

Managing Water to Sustain Life

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Background

Water, a natural life-sustaining resource, should be nurtured and managed for perpetuity. Sustained flow of good quality water depends on the integrity of the watershed and its management through institutions and infrastructures.

At the UN Conference on Sustainable Development in 2012 (Rio+20), governments acknowledged that water is “*at the core of sustainable development as it is closely linked to a number of key global challenges*”. To end poverty and boost and maintain economic development, we need healthy freshwater systems.

Bhutan’s water resources are mainly rivers, of which the major ones flow north to south. All four major river basins -- The Amo Chhu (Toorsa), the Wang Chhu (Raidak), the Punatsang Chhu (Sunkosh) and the Drangme Chhu (Manas) -- drain into the Indian plains. Nyera Ama Chu, Jomotshangkha Chhu and Shaar Chhu form smaller river basins. All river systems originate within Bhutan, except for Amo Chhu and Kuri Chhu, which originate in the southern part of the Tibetan Plateau. There is also a dense network of small -- mainly rain-fed -- tributaries that flow down the steep slopes and side valleys to join major rivers.

Water Availability

The long-term average estimated water resource is about 73,000 million cubic meters per year (adapted Water Resources Management Plan (WRMP), 2003). One of the highest per capita mean annual flow availability of water is 107,000 cubic meters. Bhutan’s major rivers provide water for hydropower and tourism/recreation. Their rain-fed tributaries, and sub-surface sources like springs and aquifers, provide for all other uses, mainly drinking and irrigation.

The availability of water, including worse-case scenario (minimum 7 days flow of 10-year drought return period), based on available hydrological

data of north-south rivers and a few tributaries, is given in Table 1.

Table 1: Gross national land area, runoff and minimum flow

Sl.#	Characteristics National Features	Value
1	Land area for entire country	38,394 Km ²
2	National population	681,720
3	Long term mean annual flow entire country	73,000 million m ³ /year
4	Per capita mean annual flow availability	107,000 m ³
5	Minimum 7 days flow of 10-year return period	13,500 million m ³ /year
6	Per capita annual minimum flow availability	19,803 m ³

Source: Adapted from WRMP, DOE/ Norconsult, 2003

The exploration and development of groundwater resources are just beginning and not included. Groundwater availability in northern parts may be due to hard rock terrain, but groundwater potential in the southern plains is estimated to be high. Infiltration facilities in alluvial deposits of river valleys do supply drinking water to some areas. The groundwater potential could be an alternative source for domestic consumption, small-scale irrigation and industrial uses in future.

Water Demand

Water demand projection is focused on the use of surface sources. For analysis, users are categorised into irrigation, municipal, rural and large industries. Municipal users include domestic, institutional, commercial and small cottage industries.

The estimated water demand¹ (WRMP Report) is 422 million m³ of gross consumptive demand in 2002, but is expected to grow to 516 million m³ by 2012 and to 541 million m³ by 2022, as given in Table 2 below.

¹ Water demand Forecasted by Department of Energy with expertise from Norconsult in preparing Bhutan's Water Resources Management Plan (WRMP)

Table 2: Gross national consumptive and non-consumptive water demand

Demand Category	2002 (million m ³ /year)	2012 (million m ³ /year)	2022 (million m ³ /year)
Urban demand	10	19	37
Irrigation demand	393	472	472
Rural demand	11	15	20
Industrial demand	0.6	0.9	1.5
Livestock demand	7.5	8.8	10.2
Sum of maximum consumptive demand	422	516	541
Sum of water supply excluding irrigation demands	29.1	43.7	68.7
Non-consumptive hydropower demand	6,700	16,600	26,900

Source: adapted Final WRMP report, 2003

Non-consumptive water demand is mainly hydropower which, estimated at 6,700 million m³ for 2002, is forecast to grow exponentially to 26,900 million m³ by 2022.

The water balance assessment indicates that at national level, there is a large surplus of water, available from the firm flow in main north/south rivers. The gross national water balance extracted from WRMP report shows that overall annual water balance is not an issue.

