Sustainability of Bhutan's Hydropower

Gongsar Karma Chhopel

Abstract: Bhutan's river potential for hydropower has been estimated at~30,000 MW, the majority of which is concentrated in the Wangchhu, Punatsangchhu, Mangdechhu and Drangmechhu river basins. Hydropower forms the backbone of Bhutan's socio-economic strength: Ninety nine percentage of its electricity supply comes from hydropower generation and hydropower alone contributes of national revenue. Bhutan has been cast as a model in South Asia for its environmental conservation policy. However, the impacts of climate change are becoming evident in the form of fast-retreating glaciers and erratic precipitation patterns that will prove to be costly for the hydropower sector as the country continues to bank on this renewable natural resource.

Key words: Hydropower, GLOF, dams, biodiversity, climate change, glaciers, IWRM, Bhutan

Introduction

Bhutan is divided into four major river basins: the Amochhu Basin, Wangchhu basin, Punatsangchhu Basin and the Manas basin (Figure 1). The fast flowing north-south rivers wind through the steep terrains and provide an ideal setting for the development of hydropower. Meanwhile, east-west flowing rivers provide much of the water required for the irrigation.

However, Bhutan's almost total dependency on hydropower to meet the country's electricity needs renders it vulnerable to climate change. While the country is endowed with abundant water resources, any likely change in the flow regime due to climate change will have direct impact on Bhutan's energy security. Furthermore, rapidly melting mountain glaciers are posing increasingly greater threats as twenty-five glacial lakes have been identified as having potential to become glacial lake outburst floods, or GLOFs.

The hydropower sector in Bhutan faces several environmental challenges:

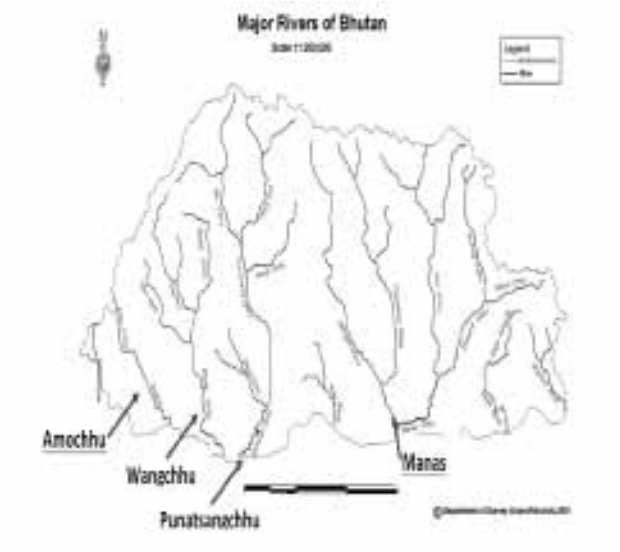

Figure 1. River systems of Bhutan

- predicting future flows;
- reservoir sedimentation;
- floods including flash floods and GLOFs;
- increasing glacier retreat and less snow cover;
- erratic rainfall patterns;
- low generation during winter; and
- big dams impairing the riverine ecosystem.

Hydropower Potential

Based on Bhutan's Power System Master Plan (2003-22), table 1 lays out the techno-economically feasible hydropower potential of energy production from existing hydropower plants and those presently under construction, an estimate of the potential is shown in table 1 below. The total adds up to roughly 23,765 MW with an estimated mean annual energy generation capability of about 99,159 GWh.

Basin	Category	Existing	Under construction	Identified	Total of all categories
Total of all basins	MW	1480	3624	18,661	23,765
	%	6.23	15.25	78.52	100
	GW	7421	12,350	79,388	99,159
	%	7.48	12.35	80.06	100

Table 1. Hydropower Potential

Bhutan's quantum jump from a very basic economy in the 1960's to the vibrant economy today has been largely possible due to growth in hydroelectricity. The total installed capacity of electricity in Bhutan as of December 2010 was 1505.32 MW, with hydropower constituting 98.7% of that generation. The hydropower electricity generation capacity has jumped markedly since the commissioning of the 1020 MW Tala Hydroelectric Project in 2007.

Following table presents the installed capacities of the hydropower plants and their commissioning dates:

Hydropower plant	Installed Capacity (MW)	Commissioning Date	River
Chukha	336	1987-88	Wangchhu
Kurichhu	60	2002	Kurichhu
Basochhu (I)	24	2001	Basochhu
Basochhu (II)	40	2005	Basochhu-Rurichhu
Tala	1,020	2007	Wangchhu

Table 2. Installed Capacities of Hydropower Plants

Bhutan has also embarked on an ambitious program to generate a minimum of 10,000 MW capacityby 2020. To meet this target, ten hydropower projects have been identified under the accelerated hydropower development program of the nation. Presently, Punatsangchhu-I (1200 MW), Punatsangchhu-II (990 MW), and Mangdechhu (720 MW) are under construction while the rest are in the various stages of detailed feasibility studies, and implementation.

