate change looms as a huge threat that is set to overturn the fundamental assumptions, especially river flows, on which these projects are planned. The impacts of climate change are likely to lead initially to high flows and extreme events – raising concerns of dam safety – and are later likely to result in sharp drops in flows – raising questions about dam performance. The frequency of catastrophic events like GLOFs is also likely to increase, further increasing risks to dam safety. Sedimentation, already a bane for dams in the Himalayas, is also set to intensify. The big dam planners seem to have adopted an ostrich-like attitude to the impacts of climate change on the Himalayan region.

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. The recent devastation caused by the breach in the embankments of the Kosi River in Nepal and the subsequent change of course that wreaked havoc with the lives of millions of people is an indication of what lies in store if we undertake far-reaching interventions in sensitive regions of the Himalayas without fully evaluating the possible 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. They call for evolving an alternative approach to meeting the pressing energy and water needs in a manner that is just and sustainable. The recommendations of the World Commission on Dams offer the best possible framework for this. The choices are not easy, and the process will be difficult. The decisions lie with the people in the respective countries. Yet, just as these countries claim the right to make their own decisions, they will have to grant the same right to local people, those who will be most affected, to have a meaningful say in these decision-making processes. And even as the interests of the local people need to be given a priority along with national interests, the people of this region should remember that they are the custodians of a treasure that is the common heritage of the entire world – the Himalayas.

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2 http://en.wikipedia.org/wiki/Himalaya

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9 The capacities are current capacities, extended from the initial capacities.

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Mountains of Concrete:
Dam Building in the Himalayas

As a region of great geographic, ecological, social, and cultural diversity, the Himalayas are a true global heritage. They are also the source of some of Asia's longest rivers, on which millions of people depend for their livelihoods. Pakistan, India, Nepal and Bhutan are planning to build hundreds of mega-dams on these great rivers, and to transform them into the powerhouse of South Asia.

Yet climate change is affecting the Himalayas faster than any other region of the world. The glaciers which feed most large Asian rivers are melting.

The new dams will destroy thousands of villages, fields, spiritual sites and even parts of the world's highest highway, the Karakoram highway. Who is pushing these projects, and who is funding them? Who will bear their costs, and who will reap the benefits? And how much electricity will the reservoirs generate once the glaciers that feed them have vanished?

Mountains of Concrete is the first report which analyzes dam building in the Himalayas in an integrated manner. Published by International Rivers, the report was written by Shripad Dharmadhikary, one of South Asia's foremost water and energy experts.

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