Available water resources are mainly utilised for drinking, sanitation, household use, agriculture and in industries. More than 85% of consumptive demand is for irrigation, to produce food grains.

Current Situation

1. Water Resources

Four river basins drain about 73,000 million m³/year of water, but its quality and quantity at different tributaries are not known. There is inadequate assessment of availability of groundwater, integral to water resources.

Water from streams and springs is of good physico-chemical and biological quality which could be tapped for drinking with minimal treatment.

Water balance issues are not critical at national level, but the picture changes at sub-basin levels or smaller sub-catchments with greater population concentrations. Since water for irrigation and drinking is mainly from tributaries, the water balance study needs to look beyond sub-basins into catchments and sub-catchment levels, to fully understand the situation.

Although Bhutan has rich water resources, global warming and climate change pose major challenges. Retreating glaciers and uneven distribution and intensity of precipitation are leading to reduced volumes of water in all river basins. Almost all towns and many villages have reported water shortages.

2. Urban Water Supply

Access to safe drinking water has improved considerably since 1990, with 97% of the rural population and 98% of urban populations able to access piped water (PHCB 2017). But water reliability and quality are of great concern. Water is not available when needed and is often contaminated with turbidity and microbiological impurity. The development of urban water infrastructures is not commensurate with the increase in population. There are more than 50 towns -- including *thromdes* (municipality), *Dzongkhag thromdes*, satellite towns and other small urban settlements and business centres -- but only 24 have some basic treatment plants. Existing water treatment plants have inadequate capacity and are poorly operated and maintained. Treated water is not always safe to drink directly from the tap. Smaller urban settlements do not even have rudimentary treatment facilities, and raw water is supplied directly to households. Existing water supply networks are old and the GI pipes corroded and rusted, with multiple leakages in some urban centres. Water supply hours in towns vary from 24 to fewer than six hours and are often unreliable.

Legal and Institutional Framework

The Royal Government of Bhutan has developed a strong legal framework to protect and manage the environment and water resources. Key legal provisions are found in the Constitution, the Water Act (2011) and the

Bhutan Water Vision and Policy² and several other water-related policies and regulations.

The National Environment Commission (NEC) is the apex body responsible for co-ordinating water resources management, including quality monitoring and development of appropriate standards. The NEC Secretariat is designated as one of the competent authorities monitoring Bhutan's water resources, including preparing plans and policies, reviewing and revising regulations, standards and guidelines, maintaining a national registry for drinking and irrigation water resources, and issuing permits and licences for water extraction.

The Water Act, 2011 has assigned responsibility for water resource management to many key agencies, including municipal agencies, district *tsbogdu* and *gewog tshogde*. The Ministry of Works and Human Settlement develops drinking water infrastructures, the Health Ministry monitors water quality, while the Agriculture and Forestry Ministry manages watersheds, water for irrigation, in forests and wetlands and protects catchment areas. Local governments work with the Home & Cultural Affairs Ministry to protect holy water sites such as *Menchhu*, *Drupchhu*, *Tshachhu* and *Neychhu*. The Ministry of Economic Affairs is responsible for hydropower development, collection, analyses and dissemination of water resources data and monitoring of water flows (discharge level) and sediment.

Emerging Challenges

a. Climate Change

Climate change affects water resources. Changes observed include precipitation patterns of intensity and extremes, bringing floods or drought, reduced snow cover and melting ice caps. (Bates et al. 2008). Global warming also causes desertification, rising sea levels and loss of biodiversity, and floods and droughts result in water pollution. Such changes compromise water quantity and quality, food production, and other economic activities.

² Legal framework governing water resources in Bhutan include - The *Constitution of Bhutan*, Article 5.

- The *Water Act of Bhutan 2011*
- The *Bhutan Water Vision and Water Policy*, *Water and Sanitation Rules*, *The Rural Water Supply and Sanitation Policy 2002*, *The Waste Prevention and Management Act 2009*, *Water Regulation of Bhutan 2014*, *Bhutan Drinking Water Quality Standard, 2015*, *Land Act*, *Forest and Nature Conservation Act 1995*, *Environment Assessment Act 2000* and *Bhutan Electricity Act 2000* have provisions on water related issues.

b. Urbanisation

Bhutan's urban population comprises 37.8% of the total. Average annual growth of urbanisation is more than 6%, compared to 1.3% average national growth. Resultant lifestyle changes and increases in water consumption, demand for timber, firewood and non-timber forest production are starting to negatively affect watersheds.

