NATIONAL ENVIRONMENT COMMISSION
ROYAL GOVERNMENT OF BHUTAN

NATIONAL INTEGRATED WATER RESOURCES MANAGEMENT PLAN 2016

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ADB

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From the People of Japan

EGIS France
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FOREWORD

For the Royal Government and the people of Bhutan, water is one of the most important natural resources. It provides livelihood, it is vital to developing the economy, and it sustains the natural environment. Under the wise and farsighted leadership of our Monarch, combined with our people's reverence and respect for nature, we have treasured water and we have been blessed with an abundant natural supply.

At the scale of river basins and even districts, there appears to be no pressing water scarcity. But this is an average picture, and it does not reflect large seasonal variations and differences in water availability at the local level. Even as large amounts of water are flowing in the deep gorges, it is generally inaccessible for many dispersed communities living on the mountain slopes. They can only access water from small springs and rivulets.

There is also increasing pressure on the quantity and quality of our water resources due to rapid socio-economic development, the effects of which are further exacerbated by climate change. Concern over the availability of water for drinking and agriculture is growing as many spring water sources are drying up, and there is minimal flow in winter for hydropower generation.

Therefore, it is important that all stakeholders understand the common issues and take a coordinated approach to managing Bhutan's water resources. The need for such an approach was recognized by the Water Act of 2011 and the Water Regulation of 2014. The 11th FYP mandated the NEC Secretariat to prepare a National Integrated Water Resource Management Plan (NIWRMP).

The overall goal of the Plan is to establish the framework and priorities for the implementation of integrated water resources management in Bhutan. The Plan presented here is based on a comprehensive assessment of the current situation and future prospects in light of growing water demands and the threat from climate change. The Plan establishes the principles and mechanisms under which agencies involved in the water sector, together with river basin stakeholders, can coordinate their respective plans and activities, as well as collectively monitor progress toward attainment of IWRM objectives.

Therefore, the Plan serves as a foundation for water resource stakeholders to work together to achieve a common goal of ensuring Bhutan's water security. Water security, as explained in the Plan, is the capacity to provide sufficient and sustainable quantity and quality of water for all types of water needs and services, and to protect people from water-related disasters. Indicators of water security have been formulated for five key dimensions of water security: rural household water security, urban water security, economic water security, environmental water security, and security from adverse effects of climate change and natural disasters. These indicators are to be used as a means to coordinate agency plans, and to assess progress in achieving the objectives of IWRM.

We are confident that the management principles and mechanisms established through this Plan will serve as a rallying point, and be used as practical guide for our collective endeavor toward water security. We hope that the key result areas and performance indicators for water security that have been formulated here will be taken on board by the Gross National Happiness Commission, and that these become integrated into the national and local planning and budgeting processes under the current 11th five-year plan and in the subsequent FYPs.

Yeshey Dorji
Minister In-charge and Vice Chairman
National Environment Commission

ACKNOWLEGEMENT

In compliance with the Water Act and the 11th FYP, the **Water Resources Coordination Division** (WRCD), and the National Environment Commission Secretariat is pleased to present the National Integrated Water Resources Management Plan. It is the result of concerted efforts by different parties. Without their contribution this document would not have materialized.

WRCD likes to thank particularly the Asian Development Bank and Japan Fund for Poverty Reduction for the financial and technical support extended to the Integrated Water Resources Management (IWRM) program being pursued in Bhutan. Special thanks go to the National Environment Commission for guidance and approval of the plan, and the Ministry of Finance for facilitating the technical assistance from the Asian Development Bank.

WRCD is greatly indebted to the Technical Advisory Committee that was established to guide the development of the IWRM program and elaboration of the National Integrated Water Resources Management Plan (NIWRMP). The Technical Advisory Committee consisted of representatives from the following agencies: Map Production Division, National Land Commission; Department of Public Health, Ministry of Health; Renewable Natural Resources Engineering Division, Department of Agriculture, Ministry of Agriculture and Forestry; Watershed Management Division, Ministry of Agriculture and Forestry; Gross National Happiness Commission; Water and Sanitation Division, Ministry of Works and Human Settlements; Department of Disaster Management, Ministry of Housing and Cultural Affairs; Department of Local Governance, Ministry of Housing and Cultural Affairs; Flood Engineering Management Division, Ministry of Works and Human Settlement; Climate Change Division, National Environment Committee; Bhutan Chamber of Commerce and Industries; Department of Hydropower and Power Systems; Department of Hydro-Met Services; Department of Geology and Mines, Ministry of Economic Affairs; Tarayana Foundation; Royal Society for the Protection of Nature.

WRCD is also grateful to the Technical Assistance team of EGIS (France) in joint venture with the Royal Society for the Protection of Nature and the Bhutan Water Partnership, who has put a lot of effort into the realization of the NIWRMP.

Acronyms

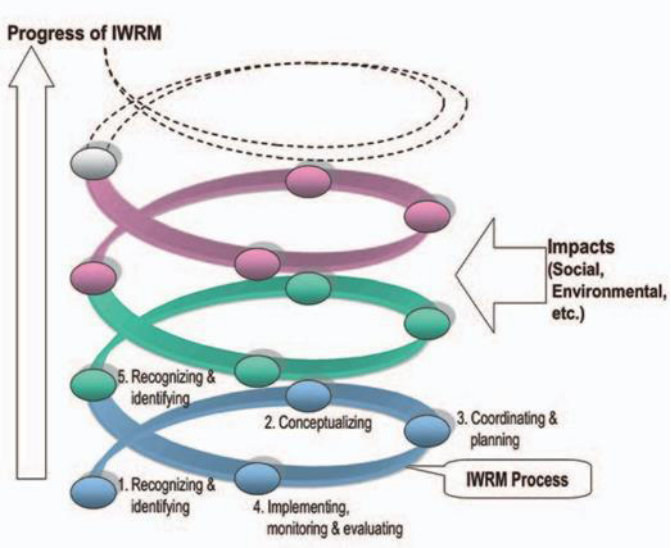
ADB	Asian Development Bank
AWDO	Asian Water Development Outlook
BCCI	Bhutan Chamber of Commerce and Industries
BhWP	Bhutan Water Partnership
BNWRI	Bhutan National Water Resources Inventory
BTFEC	Bhutan Trust Fund for Environmental Conservation
BWSI	Bhutan Water Security Index
CD	Capacity Development
CDTA	Capacity Development Technical Assistance
CFO	Chief Forestry Officer
CMIP5	Coupled Model Inter-comparison Project Phase 5
DAO	Dzongkhag Agricultural Officer
DDM	Department of Disaster Management
DEC	Dzongkhag Environment Committee
DEO	Dzongkhag Environment Officer
DES	Department of Engineering Services
DG	Director General
DGM	Department of Geology and Mines
DHMS	Department of Hydro-met Services
DHPS	Department of Hydropower and Power Systems
DLO	Dzongkhag Livestock Officer
DMF	Design and Monitoring Framework
DOA	Department of Agriculture
DOFPS	Department of Forest and Park Services
DHMS	Department of Hydromet Services
DRC	Department of Revenue and Customs
EIA	Environmental Impact Assessment
ESD	Environment Service Division
FAO	Food and Agricultural Organization (of the United Nations)
FEMD	Flood Engineering Management Division (MOWHS)
FGD	Focus Group Discussion
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Flood
GNHC	Gross National Happiness Commission
GNHCS	Gross National Happiness Commission Secretariat
IEC	Information, Education and Communication
IT	Information Technology
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
KRA	Key Result Area
m.a.s.l	Meters above sea level

MOAF	Ministry of Agriculture and Forest
MOEA	Ministry of Economic Affairs
MOF	Ministry of Finance
MOH	Ministry of Health
MOHCA	Ministry of Home and Cultural Affairs
MOWHS	Ministry of Works and Human Settlements
MPR	Monthly Progress Report
NEC	National Environment Commission
NECS	National Environment Commission Secretariat
NIIS	National Irrigation Information System
NIMP	National Irrigation Master Plan
NIWRMP	National Integrated Water Resources Management Plan
NLC	National Land Commission
NSB	National Statistics Bureau
NWRB	National Water Resource Board
ODE	Organizational Development Exercise
PES	Payment for Environmental Services
PHED	Public Health Engineering Division
PlaMS	Plan Monitoring System
PPT	Power Point (Presentation)
RBC	River Basin Committee
RBMP	River Basin Management Plan
RCSC	Royal Civil Service Commission
RGOB	Royal Government of Bhutan
RNR	Renewable Natural Resources
RSPN	Royal Society for Protection of Nature (Bhutan)
TA	Technical Assistance
TAC	Technical Advisory Committee (advising WRCD, NECS)
TNA	Training Needs Assessment
TOR	Terms of Reference
UNESCO	United Nations Educational, Scientific and Cultural Organization
WMD	Watershed Management Division
WRCD	Water Resources Coordination Division
WUA	Water Users Association

GLOSSARY

Integrated Water Resources Management (IWRM)	IWRM is defined as 'a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems'.[1]
IWRM components	The components of IWRM are as follows: **1. Managing water at the basin or watershed level** This includes integrating land and water, upstream and downstream, groundwater, surface water, and coastal resources. **2. Optimizing supply** This involves conducting assessments of surface and groundwater supplies, analysing water balances, adopting wastewater reuse, and evaluating the environmental impacts of distribution and use options. **3. Managing demand** This includes adopting cost recovery policies, utilizing water-efficient technologies, and establishing decentralized water management authorities. **4. Providing equitable access** This may include support for effective water users' associations, involvement of marginalized groups, and consideration of gender issues. **5. Establishing policy** Examples are implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms. **6. Inter-sectoral approach** Utilizing an inter-sectoral approach to decision-making, where authority for managing water resources is employed responsibly and stakeholders have a share in the process.
IWRM pillars	The three IWRM pillars relate to: (i) enabling environment (suitable policies, strategies, and legislation); (ii) capable institutional framework; and (iii) management instruments.
IWRM spiral	The traditional one-track approach of "predict→plan→control" is no longer appropriate. Rather, an approach that incorporates iterative learning and flexibility is needed to make water development plans robust in the face of an uncertain future involving a variety of change drivers and challenges. This can be achieved within the context of IWRM, in particular through a process of continual evolution and improvement – which in the IWRM literature is referred to as the "**spiral" approach**, see figure below.