S. No.	Projects	Submission Date of Final DPRs	Final Approval of DPRs by two Govts.	Start Dates of Construction	Development Mode
1	Punatsangchhu-I (1200 MW)	Done	Done	Construction underway.	Inter-Governmental
2	Punatsangchhu-II (990 MW)	Done	Done	Construction started in 2010	Inter-Governmental
3	Mangdechhu (720 MW)	Done	Done	Construction started in 2010	Inter-Governmental
4	Sunkosh Storage (Approx. 2040 MW)	September 2010	December 2010	Construction yet to begin.	Inter-Governmental
5	Kuri-Gongri (1800 MW)	December 2011	March 2012	Construction yet to begin.	Inter-Governmental
6	Amochhu storage (620 MW)	September 2011	December 2011	Construction yet to begin.	Inter-Governmental
7	Wangchhu (600 MW)	December 2011	March 2012	Construction yet to begin.	Joint Venture
8	Bunakha Storage (180 MW)	March 2011	June 2011	Construction yet to begin.	Joint Venture
9	Kholongchhu (650 MW)	June 2011	September 2011	Construction yet to begin.	Joint Venture
10	Chamkharchhu-I (670 MW)	December 2011	March 2012	Construction yet to begin.	Joint Venture
Total: Approx. 9,470 MW					

Table 3. List of the Projects and Status on the Proposed 10,000 MW Plan

Bhutan's Pristine Environment

Bhutan has followed a high-level commitment to conserve its pristine environment and has been recognized internationally by the WWF Paul Getty and the Champions of the Earth awards, which cited, in particular, the leadership of His Majesty the King. Bhutan's constitution guarantees 60% forest-cover for all times, and, accordingly, the current forest cover is more than 70%. This thick forest cover harbors a rich biodiversity that puts the country on a pedestal of being one of the ten biological hotspots in the world.

Several species of aquatic fauna has been discovered in Bhutan: Epiophlebialaidlawi (Figure 2), a beetle species Hydraenakarmai (Figure 3), and EPT taxa HydropsychegkarmaiMalicky.The latter two species were discovered by the author and are thus named in his honor.

Figure 2. Epiophlebialaidlawi

Figure 3. Hydraenakarmai

The discovery of such species illustrates the natural state of the Bhutanese riverine ecology, and marks them asamong the rarest in the world with few human perturbations. These indisputable assets could be showcased to the world at large as such ecosystems are fast disappearing. Weighing carefully the pros and cons of accelerated hydropower development vis-à-vis conservation of this rich biodiversity warrants serious considerations. The Bhutanese belief of following "the middle path" may be the most viable solution.

Dams and their Impact

Rather than uncritically accepting the belief that the run-of-river (RoR) scheme are totally benign, it would be worthwhile to reflect upon the experiences of countries that are beginning to ponder and debate such schemes.

Dams are the single largest impediment to continuous freshwater flow in rivers, and their impact could be felt significantly in the reservoirs, upstream and downstream of the command areas, and at global level through the emission of methane. Worldwide, dams and reservoirs may be responsible for as much as 25% of all human-caused methane, or, in other terms, 4% of all human-caused warming. As a greenhouse gas, methane is 25 times more potent than carbon dioxide.

The Swedish Government's Natural Resources Act of 1987, explicitly prohibits construction of new hydropower dams on its last four large free-flowing rivers: The Torne,

Kalix, Pite and Vindel. Before too long, Bhutan should also earmark a few of its river basins or river systems to render them off-limits to developmental activities. This decision aligns very well with the provision in our 2011 Water Act that stipulates thirty meter buffer strips along side rivers not to be disturbed. But some ongoing hydro projects have implemented these holistic provisions only in theory. As seen in the picture below from December 2013, the ongoing Punatsangchhu hydro project diverts the entire river and leaves long stretches of the riverine ecosystem completely dewatered! The Punstsangchhu is known for its endangered Golden Mahsheer (Torputitora) that inhabits this river. This species will mostly like be smothered if the original river course is not immediately restored.

As Bhutan plans for more hydropower projects, it needs vigilant government regulation and an equally strong voice from civil society to balance its proper development. The Royal Society for Protection of Nature (RSPN) was known to have played a key role of protecting the white bellied heron some years ago in the upper stretches of Punatsangchhu. There are few critics in the region who criticize that project's improper EIA and public consultation. Many believe it was rushed through to serve India's larger plans and gains.

Photo 1. The ongoing Punatsangchhu construction in Punakha Wangdue valley

De-commissioning of dams is said to be one of the best remedies for restoring river health. But it is common knowledge that once the river is disturbed (dammed or embankment built), irreparable damage is done to the otherwise pristine unregulated riverine ecology. The US, Spain, and France have decommissioned hundreds of dams over the years. The United States alone, according to the World Commission on Dams, has decommissioned a total of 467 dams by the year 2000, twenty-eight of which were large dams. Several investigations and studies have revealed that it was economically more beneficial to remove the dam rather than let it continue to exist. Therefore, Bhutan should revisit this question as it forms its plans for hydropower development.