Freshwater rivers and streams provide affordable and easy access for drinking and irrigation, but uncontrolled discharge of domestic and industrial effluents, and solids waste has polluted urban rivers.

c. Sustainability and Inadequacy of Water Infrastructures

Sustainability of urban and rural water supply is a major challenge. Analysis of the comprehensive Rural Water Supply and Sanitation inventory report in 2009 revealed that 31% of rural schemes are non-functional, covering only piped water, not necessarily treated. Rudimentary water treatment plants exist in 24 urban centres and are not operated and maintained to desired standards. The water supply network in most urban centres need to be redesigned or replaced and upgraded. More than 50% of water in some urban supply systems is unaccounted for.

d. Management of Wastewater

Wastewater management is an issue in urban areas. Conventional piped sewerage, with oxidation pond treatment plants, was installed in the bigger towns of Thimphu, Phuntsholing and Gelephu. The smaller municipalities of Trashigang, Damphu, Gyalpozhing, Bajo, Samdrup Jongkhar and Wamrong have compact Eco-line sewerage treatment plants that connect only core commercial areas to underground sewers. In other towns, individuals are responsible for providing sanitation facilities, like on-site disposal systems -- septic tanks with outlets to soak-pits or open drains. About 70% of wastewater is discharged without treatment. Malfunctioning septic tanks, often without soak pits, and a lack of sewerage systems in many towns, lead to the release of raw wastewater -- domestic, hospital, industrial and agricultural -- into the pristine environment, threatening people's health and natural ecosystems.

e. Increasing Conflicts and Pressure on Water Resources

Despite the national abundance of surface water sources, there are local water shortages, leading to increasing conflict, even among farmers over irrigation. Continuing population growth, urbanisation, and intensification of food production are adding further pressure.

f. Sustainability of Hydropower Generation Capacity

Steep mountain terrain with perennial river flow provides vast potential for hydropower development. Bhutan has an estimated hydropower potential of 30,000 MW, out of which about 25,000 MW has been identified and assessed to be technically feasible. Hydropower accounts for more than 40% of government revenue. Potential to generate more is being threatened by increasing sediment load in rivers, urbanisation and other development activities.

g. Sustainability of Water Intensive Industries

Distilleries, agro-industries, and beverage, food and metallurgical industries are heavily dependent on water. Local tributaries, springs and streams, and municipal water systems currently meet the needs of most of these industries but reported cases of the drying up of water sources, and the decline in water yield in the headwater, will jeopardise their sustainability.

Issues and Gaps

a. Weak Linkages and Co-ordination Amongst Stakeholders

Existing water sector institutions are very weak at policy, planning and implementation. Different sub-sectors are working independently of each other without co-ordinating or sharing information with other stakeholders. There is duplication, a waste of resources and a lack of an integrated and holistic management of water resources.

A review of regional institutions reveals that consolidation and capacity development is required to manage water resources well. Nepal improved by consolidating its water and sanitation sectors in 1990, under the Department of Water Supply and Sewerage (DWSS). Singapore's Ministry

of Environment and Water Resources sets policies for water and sanitation, while its statutory body, the Public Utilities Board, carries them out. South Korea's autonomous K-Water, established under an Act, is responsible for all water-related activities, including watershed protection.

b. Lack of Convergence of Policy and Practice

Legislation and policies on management of water resources and sanitation are piecemeal, rendering implementation ineffective. NEC is the apex body for water resources management, but lacks the institutional capacity for implementation, as mandated by the Water and Wastewater management Act. The Water Act of Bhutan, 2011 is the legal tool for implementing water policy, which emphasises co-ordination, but different Ministries and agencies still work in isolation. There are water-related activities in almost all ministries and agencies, mainly the Ministry of Works and Human Settlement, Ministry of Health, Agriculture and Forests, Ministry of Economic Affairs and Local Governments.