[1] Global Water Partnership: http://www.gwp.org/The-Challenge/What-is-IWRM/

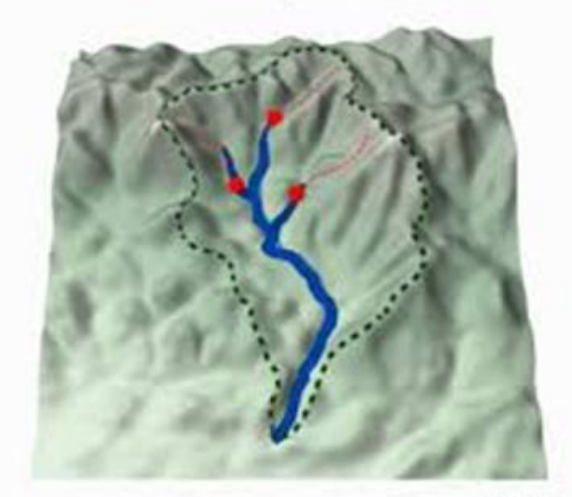


From AWDO, 2013

Each spiral describes the cycle of (1) recognizing and identifying the issues at stake; (2) conceptualizing the mitigating strategies; (3) coordination and planning of activities; (4) implementing, monitoring and evaluation. Each cycle typically takes about 5 years, and thus corresponds well with the five-year planning practice of the GNHC in Bhutan. Conclusions from the evaluation of previous round of activities will lead to renewal or adjustment of plans in the next cycle.

River basin	A river basin can be defined as:[2] The geographical area determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus (cf. Helsinki Rules, International Law Association, 1966, article II). Or: A river basin is the portion of land drained by a river and its tributaries. It encompasses the entire land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into the river and exiting the area at one point, see figure below.

[2] https://docs.google.com/a/universitywatersectorpartnership.org

	 Schematic presentation of a river basin NB: A (drainage) basin is basically the same as catchment area or watershed. The distinction is mainly based on the scale of the area being referred to.
The Dublin principles for IWRM	IWRM strategies are based on the four principles formulated at a water conference in Dublin in 1992 (referred to as the Dublin Principles of IWRM) and presented to world leaders at the World Summit in Rio de Janeiro in 1992. The four principles are: (i) water is finite and vulnerable resource; (ii) need for a participatory approach in water management; (iii) the role of women is stressed; and (iv) water has social and economic value. Later, a fifth principle was added: (v) integration of the three E's: economic efficiency – social equity – environmental sustainability.
Water security	Defined as "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."[3] Water security may be viewed in physical or economic terms. Physical water security is a situation wherein water is abundant enough to meet all demands, whereas economic water security depends on providing adequate investments in water infrastructure and services delivery.
Water availability	The hydrologic capacity of a water source (surface water body, groundwater, municipal water) to sustain additional water demands after considering other current water uses and water conditions (GEMI, 2012).[4] In the context of this NIWRMP, the water availability in an area has been determined as runoff generated from rainfall within the concerned area augmented with the inflow from upstream areas after deducting consumption.
Hydrological water balance	Any water entering a system (via precipitation), must be transferred into either evaporation, surface runoff (eventually reaching the channel and leaving in the form of river discharge), or stored in the ground as groundwater and on the

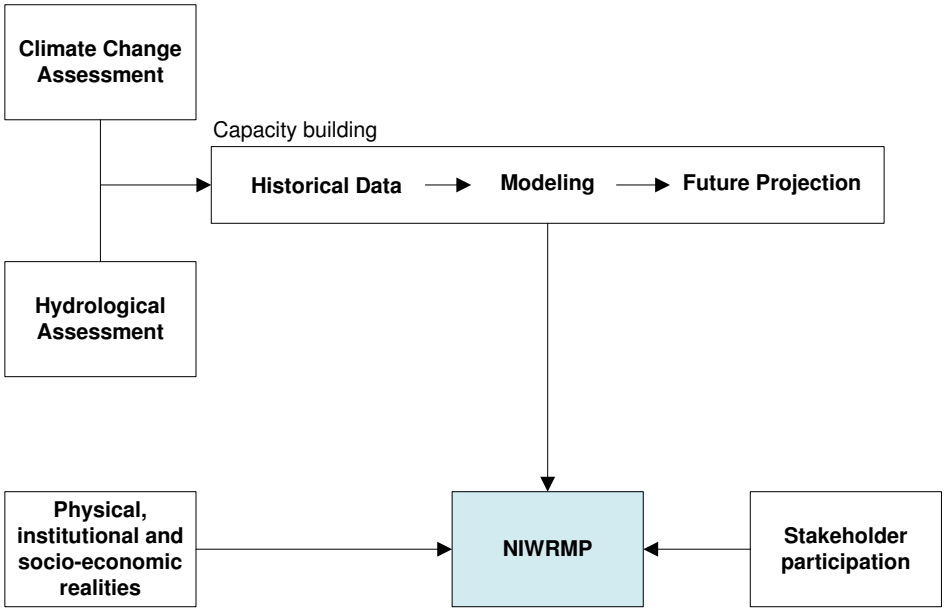
[3] UN-Water: http://www.unwater.org/topics/water-security/en
[4] http://www.iadclexicon.org/water-availability/

	ground as snow or ice. This equation requires the system to be closed (hydrological unit).[5]
Water accounting	The systematic study of the current status and future trends in water supply, demand, accessibility and use within a given spatial domain.[6]
Wetlands	"Wetland" is a generic term for all the different kinds of wet habitats--implying that it is land that is wet for some period of time, but not necessarily permanently wet.[7] There are various definitions which usually highlight three aspects: (i) the hydrological regime (depth of flooding or soil saturation; (ii) the type of plant growth (hydrophytes); and (iii) soil development (hydric soils). Not all definitions include deep permanent lakes and/or glaciers. Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favour the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils. [8] Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance. Inland wetlands, like in Bhutan, are non-tidal and can comprise floodplains along rivers and streams; isolated depressions surrounded by dry land along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (vernal pools and bogs); marshes and wet meadows dominated by herbaceous plants, swamps dominated by shrubs, and wooded swamps dominated by trees.

[5] https://en.wikipedia.org/wiki/Water_balance
[6] Godfrey, J. and K. Chalmers (editors). Water Accounting: International Approaches to Policy and Decision-making. Edward Elgar Publishing, 2012
[7] https://water.usgs.gov/nwsum/WSP2425/definitions.html
[8] http://www.epa.gov/wetlands/what-wetland

EXECUTIVE SUMMARY

The National Integrated Water Resources Management Plan (NIWRMP) has been prepared on the basis of climatic, hydrological, and social/institutional assessments as shown in the simplified diagram below.



Bhutan is faced with what could be dubbed as the 'challenge at dual scale'.

- There are reports about water shortage and scarcity at the local community level. However, at the larger scale of the river basins (and districts), there are no pressing water problems evident at the present time, suggesting that the issues can be addressed with improved access. The challenge is to coordinate and integrate water management plans. This is addressed in the Water Act and Regulations, along with the formation of River Basin Committees. The necessity of maintaining sustainability of water utilization in the future has been elaborated further in the NIWRMP - specifying priority steps to be taken. The NIWRMP is not a macro-economic analysis of best development alternatives.

- However, water-related problems are felt acutely at the local level by dispersed communities living on mountain slopes where they draw water from small (sometimes distant) sources and rivulets. Their problems cannot be addressed at a central or even basin level, and should be addressed at the level of villages and Gewogs. To that effect, the Gewogs should start collecting information about the fragmented water sources: their location, type and name, utilization, quantities of abstraction, but also their significance for religion, culture and ecology.

Climate change is expected to result in higher temperatures and more erratic and intensive rainfall during the monsoon – when water is already plentiful. Extreme river discharges are expected to occur, calling for new design criteria for water works, and 'room for the rivers' to avoid flooding. Conversely, lean period flows are expected to be lower. The storage of monsoon water is consequently an appropriate measure where possible.

Although water shortages as such have not been identified, a problem with water accessibility has been. Given the scattered habitations and the rugged mountain terrain, the delivery of a stable water supply is inherently costly.

Water demand for expanded irrigation may negatively affect the amount of water that is available for hydropower generation. It has been estimated that achieving full cereal self-sufficiency could in some cases

substantially reduce the discharge of the main rivers in certain months of the year. Competition for water should be taken into account in national food self-sufficiency and power generation policies, and include a consideration of ecological flows.

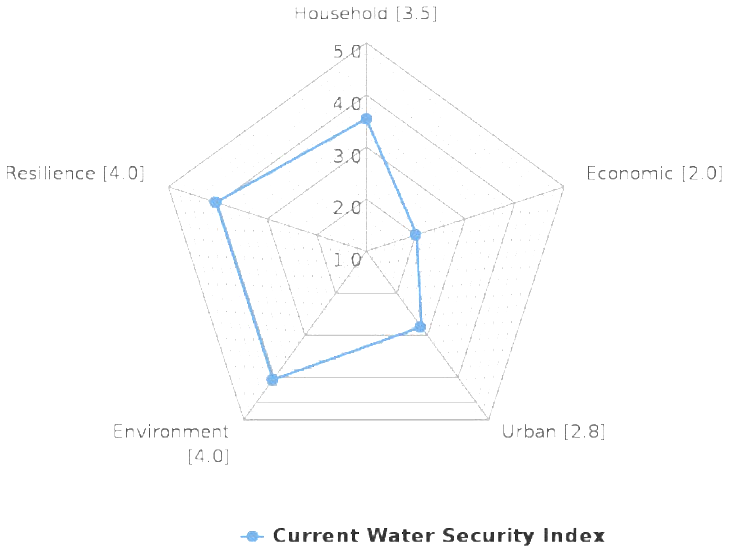
To support water management at a smaller scale, it is essential to increase the number of weather, river flow and groundwater monitoring stations, and spread them evenly throughout the country. This will enable the Department of Hydro-met Services (DHMS) to make more detailed assessments of climate and water availability.

The Water Act of Bhutan 2011 and Water Regulation of Bhutan 2014 are basically sound and in harmony with other water-related legislations. Guidelines have been prepared to supplement the Water Regulation, particularly for the registration of Water Users Associations. There is, however, scope for fine-tuning the legal framework.

Bhutan has five major and five minor *hydrological* basins. It is proposed to group them into five *management* units: (i) Amochhu; (ii) Wangchhu; (iii) Punatsangchhu; (iv) Mangdechhu; and (v) Drangmechhu. The five River Basin Committees (RBCs) overseeing these management units are designed along the 'coordination model', building as much as possible on existing institutions and keeping the regulatory and implementation mandates where they are already. The RBCs can have committees for minor basins or catchment areas. The future will tell us how workable this is for the RBCs.