Traditionally, the Bhutanese value the power of the water bodies and rivers as they attach spiritual and divine importance to these ecosystems. Prayers, rituals, frescoes and thangka paintings include portrayals of lakes, rivers, springs, rivulets and aquifers. How true and benevolent are the words of Great Gautama Buddha who said that our rivers are the very source of life hosting the largest repositories of biodiversity.

Way Forward

Due to present day economic and environmental realities, it would be in the long term interest of Bhutan to safeguard its wonderful rivers. The potential impacts of climate change on glaciers as well as river systems could be mitigated or altogether averted if we move to protect our environment by maintaining strong forest cover to absorb the shocks of erratic changes. The resilience of our environment will depend to a great extent on how well the natural state of the aquatic environment is conserved and how we can maintain in its present statethe natural regime of our rivers and water bodies.

The previous government (2008-2012), DPT (Druk Phuensum Tshogpa), had set the country in a spiral motion of accelerated hydropower development. The current government, the PDP (People's Democratic Party), should take this time to scrutinize the consequences of ambitious and rapid hydropower development against the greater interest of its healthy rivers and happy people. Healthy rivers are crucial for supporting fisheries, sustaining biodiversity, maintaining water quality, nourishing agricultural flood plains, and sustaining livelihoods and food security.

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Gongsar Karma Chhopel *M.Sc. (Texas State University, USA), has participated in numerous international and regional water-related activities that helped him to infuse some of the holistic elements of IWRM and gender into various environmental legislations of the country. Until recently, Chhopel has been in-charge of the Water Resources Coordination of Bhutan. Notable among his work are the Water Act of Bhutan, 2011, and its pursuant regulation, the Bhutan Water Vision and Policy, 2007, National Environment Protection Act (NEPA). Currently, he is the Chief Executive Officer of Bhutan Statistical Services and*

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References

Department of Energy (2005), Royal Government of Bhutan,(RGoB) "Flash Floods in Bhutan and Management Options".

Department of Energy, "Water Resources Management Plan", 2003

Chhopel, Gongsar Karma (2013), Water Governance in South Asia, IWRM, Gender and water, Thimphu, Bhutan.

Kalpavriksh (2013), Large Dams for Hydropower in North East India, New Delhi, India.

National Environment Commission (2000), "Initial National Communication of Bhutan to UNFCC".

National Environment Commission (2002), "Bhutan the Road from Rio, National Assessment of Agenda 21 in Bhutan".

National Environment Commission (2006), "Bhutan National Adaptation Programme of Action".

Smith.N. (1971). A History of Dams. Peter Davis. London.

Singh, Chattrapathi (1998), Damming Rivers. In Report on the "Support for Applied Legal

Singh, Sathyajit. (1997). Taming the Water: Political economy of large dams. Oxford University Press. New Delhi.

Earthscan Publications, (2000), Dams and Development: A New Framework for Decision making, the report of the World Commission on Dams.

Thakkar Himanshu (1999), Assessment of Irrigation Options: A study of Indian situation, World Commission on Dams.

Water Act of Bhutan, 2011.

Call for papers of Department of Irrigation (DOI) National Irrigation Seminar on " Irrigation to all Cultivable land: Challenges and Opportunities"

The Department of Irrigation (DOI) is organizing a National Seminar on " Irrigation to all Cultivable land: Challenges and Opportunities". Its main objective is to provide a common platform for participants to share experiences, lesson learned and discuss on issues, challenges and opportunities related to irrigation development and management. Following are few identified issues on which papers are expected. Papers are welcome on any other issues relevant to irrigation.

1. Claims, Disputes and Arbitration
2. Issues and challenges in land Acquisition
3. Procurement and Contract Management
4. Year Round Irrigation
5. IWRM: New tools and Approaches
6. Multiple use of Water
7. Ground water Irrigation and Lift Irrigation
8. Non-Conventional Irrigation Technologies
9. Scope and Potential of Multipurpose Projects
10. On Farm Water Management
11. Contribution of FMIS in food security
12. Service Delivery, Efficiency, sustainability in Irrigation
13. Challenges in Irrigation Financing
14. Management Information System in Irrigation
15. Climate Change, Drought management and Deficit Irrigation
16. Human Resources Management in Irrigation
17. Irrigation Development and management from Gender Equity and Social Inclusion perspective
18. Irrigation and Creation of wealth

Schedule for paper Submissions:

- Abstract Submission: 6th Falgun,2070(18th February,2014)
- Notification of Abstract Selection: 20th Falgun, 2070(4th March, 2014)
- Submission of full text paper : 30th Chaitra, 2070 (13th April,2014)
- Date of Seminar : 15-16th Baishak, 2071 (28-29th April,2014)

The abstract should not be more than 250 words and should contain all the features of the main paper in brief. All abstract submission will be peer reviewed and evaluated based on originality, technical content and relevance. The accepted full paper will be published in the Seminar Proceedings of DOI.

For technical guidelines and other information, please contact Er. Basudev Lohanee, Ph no: 9841 277760, email:lohanibasu@yahoo.com and Er. Basudev Timilsina, Ph no: 9841 516405, email: basutimilsina@yahoo.com