c. Lack of Comprehensive Data and Inventory on Water Resources

Data and information are very basic, without a comprehensive inventory of water resources.³ Information on surface water, especially minor tributaries and associated streams and springs, is not comprehensive. The work on groundwater resources is in its infancy and there is no information except for a few tube wells and hand-dug wells in southern Bhutan.

d. Lack of Education and Awareness on Conservation of Water and Sanitation

A lack of education and awareness of water conservation has led to improper utilisation. There is a strong need to create awareness of protecting catchments and watersheds from excessive exploitation through forest degradation and overgrazing. People should better understand the benefits of water conservation, and how to put it into action, such as using water-saving devices and technologies to “do more with less water”, promoting the 3Rs (reduce, reuse, recycle).

³The only source of data currently available is a publication of the Department of Energy and Norconsult on the Water Resources Management Plan, 2003.

e. Lack of Capacity

Institutions and workers lack the capacity to manage water resources and sanitation issues. This should be addressed along with institutional development, technology transfer, the growth of technical expertise and financial prioritising.

f. Differentiating Between Urban and Rural Communities in Service Provision

There is a difference in the level of basic water provision -- both quality and quantity -- between rural and urban areas, even though they often share the same water source and catchment area. Some settlements in peri-urban areas are neither catered for by rural or urban water supply programmes.

Recommendations

For an integrated and holistic management of water resources, we must focus on improving policymaking, legislation, planning, co-ordination and implementation. This critical responsibility must be entrusted to a single agency with the necessary manpower and technical skills. The following steps are recommended:

1. Establish a Central Agency for Water and Sanitation.
 - An independent “Water and Sanitation Authority” will have the executive/policy functions of NEC and policy/implementation functions of line Ministries.
 - or
 - Establish a new “Department of Water and Sanitation” under the Ministry of Works and Human Settlement, with a clear mandate for long-term planning and implementation of programmes.
2. Develop a National Integrated Water Resources Management Plan (NIWRMP).
 - Develop an inventory, -- quality and quantity -- for all water resources, project future demand, and prepare water balance at catchments, sub-catchment and national levels.
 - Develop an integrated long-term plan for building infrastructures (drinking water, sanitation, tourism, hydropower and irrigation).
 - Establish a Catchment/Sub-basin level Water Resource Management Committee.

3. Conduct an Inventory of Water and Sanitation Infrastructures to develop and manage a comprehensive data base.
4. Enhance existing water and sanitation infrastructures.
 - Upgrade and expand the operation and maintenance of existing water supply systems.
 - Institutionalise a water safety plan.
5. Strengthen institutional, technical and managerial capacity.
 - Assess existing capacity, identify gaps, and mobilise resources to implement a long-term institutional and human resources development plan.
6. Conduct Advocacy and Awareness Campaign.
 - Disseminate messages on proper use and conservation of water resources, wastewater management, and 3R principles through media, campaigns and outreach/advocacy materials.
7. Implement climate change adaptation measures.
 - Initiate appropriate/innovative climate adaptation measures, promote traditional water conservation techniques and adopt good practices to minimise the adverse impacts of climate change on water resources.
8. Adopt eco-efficiency and water sensitive urban design principles.
 - Design water and sanitation infrastructures with a lifecycle approach and strengthen legislation to support eco-efficient concepts.
 - Develop impounding/multipurpose reservoirs for use during dry periods.
 - Introduce water-saving devices and technologies.
 - Promote rainwater harvesting.
 - Encourage water sensitive urban planning and design.
9. Introduce deterrents against wastage, improper use of water, and improper management of wastewater and solids waste.
 - Develop adequate rules and regulations, and implementation mechanism.
10. Encourage Corporatisation/Privatisation.
 - Create enabling environment for private sector and community participation in water and sanitation services.
 - Develop policy and legal formwork to encourage private firms.
11. Strengthen legal framework.
 - Revisit the existing legal framework, identify the gaps, amend/develop new legislations if necessary, and implement effectively.