Planning, implementation and monitoring water security is built around the concept of the Bhutan Water Security Index, which is comprised of five key dimensions: (i) Rural household drinking water supply and sanitation; (ii) Economic water security; (iii) Urban drinking water supply, sanitation and drainage; (iv) Environmental water security; and (v) Resilience to disaster and climate change. Water security is expressed in an index figure and visualized in a spider web diagram of the five key dimensions. The baseline score and pentagram of the BWSI 2015 are shown below. The average baseline score is 3.08.

Baseline 2015 BWSI Scores by Water Security Dimension



Agency coordination is structured along the key water security dimensions and indicators. It is essential that the water security concept be incorporated in the GNHC guidelines for preparing future Five-Year Plans (FYPs), starting with the 12th FYP.

There is an acute need to strengthen the capacity of the National Environment Commission Secretariat (NECS) for the implementation of the Water Act and the NIWRMP. There is also an urgent need to strengthen the Department of Agriculture (DOA) for the implementation of the National Irrigation Master Plan in the context of achieving food self-sufficiency. The Department of Hydro-met Services (DHMS) should be strengthened and

reoriented to become a broad service provider to other agencies in terms of weather forecasting and hydrological assessments. Lastly, the Gewogs need support for registration and capacity building of water users associations (WUAs) and for documenting local water sources and their uses. There is a role for non-government organizations (NGOs) to work with government agencies in terms of awareness raising, education, resource mobilization and implementation support. The role of the private sector in the construction of water infrastructure and the provision of water services needs to be enhanced especially in relation to irrigation and water supply and sanitation.

River training works and flood protection measures should be expedited in order to mitigate the expected impacts of climate change.

It is recommended to carry out a study into the potential of groundwater utilization as a supplementary water source, particularly during the lean season.

NATIONAL INTEGRATED WATER RESOURCES MANAGEMENT PLAN 2016

Contents

1 Introduction

1.1 Background

The Kingdom of Bhutan is endowed with abundant water resources. However, owing to rugged topography and associated climatic variations, accessibility remains a major challenge with communities facing seasonal and local scarcity of water. Historically, water resources have been managed through community-based traditional institutions focusing primarily on the provision of water for drinking and irrigation. The pursuit of economic development, a growing population, and changes in lifestyles have resulted in an increasing demand for water. The role of government in the management of water has increased over the years, but it is still constrained by weak coordination and regulatory mechanisms characterized by government agencies pursuing their own sectoral objectives. Over the course of eleven five-year plans, water for hydropower development, though non-consumptive, has received increasing focus with seemingly less priority given to irrigation, industrial and environmental water demand. With increasing consumptive demand, competition for water is emerging. The impact of climate change on water availability is a concern for drinking water supply, agricultural production as well as hydropower generation.

Recognizing that increasing pressure on the quality and quantity of water resources under rapid socio-economic development may further be exacerbated with threats from a changing climate, the Water Act of Bhutan 2011 was enacted to protect the environment and human health and to enhance the quality of lives through more secured access to adequate, safe and affordable water. The Act identifies integrated water resources management (IWRM) as the approach to be followed to ensure that water resources are protected, conserved and/or managed in an economically efficient, socially equitable and environmentally sustainable manner. For this, the Act requires the National Environment Commission Secretariat (NECS), in consultation with competent authorities, to 'prepare and periodically update a National Integrated Water Resources Management Plan (NIWRMP) for the conservation, development and management of water resources'. The Act requires the NEC and competent authorities to take account the approved plan in all water-related decisions and that the plan be mainstreamed into national policies, plans and programs.

In taking forward the Royal Government's drive for a more comprehensive management of water resources, the NECS has initiated the preparation of the NIWRMP under the ADB-funded technical assistance 'Adapting to climate change through Integrated Water Resources Management' and with the guidance of a Technical Advisory Committee (TAC) comprising representatives from the competent Authorities. The time horizon for this plan is 2030.

At the United Nations Sustainable Development Summit held on 25 September 2015, world leaders adopted the 2030 Agenda for Sustainable Development. This 2030 agenda includes a set of 17 Sustainable Development Goals (SDGs) to be achieved by 2030. Goal 6 addresses water concerns and serves as a foundation for the water security objectives that underpin the establishment of IWRM in Bhutan. Specifically, the SDG water-related targets set for attainment by 2030 are:

- implement integrated water resources management
- achieve universal and equitable access to safe and affordable drinking water for all
- achieve access to adequate and equitable sanitation and hygiene for all

- improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse
- substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity
- protect and restore water-related ecosystems
- expand international cooperation and capacity-building support in water and sanitation-related activities and programs.

1.2 Main issues relating to IWRM to be addressed

The main issues to be addressed are summarised as follows:

- agreement on common goals in water-related planning and management
- strong capacity and coordination of agencies involved in water management
- capturing the present status of water resources in terms of: water availability, demand and quality; water-scarce and/or flood-prone areas; and licensing of abstractions
- assess the impact of the main pressures on water management such as: climate change, change in land use, population growth, and economic development.

1.3 Goal and objectives of the NIWRMP

The overall goal of this NIWRMP is to establish the framework and priorities for the implementation of IWRM in Bhutan.

Specific objectives of the NIWRMP are:

- to assess the current situation and future prospects of water resources in the light of a changing climate
- to formulate the principles and framework within which players in the water sector can plan, implement and monitor water resources management in a coordinated manner
- to propose priority interventions and tools for integrated water resources management in the country.

NIWRMP is not a macro-economic analysis of best development alternatives, but rather an elaboration of the water security development framework, assessment of driving issues, intervention strategies, institutional roles and performance management system.

1.4 Methodology

The methodology followed in formulating the NIWRMP may be summarized in terms of the following roadmap comprised of three main components as presented in Figure 1.

Situation assessment

This entailed assessment of national water resources through two sources of information. First, climate and river basin modelling was performed to generate information on present and future states of climate and hydrology. Hydrological basins were identified and water availability and water demand for each of the basins were analysed. Secondly, information on water issues was generated through surveys and existing studies. This not only allowed a comprehensive understanding of the current situation with regard to water availability and accessibility, but also the prospects of water resources in the future.

Development of framework for coordination of planning, implementation and monitoring

IWRM requires coordinated and concerted efforts on the part of stakeholders to plan, implement and monitor progress. For this, a comprehensive review of policies, Acts, rules and regulations as well as existing institutional arrangements for planning and budgeting system was carried out. In addition, institutional experts performed stakeholder analysis, identified capacity gaps and entry points for planning, implementing and monitoring IWRM and assessed the organizational structure of the Water Resources Coordination Division of NECS, Department of Agriculture, and Department of Hydro-Meteorological Services. These are the three most important institutional players in initiating implementation of the water security agenda, and in the case of NECS, in coordinating the roles of various other agencies. In working towards a coordination framework and performance monitoring system, the ADB's Asian Water Development Outlook was reviewed and adapted to formulate the Bhutan Water Security Index.

Identification of priority interventions and tools

Based on the outcomes of the processes outlined above, interventions were formulated on the basis of priority issues and challenges. These interventions are presented in the form of Key Result Areas (KRAs) to concur with the process and terminology adopted by GNHCS in formulating plans. The approach was taken with the expectation that the interventions will feed into the GNHC guidelines for the preparation of the next FYP.

In support of the proposed mechanisms and interventions, an online Bhutan Water Security Information system comprising i) Bhutan Water Security Index System, ii) Interactive Web-based GIS[9], iii) Water Balance and iv) thematic maps has been developed to provide a basis upon which the NECS can constantly refine and improve over time.

[9] For details on the GIS database, refer to the standalone supporting documents entitled: (i) *GIS Software Installation User Manual* and (ii) *Interactive Web GIS User's Manual.*

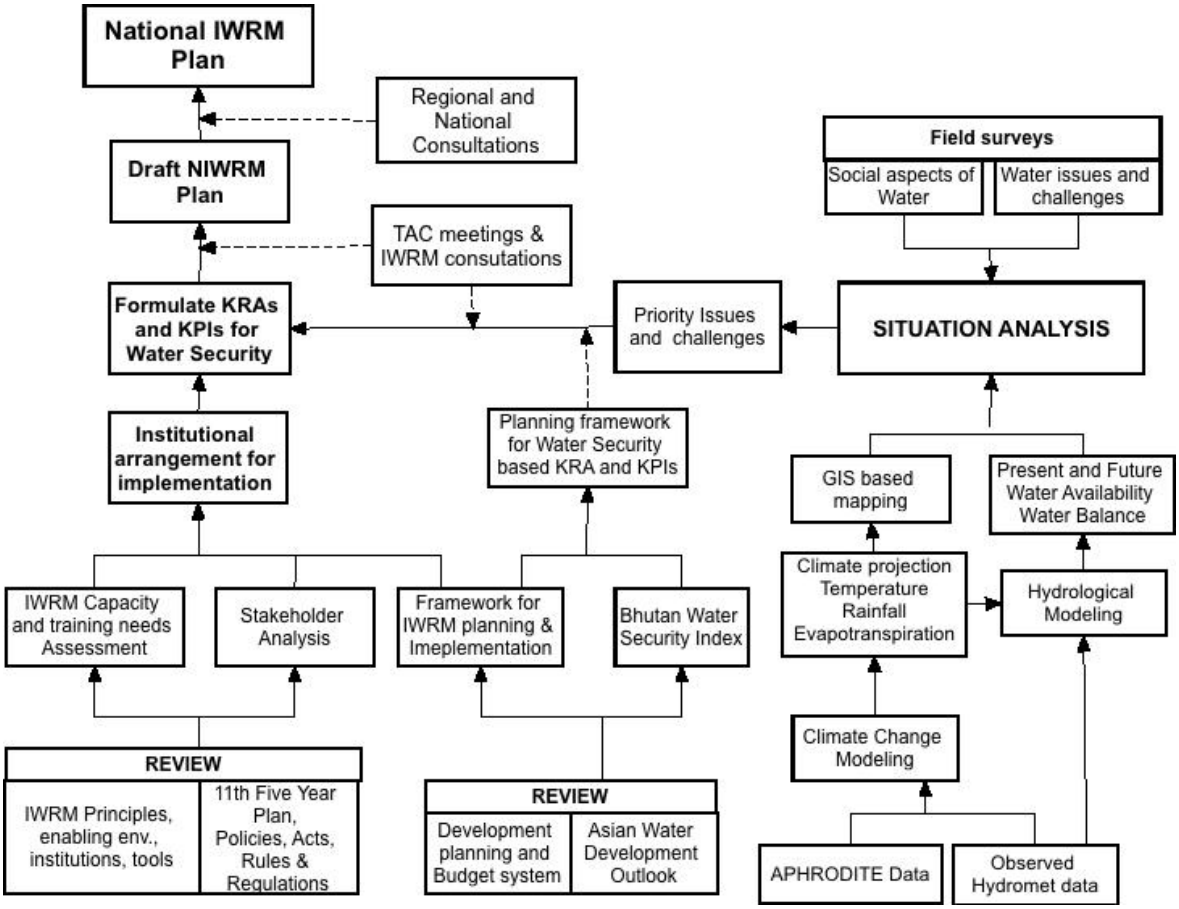


Figure 1: Diagram showing the roadmap for planning of the NIWRMP

Consultation process

Considering that the NIWRMP is a national cross cutting document, constant efforts were made to solicit input and guidance from stakeholders. In the early stages of preparing the NIWRMP, a Technical Advisory Committee (TAC) comprised of representatives from concerned government and non-governmental agencies and competent authorities was established with the purpose of stakeholder coordination with respect to IWRM, and to guide the elaboration of the NIWRMP.[10] Feedback and guidance were sought through the inception workshop, interim progress review and regular TAC meetings. The draft final plan was presented to stakeholders in four regional and one national consultation meetings. The final plan incorporates the feedbacks and comments from these consultations.

Moreover, the draft NIWRMP was posted on the NEC website for public review for one month before finalisation.

The overall logic and linkages in the formulation of the plan may be best understood in the context of the diagram presented in figure 2 below.

[10] The Technical Advisory Committee consisted of representatives from the following agencies: Map Production Division, National Land Commission; Department of Public Health, Ministry of Health; Department of Hydropower and Power Systems; Renewable Natural Resources Engineering Division, Department of Agriculture, Ministry of Agriculture and Forestry; Department of Hydro-Met Services; Watershed Management Division, Ministry of Agriculture and Forestry; Gross National Happiness Commission; Water and Sanitation Division, Ministry of Works and Human Settlements; Department of Disaster Management, Ministry of Home and Cultural Affairs; Department of Local Governance, Ministry of Home and Cultural Affairs; Flood Engineering Management Division, Ministry of Works and Human Settlement; Climate Change Division, National Environment Committee; Bhutan Chamber of Commerce and Industries; Department of Geology and Mines, Ministry of Economic Affairs; Tarayana Foundation; and the Royal Society for Protection of Nature.

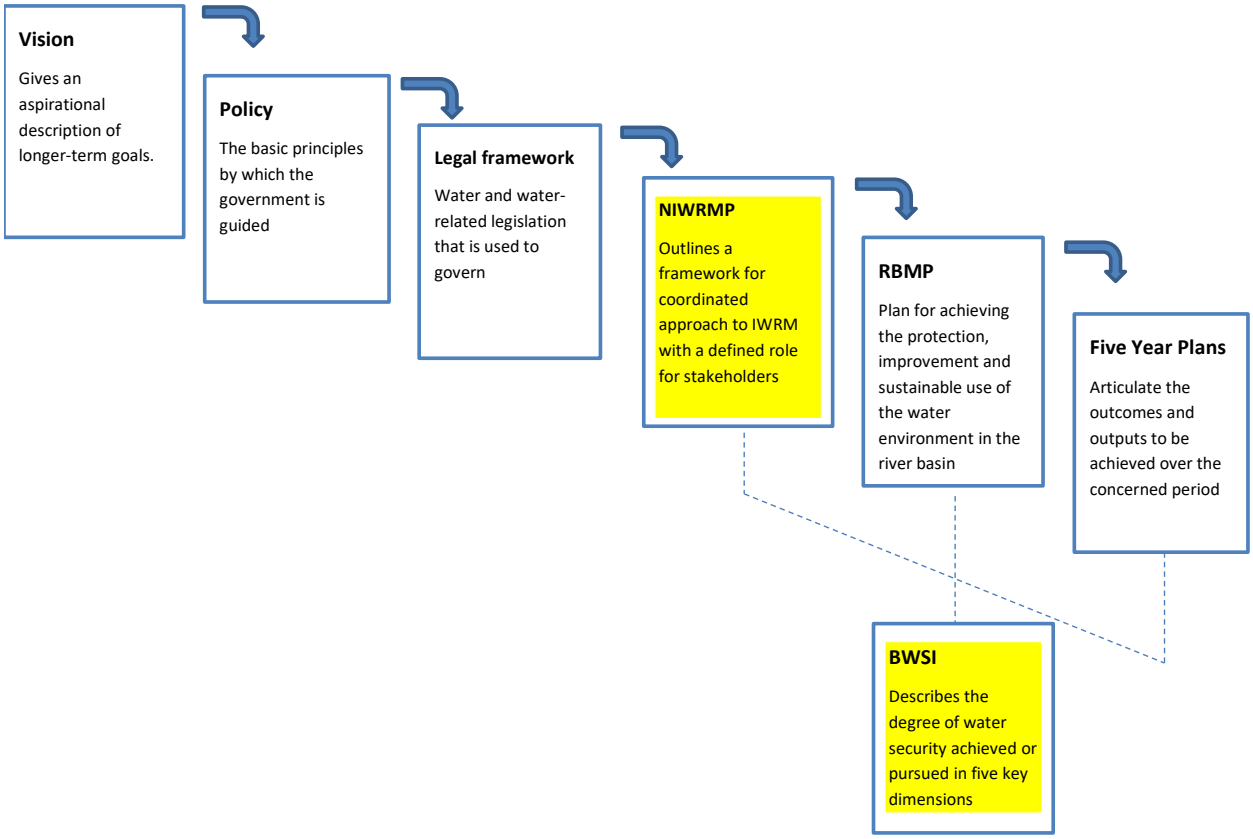


Figure 2: Diagram showing the relation between different documents

1.5 Spiral Learning Process in Implementing IWRM

IWRM is understood as an iterative learning process which is shown in Figure 3. Each spiral describes the cycle of: (i) recognizing and identifying the issues at stake; (ii) conceptualizing the strategy; (iii) planning and coordinating interventions by multiple players (i.e., competent authorities), and (iv) managing performance. Lessons from assessments in the previous round of activities are used to renew and adjust plans in the next cycle.

Stakeholders are to be kept informed of the IWRM's progress along the IWRM spiral, and of the activities that various stakeholders are contributing to attain the IWRM objectives at each iteration of the cycle. It is also important to keep stakeholders aware of the larger picture in which their individual roles are set and are coordinated through the national IWRM plan and the river basin management plans.

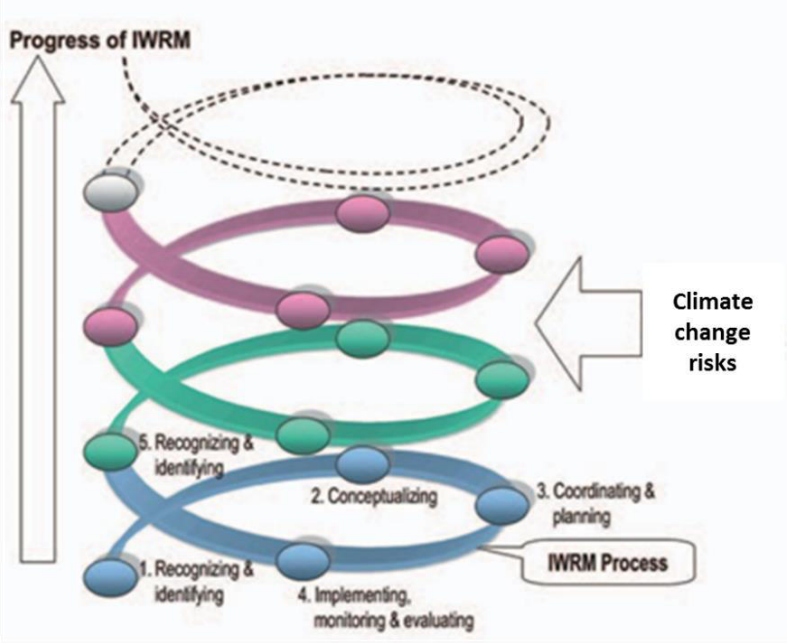


Figure 3: Spiral learning process for implementing IWRM

1.6 Structure of the NIWRMP

The NIWRMP is a framework document that establishes the foundations and framework for the coordinated planning, implementation, and monitoring of the status of water security in the country. The structure of this plan follows the logic of first setting the context, then describing the water related issues therein that the plan intends to address, followed by the guiding framework and foundations within which the players in the water sector are expected to perform. Based on the context, issues and guiding framework and foundation, the plan outlines the priorities in the form of Key Result Areas (KRAs) and Key Performance Indicators (KPIs) for ready integration in the sectoral plans and national five-year plans. The chapters are presented accordingly. Chapters 1, 2 and 3 are dedicated to introductory and context setting aspects of the plans. Chapters 4, 5 and 6 are dedicated to the guiding framework and foundations for IWRM planning, implementation and monitoring progress towards water security. Based on the context and framework established in earlier chapters, Chapter 7 sets out the priorities for the next three five-year plans. The details for specific chapters are described below:

Chapter 1 is an introduction to the plan. It provides background information, defines goal and objectives of the plan and describes the methodology adopted in formulating the plan.

Chapter 2 describes the main characteristics of Bhutan, its location in the eastern Himalayan mountain range, physical features, society and culture, economy, governance structure and the hydrological context.

Chapter 3 gives an overview of water and water-related issues in the country. Issues identified in this chapter relate not only to the current situation but also include future prospects especially in terms of climate change and associated impacts on hydrology. The plan does not elaborate on commonly known issues such as drinking water supply, glacial lake outburst floods, and landslides. The current policy and management approach to these issues is sound and should be continued by the concerned agencies. Development of irrigated agriculture is addressed separately in the National Irrigation Master Plan, 2016. Given its relevance for water management, the main conclusions have been incorporated in the NIWRMP. Other issues such as institutional coordination, water availability per district, and identification of water-scarce and flood-prone areas, to mention a few, have been studied in greater depth for the NIWRMP. Details are provided in standalone supporting documents, while the results and main conclusions are briefly presented in the NIWRMP.

Chapter 4 provides an overview of the governance framework. It begins with IWRM as understood in the global context, and a description of how water management approaches have evolved. An overview then follows of IWRM pillar 1: policies and legal instruments that are binding on government and non-governmental agencies to contribute to integrated water resources management in the country. It elaborates the Water Policy of 2008, Water Act of 2011, Water Regulations of 2014 and other water-related legal instruments.

This is followed by a review of IWRM pillar 2: the institutional framework and stakeholder analysis, and IWRM pillar 3: tools used in IWRM. The chapter continues with a training needs assessment, and ends by presenting a framework for inter-agency coordination.

Chapter 5 introduces the Bhutan Water Security Index (BWSI), a system for planning and monitoring the status of water resources at the basin and sub-basin/district-level scale and their related services towards water security. Adapted from the Asian Water Development Outlook (ADB, 2013), the BWSI comprises five dimensions, each with a set of indicators. The chapter proposes the BWSI dimensions and the indicators as handy lenses through which policy makers and leaders can visualize the status of water security at the national level. But they can also zoom into each dimension and indicator to assess the performance of specific sectors. It is also the basis for inter-agency coordination.

Chapter 6 focuses on the management framework for implementing IWRM at the basin level. The Chapter explains the delineation of basin-scale management units, the proposed role of River Basin Committees and their composition and specific functions, and the arrangements for formulating river basin management plans that incorporate stakeholder participation.

Finally, chapter 7 contains the priorities that need to be pursued within the IWRM framework set forth in the earlier chapters.

2 Country Context

This chapter describes some main characteristics of Bhutan that are relevant to water management.

2.1 Location

The Kingdom of Bhutan is situated in the eastern region of the Himalayan mountain range, between 88°E and 93°E longitudes and 26°N and 29°N latitudes. It is a landlocked country bordered to the north by (the Tibetan Autonomous Region of) China and to the south by India with the states of Sikkim in the west, West Bengal in the south and Arunachal Pradesh in the east, see Figure 4.

Figure 4: Administrative map of Bhutan

2.2 Geographical features

Geography

Covering an area of 38,394 km^2, Bhutan is located in one of world's most rugged and fragile mountain ranges. Extreme altitudinal variations ranging from 97 meters (m) in the south to over 7,500 meters above sea level (m.a.s.l) in the north make Bhutan one of the most ecologically diverse places. Seventy-two percent of Bhutan is covered by forest, and about 7.5% by snow and glaciers. Only about 3% of the total area is arable land. The remaining area is covered by water bodies, shrubs, meadows and other land use types. The country is also known for its rich natural water resources with a network of east-west flowing tributaries and major north-south rivers flowing through deep gorges and narrow valleys and ultimately draining into the plains of India and discharging into the Brahmaputra river. Over 90% of the land area has slopes exceeding 25%, which promotes runoff and erosion while making access to and management of water resources a costly affair.

Climate

Bhutan may be broadly divided into three geographic areas and corresponding climatic zones. They are the southern foothills, inner Himalayas and higher Himalayas. The southern foothills, only 20 km wide, rise from 100 to 1,500 m.a.s.l. The climate is hot and humid in the southern foothills, with temperatures ranging from 15 to 30^0C throughout the year and precipitation ranges between 2,500 and 5,550 millimetres (mm) per year. The inner Himalayas, which rise to 3,000 m, constitute, with their broad valleys, the economic and cultural heartland of the Kingdom.

The central inner Himalayas are characterized by a cool temperate climate with an annual average precipitation of 1,000 mm. The higher Himalayas constitute the northernmost and highest mountain ranges with elevations up to 7,550 m. These northern regions, under perpetual snow, are sparsely populated and have an alpine climate with average annual precipitation of 400 mm.

The temperature varies significantly over the country, with some higher Himalayan regions always below the freezing point throughout the year. Precipitation also varies significantly due to high topographic variability. Basically there are four seasons: pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and cold dry winter (December-February). July has the highest precipitation followed by August. About 80% of rainfall occurs from June to September. Precipitation remains low during the winter season and gradually increases from March. The mean monthly precipitation sum for two representative meteorological stations, located at Druyagang and Phobjikha, for the period 1990-2009 is shown in Figure 5.

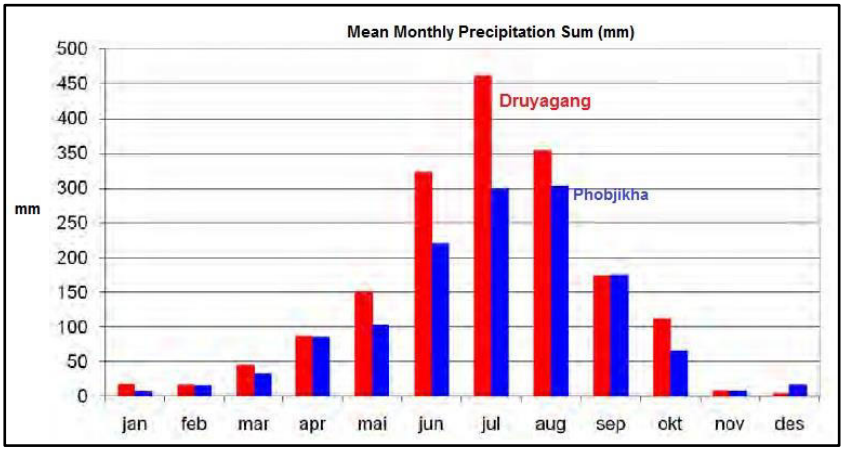


Figure 5: Mean monthly precipitation for Drujaygang and Phobjikha

Climate change projections

Climate change has been assessed during the preparation of the NIWRMP. The temperature is expected to rise, and more so in the north of the country. Increased snow and glacial melt will have an impact on river discharge. The temperature and its change over time are presented for RCP 4.5 in Figure 6.[11] Higher temperatures will also

[11] Representative Concentration Pathways (RCPs) were developed by the IPCC and are identified by their *total radiative forcing*, measured in watts per square meter (W/m^2) in year 2100 relative to 1750. Radiative forcing is defined as the difference of the solar energy absorbed by the Earth and the energy radiated back to space. Essentially, these scenarios describe the degree to which greenhouse gas emissions are actively mitigated, stabilized, or increased. RCP 4.5 is a "stabilization scenario" wherein total radiative forcing is stabilized before 2100 through a range of technologies and strategies for reducing GHG emissions.

increase forest and crop water demand through greater evapotranspiration, which in turn would reduce the river flows.[12]

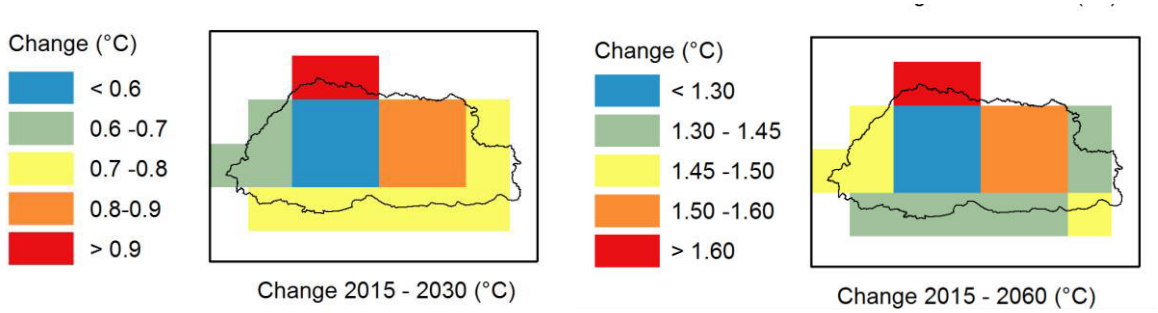


Figure 6: Projected changes in temperature for RCP 4.5

Source: ADB TA 8623

The rainfall shows an increasing trend, as displayed in Figure 7 for RCP 4.5.

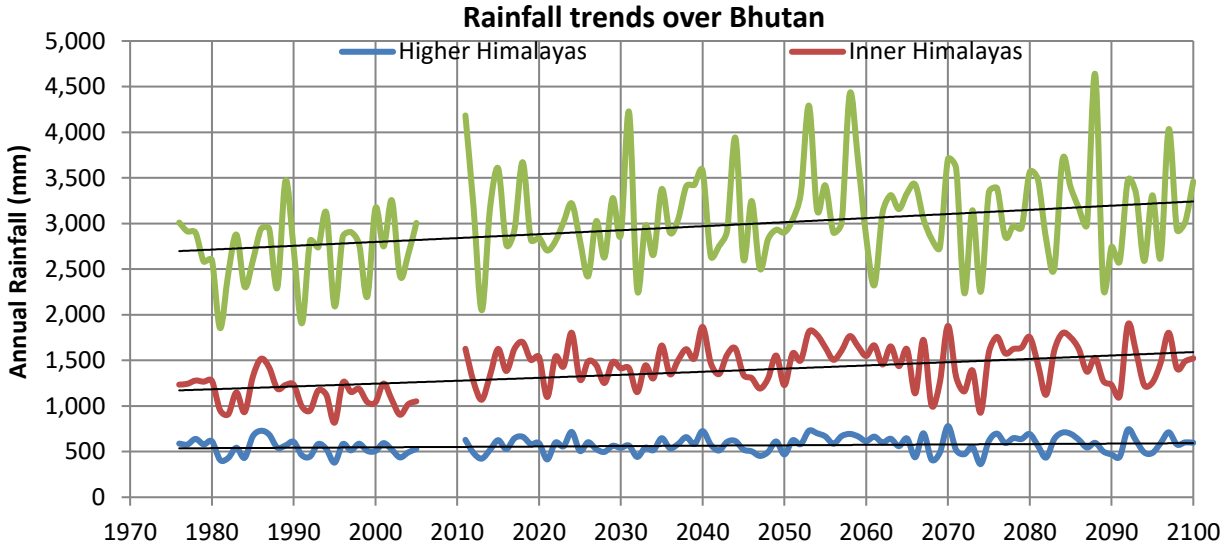


Figure 7: Long-term rainfall trends for different elevations in Bhutan

The spatial variation of rainfall is presented for RCP 4.5 in Figure 8.

[12] Refer to supporting standalone document entitled: *Hydro-meteorological projections for Bhutan based on CMIP5 scenarios.*

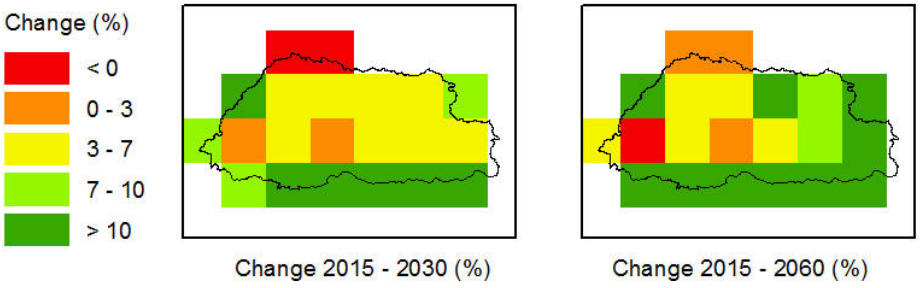


Figure 8: Projected change in precipitation for RCP 4.5

As can be seen in Figure 8, rainfall is projected to increase, particularly in the south of the country and during the monsoon period when water is already abundant.

Agro-ecological zones

Such altitude variations lead to very diverse climatic conditions and varied vegetation ranging from warm broad-leaf forest in the south to cool temperate coniferous forest in the inner Himalayas and alpine shrubs and meadows in the higher Himalayas. The geographical and climatic diversity is best illustrated by the six agro-ecological zones described in Table 1 and shown in Figure 9.

Table 1: Six agro-ecological zones in Bhutan

Agro-ecological zones	Altitude (m)	Area (ha)	Area (%)
Wet subtropical	100-600	214,918	5.6
Humid subtropical	600-1200	392,700	10.3
Dry subtropical	1200-1800	503,465	13.1
Warm temperate	1800-2600	714,554	18.6
Cool temperate	2600-3600	917,155	23.9
Alpine	3600-7500	1,096,618	28.6
Total		3,839,409	100.0

Source: Bhutan RNR statistics 2015

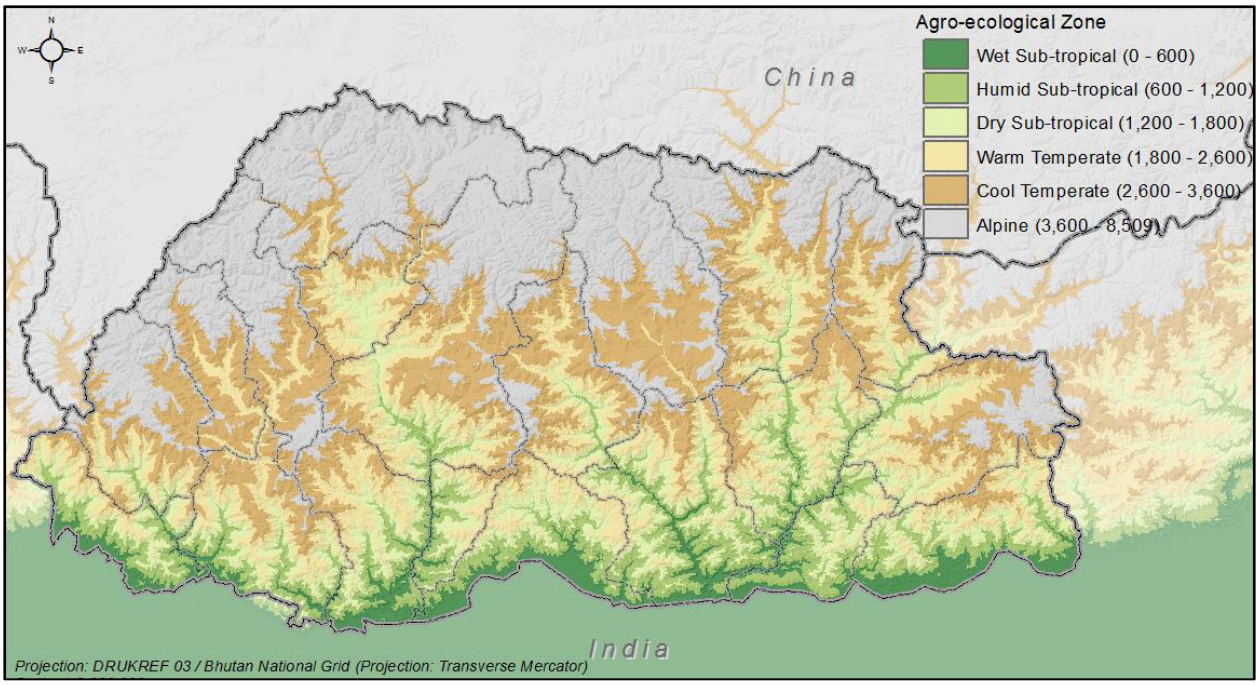


Figure 9: Map of agro-ecological zones in Bhutan

2.3 Society and culture

Bhutan is a place of social and cultural diversity with local dialects, social norms, local beliefs, and livelihood practices varying across the country. This may be attributed to the high mountains, deep gorges, and fast flowing rivers that have isolated communities. The limited communication and interaction with other communities have led to an evolution of livelihood practices, dialects, religious beliefs, traditions and culture that are unique to the ecological zones. The higher Himalayas are inhabited by nomads who are dependent on livestock and dairy products. Those living along the mountain slopes practice dryland agriculture depending primarily on wheat, barley, maize and horticulture. Some communities practice terraced rain-fed as well as irrigated paddy cultivation. The fertile valleys of the inner Himalayas and southern foothills are inhabited by communities that are dependent on paddy and horticultural production. Such livelihood practices are still prevalent in the rural communities that make up an estimated 69% of the country's population.[13] Day to day livelihood practices still revolve around subsistence farming and dependence on local natural resources and environmental services, especially water supply and forest products.

The majority of the population practice Buddhism followed by a smaller section of Hindus and Christians. Buddhist reverence for living beings and beliefs in local deities contribute immensely to preservation and protection of nature and natural resources. Both urban and rural communities maintain strong links with ancestral traditions, culture, and religious beliefs that promote respect for nature. Today, Bhutan strongly pursues the preservation of these cultural heritages – in which water plays a major role.

Bhutan is a welfare state with free education, health services and agricultural subsidies. The population is expected to grow from 745,000 to some 886,500 by 2030.[14] Although the average registered household size is about 4.6, most of the family members explore livelihood opportunities in urban areas. About 30% of the population resides in urban areas and this is expected to reach 50% by 2020. Some 13% of the population lives

[13] According to National Statistical Bureau, Bhutan's population was 745,153 in 2014.
[14] Statistical yearbook of Bhutan, 2014

in Thimphu alone. Given the difficulties of farming on the mountain slopes, more of the educated younger generation migrate to urban areas in search of employment, leaving behind the older members of the family. Migration from rural areas has resulted in a decline in the agriculture work force and has translated into rapid urbanization, unemployment and associated social issues. Half of the population is under 22 years old. The Child (under 5-years old) Mortality Rate is 6.16%.

2.4 Economy

The GDP per capita in 2013 was Nu 142,983.67 (US$ 2,300).[15] The average economic growth over the last five years (2009-2013) was 6.7%, but slowed down to 2.07% in the last year, mainly due to negative growth in manufacturing, services and construction. Conversely the positive growth in hotels and restaurants, electricity and water supply, trade, and business services accounted for the net growth of the GDP. (In dollars the GDP declined by 2.31% to $ 1,781.5 million, or US$ 2,440 per capita.) The World Bank has classified Bhutan as a lower middle-income country. Bhutan's economy is based primarily on agriculture and forestry, providing livelihoods for about 69% of its population. Agriculture mainly consists of subsistence farming and animal husbandry. The share in GDP for key sub-sectors related to water is given in Table 2.

Table 2: Share of sub-sectors in GDP

Sub-sector	% share in GDP
Agriculture	9.18
Livestock	4.11
Forestry (and logging)	2.89
Water supply	0.03
Electricity	14.15
Manufacturing	8.51

Source: National Accounts Statistics

The country has embarked on increasing investments in hydropower development for export to India. With over 2000 MW of hydropower generation capacity and another few thousand megawatts of hydropower under construction, the country's economy is commonly regarded as hydropower driven. High-value low-impact tourism is also a major source of foreign currency earnings. Industries are mainly small-scale cottage based, but there are breweries, mines, and a chip board industry.

Through the bilateral India-Bhutan hydropower cooperation agreement, most of the hydropower investments come from India and is made available in the mixed grant-loan mode.[16] Bhutan's foreign debt with India for hydropower has surpassed the value of its GDP. Hydropower-driven economic development, urbanization, and a lack of investment in agriculture have made Bhutan dependent on cereal imports. Improving food self-sufficiency through agricultural development and irrigation is a key water-related objective of the Royal Government of Bhutan (RGOB).

2.5 Governance system

The Governance system in Bhutan is a Democratic Constitutional Monarchy as enshrined under Article 1(2) of the Constitution of the country. His Majesty the Druk Gyalpo is the Head of the State. The executive power is

[15] National Accounts Statistics of 2014

[16] Under the India Bhutan Hydropower cooperation arrangements, the grant loan proportion was 40% grant and 30% loan with a 10% annual interest rate. The grant proportion has been revised to 30% grant and 70% loan at a 10% annual interest rate.

vested in the Lhengye Zhungtshog which consists of ministers headed by the Prime Minister. The legislative power is vested in the parliament which consists of the Druk Gyalpo, the National Council (upper house) and the National Assembly (lower house).

The Royal Government of Bhutan has 10 ministries which work to bring the goal of Gross National Happiness closer to reality. The ten Ministries are:

- Ministry of Agriculture and Forest (MOAF)
- Ministry of Economic Affairs (MOEA)
- Ministry of Education (MOE)
- Ministry of Finance (MOF)
- Ministry of Foreign Affairs (MOFA)
- Ministry of Health (MOH)
- Ministry of Home and Cultural Affairs (MOHCA)
- Ministry of Information and Communication (MOIC)
- Ministry of Labour and Human Resources (MOLHR)
- Ministry of Works and Human Settlements (MOWHS)

Under the Cabinet there is –among others- the Gross National Happiness Commission (GNHC) for planning, and the National Environment Commission as a regulatory body. Both have their own Secretariat. The ministries have representation in the dzongkhags.

Bhutan is divided in 20 Dzongkhags (districts): Bumthang, Chukha, Dagana, Gasa, Ha, Lhuentse, Monggar, Paro, Pema Gatshel, Punakha, Samdrup Jongkhar, Samtse, Sarpang, Thimphu, Trashigang, Trashiyangtse, Trongsa, Tsirang, Wangdue Phodrang, and Zhemgang. The Dzongkhags are sub-divided into Gewogs, the smallest administrative unit, of which there are 205 in total.

A brief description of the role of functionaries of local government is given in table 3 below.

Table 3: Roles of local government functionaries

Name	Description	Executive Arm
Dzongkhag Tshogdu	This serves as the District Assembly and comprises the Gup and Mangmi as the two elected representatives from each Gewog; one elected representative to represent the Dzongkhag Thromde, and another elected representative to represent the other smaller towns. The Chairman of the Dzongkhag Tshogdu is elected from among the elected Gups.	**Dzongkhag Administration**
		Dzongkhag Administration: Dzongkhag Administration is headed by the Dzongdag (district governor). Dzongkhag Administrations are staffed by civil servants working under different development sectors.
		Dungkhag Administration: Sub-district administration extending to a group of Gewogs in selected districts with large numbers of far flung Gewogs. Dungkhag is headed by Dungpa and staffed by civil servants.
Dzongkhag Thromde Tshogde	Dzongkhag Thromde Tshogde is primarily a committee charged with the responsibility of deliberating on issues pertaining to planning and budgeting for the district capital towns that do not have adequate capacity to function independently.	**Municipality office under District Administration**
		Municipality staff are civil servants under the district administration.
Gewog Tshogde	Gewog Tshogde is Gewog Development Committee comprised of elected Gup as Chairman and members comprising Mangmi and Tshogpa (representatives) elected by basic electoral constituencies called Chiwogs i.e., a cluster of villages.	**Gewog Administration**
		Gewog Administration is headed by the elected Gup. The Gewog Administration is staffed by Gewog Administrative Officer.
Gyelyong Thromde Tshogdu	Gyelyong Thromde Tshogdu is the Executive Council for larger urban areas (categorized as Class A Thromde) within a district. It is comprised of elected members of the constituencies and an overall elected Mayor cum Chairman known as Thrompon.	**Thromde Office**
		Thromde Office commonly termed as 'City Corporation' headed by the elected Mayor and supported by an Executive Secretary with full-fledged independent administrative and program operations. The Thromde Administration is staffed by civil servants and contract employees.

2.6 Hydrological characteristics

Main and minor rivers[17]

Bhutan has an extensive river system that is generally distinguished by main rivers flowing north to south, with tributaries flowing in an east-westerly direction. The main rivers are Amochhu, Wangchhu, Punatsangchhu and Manas. The latter covers about half the country and is made-up of Mangdechhu and Drangmechhu. These two large rivers converge into one river just before crossing the Indian border. For purposes of management, Mangdechhu and Drangmechhu shall be considered as two separate basins; see Figure 10.

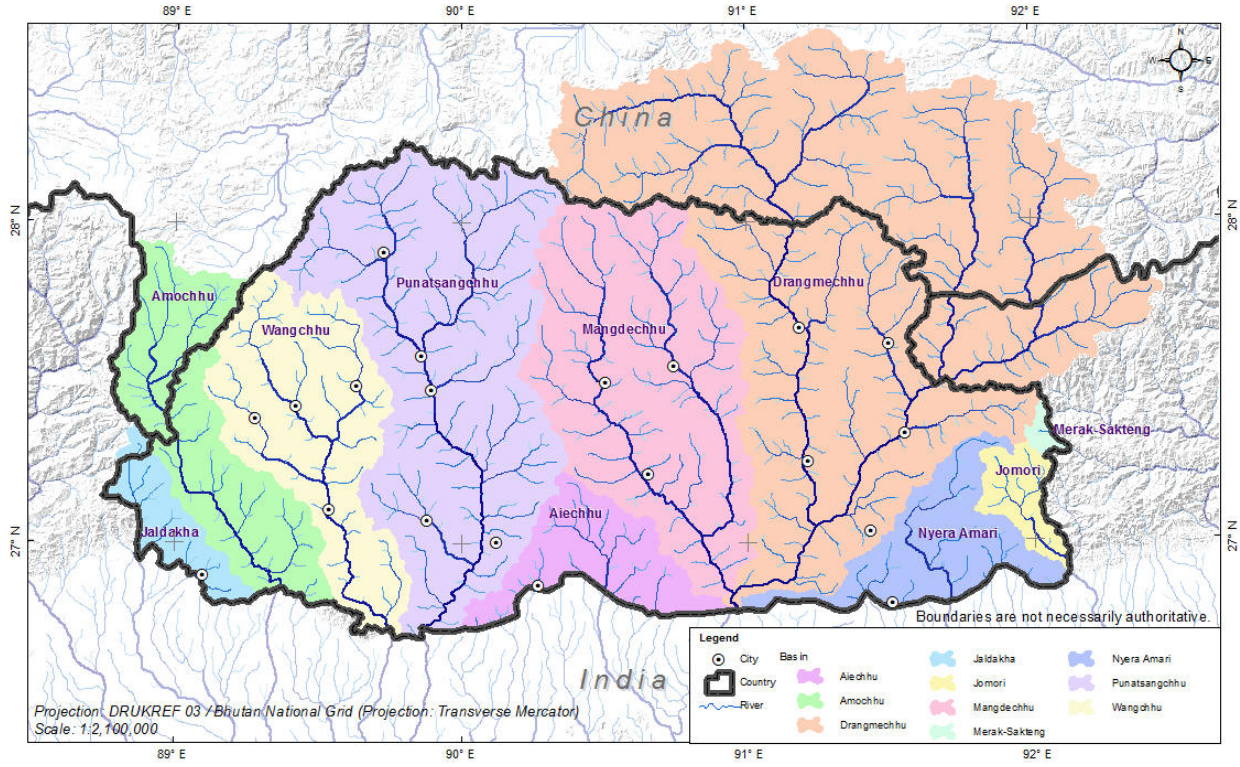


Figure 10: Hydrological basins in Bhutan

As can be seen, Amochhu and Drangmechhu originate in China. There are smaller rivers, namely Jaldakha, Aiechhu, Nyere-Amari, Jomori/Dhansari, and Merak-Sakteng.

The boundaries of the hydrological basins and district administrative units are shown in Figure 11. The map shows that one district can be located in two hydrological basins. For example, Chukha and Haa districts are located in Amochhu as well as Wangchhu basins. Trashigang district is located in Drangmechhu and Nyere-Amari basins.

Most of the river discharge is fed by rainfall, supplemented by an estimated 2-12% glacial melt and another 2% from snow melt.[18] The combined outflow of the rivers is estimated at 70,576 million m^3, or 2,238 m^3/s. This

[17] For additional information and maps on Bhutan's hydrological characteristics, refer to the standalone supporting document entitled: *National Atlas of River Basins and Water Infrastructure in Bhutan*.

[18] Ministry of Water Resources, Government of India, Brahmaputra Basin, 2014. http://www.indiawris.nrsc.gov.in/Publications/BasinReports/Brahamaputra%20Basin.pdf

corresponds to a flow of 109,000 m^3 per capita per year, the highest in the region. Table 4 presents an overview of the outflow of the main rivers.

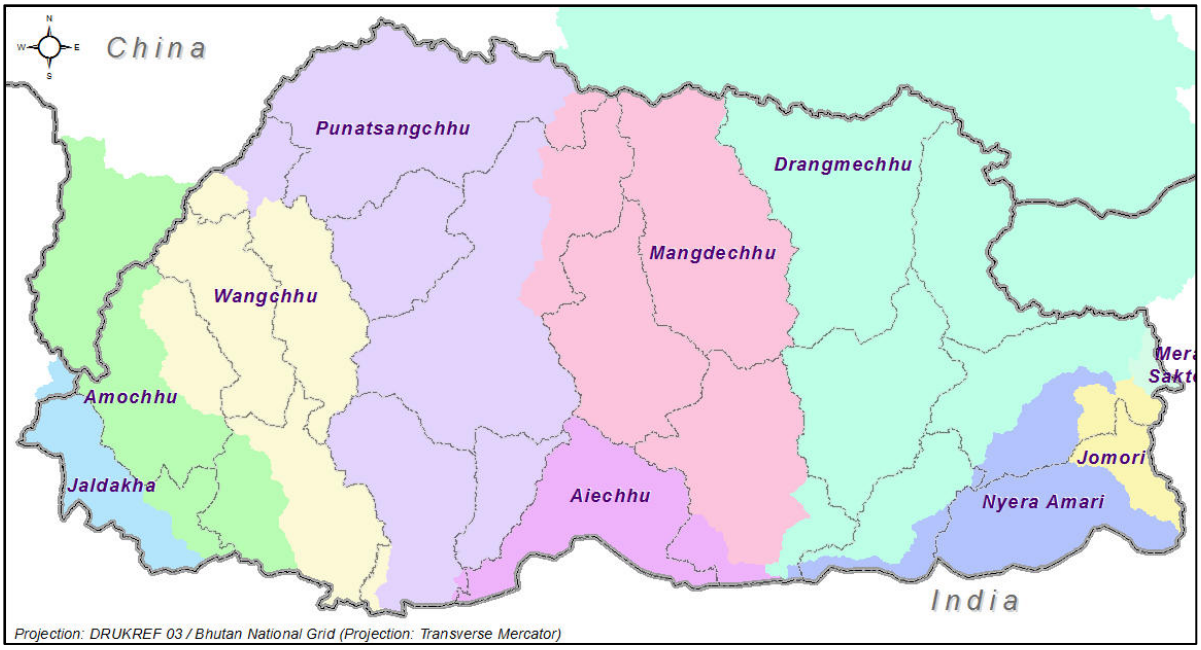


Figure 11: Boundaries of hydrological basins and Dzongkhags

Table 4: Average net monthly outflow (MCM and %) per basin

Basin	Aiechhu	Amochhu	Drangme chhu	Mangde chhu	Nyera Amari	Punatsang chhu	Wang chhu	National
Jan	99	137	189	188	64	268	82	1,028
Feb	184	211	230	213	114	283	102	1,336
Mar	51	151	425	329	31	381	144	1,512
Apr	92	202	1,011	723	58	762	265	3,115
May	243	375	1,160	1,008	159	1,373	397	4,713
Jun	1,040	1,500	1,904	1,453	690	2,703	713	10,002
Jul	1,864	2,410	2,893	2,556	1,196	4,332	1,132	16,382
Aug	1,415	1,785	2,355	2,247	897	3,746	965	13,410
Sep	1,172	1,513	1,841	1,555	763	2,826	723	10,392
Oct	520	701	1,080	1,087	337	1,601	441	5,769
Nov	191	240	299	275	124	521	143	1,792
Dec	119	149	180	164	75	336	103	1,126
Total MCM	6,989	9,375	13,569	11,797	4,507	19,130	5,209	70,576
Total in %	9.9%	13.3%	19.2%	16.7%	6.4%	27.1%	7.4%	100.0%

The national water balance is composed of the water balances per basin. Water balances have been assessed for the month of May when irrigation demand is high for paddy transplantation and the monsoon rainfall is just starting up. 80% dependable flow (occurring at least in 4 out of 5 years) and consumptive demand in the month of May have been assessed. The results are given in Table 5 where it can be seen that the additional total water

demand in 2030 takes only a few percent of the 80% dependable amount of water available, with Amochhu and Punatsangchhu the highest at 3.7% during the month of May. The 80% dependable flow is the quantity which is available 80% of the time, or during 4 out of every 5 years, on average.

Table 5: 80% Dependable water balances for the month of May 2030 [19]

	Aiechhu	Amochhu	Drangmechhu	Mangdechhu	Nyere-Amari	Punatsangchhu	Wangchhu	National
Runoff (MCM)	194.1	250.0	653.0	404.8	126.9	493.1	246.0	2,367.9
Add'l Demand (MCM)	0.3	9.3	10.0	4.9	1.8	18.4	4.9	49.7
Balance (MCM)	193.8	240.7	642.0	399.9	125.1	474.7	241.1	2,318.2
Add'l Demand ratio (%)	1.3	3.7	1.5	1.2	1.4	3.7	2.0	2.1

Falkenmark water availability indicator

The Falkenmark Water Stress Indicator, which was developed by the Swedish water expert Falkenmark in 1989, is one of the most commonly used indicators for renewable water resource availability.

Water availability of 1,700m³/capita/year is defined as the threshold above which water shortage occurs only irregularly or locally. Below this level, water scarcity occurs with different levels of severity. Below 1,000m³/capita/year water scarcity is a limitation to economic development and human well-being, and below 500m³/capita/year water availability becomes a major constraint.

Note, however, that only the renewable water resources within the country are considered in this indicator, i.e., there is no account of water flows or transfers from outside the country. Moreover, the water availability per person is calculated as an annual average and thus neglects water shortages in dry seasons or in certain regions within a country. Nonetheless, it is a useful overall indicator for comparing water resource endowments across countries. The map in Figure 12 shows a comparison of Falkenmark indicator values for areas covering Bhutan and its neighbouring countries.[20]

[19] Relevant hydrological information has been put together in a database and GIS called *Bhutan Water Security Information System*. It is accessible online through the portal of NEC, and contains the following menu options: (i) Bhutan Water Security Index; (ii) Web-GIS; (iii) Water balances; and (iv) Thematic maps.

[20] Abracosa, R. Regional Economics of Climate Change in South Asia Part II - Adaptation and Impact Assessment, Sectoral Assessment Report on Water Resources. Asian Development Bank R-PATA 7423, 2012 (unpublished).

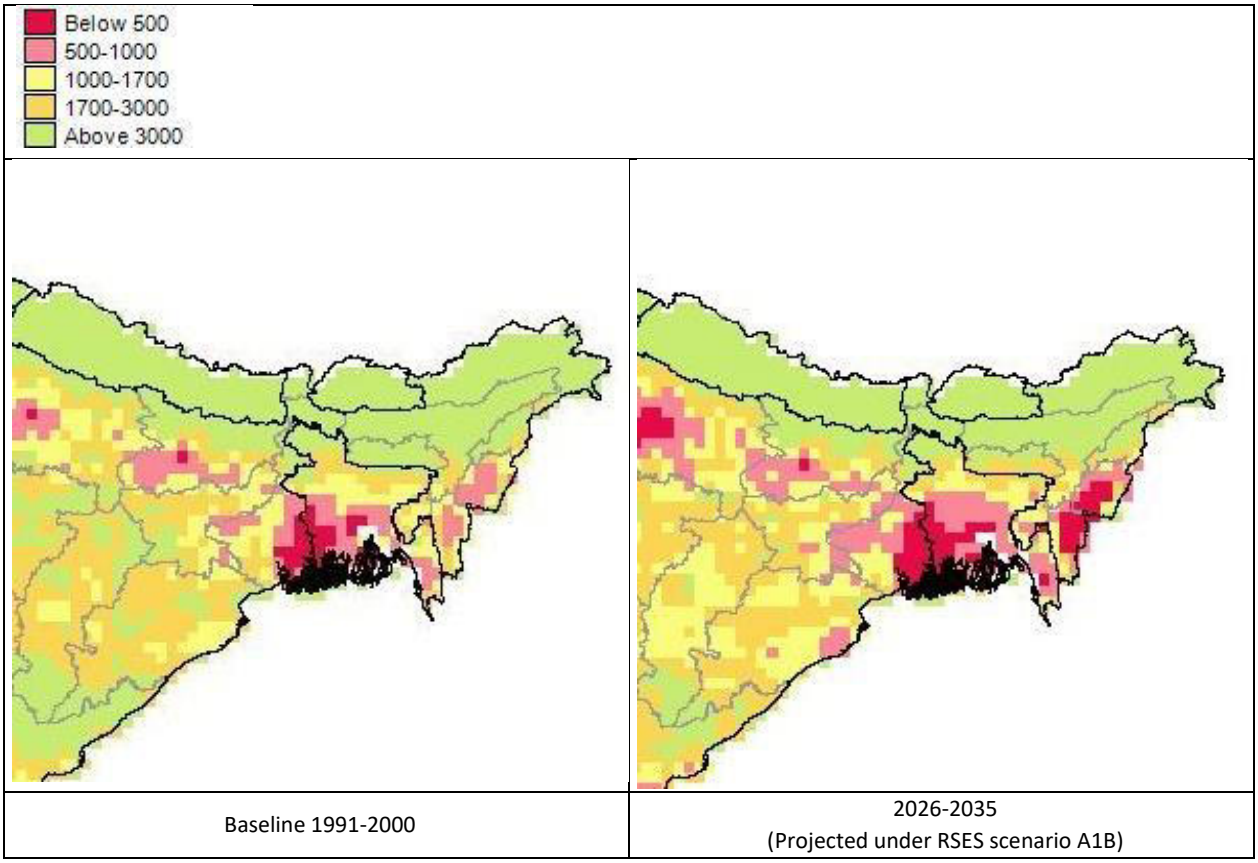


Figure 12: Falkenmark index of water availability (renewable water resource in cubic meters per capita)

Glaciers, snow and ice

According to Landsat satellite image analysis, Bhutan had 885 Clean Glaciers, and 50 Debris Covered Glaciers covering an area of 642 and 16.1 km^2 respectively.[21] This is about 1.6% of Bhutan's total land area as shown in Figure 13. It has also been determined that the glaciers range from 4,050 to 7,230 m.a.s.l with an area of 362 km^2 in the Punatsangchhu basin (466 glaciers); 33 km^2 in the Wangchhu basin (58 glaciers); 180 km^2 in Mangdechhu basin (287 glaciers); and 781 km^2 in Drangmechhu basin (124 glaciers). The largest glacier in Bhutan with an area of 36 km^2 is in the Punatsangchhu basin.

Glaciers are good indicators of climate change as they react to temperature and precipitation changes and provide direct visual evidence. Glaciers change in terms of their thickness, area and tail end - features which are directly proportional to the change in atmosphere around them. Melting glaciers are also important sources of freshwater.

Glacial lakes

When glaciers melt they form water bodies which later become glacial lakes. Glacial lakes can pose a serious threat to downstream communities as they have the potential to burst and create massive flooding. See Section 3.9.

[21] Bajracharya et al. 2014. The status and decadal change of glaciers in Bhutan from the 1980s to 2010 based on satellite data. Samjwal Ratna Bajracharya, Sudan Bikash Maharjan, and Finu Shrestha. Annals of Glaciology 55(66) 2014 doi: 10.3189/2014AoG66A125.

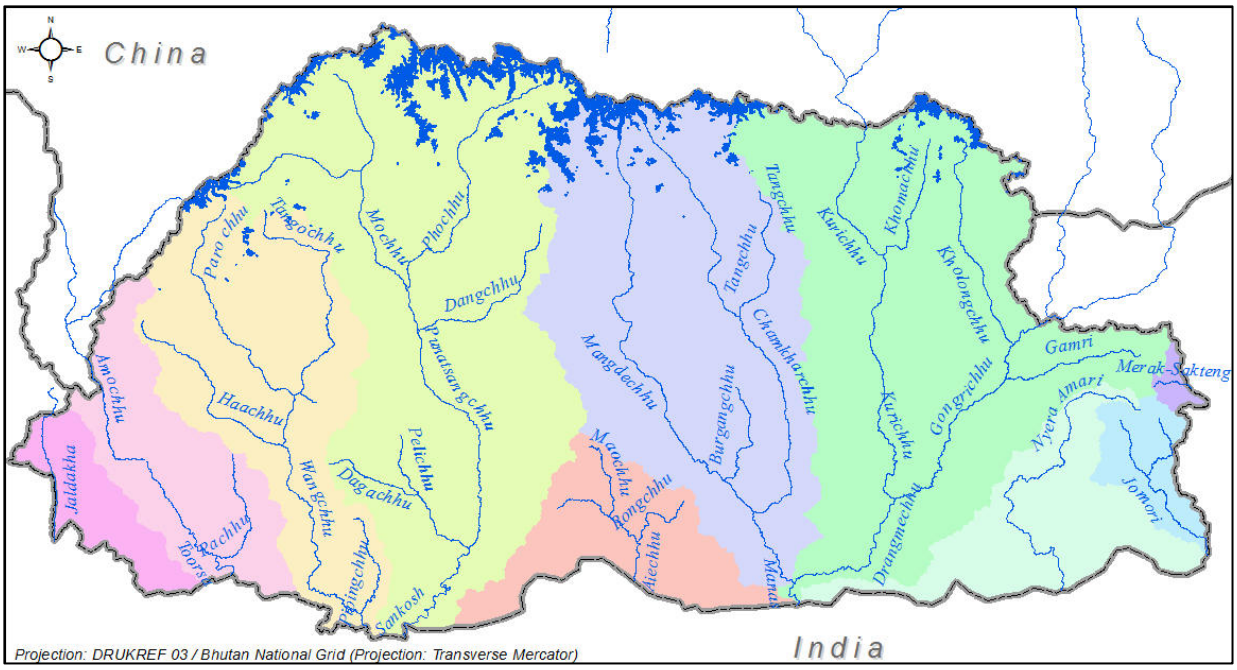


Figure 13: Map showing glaciers in Bhutan

Wetlands

Wetlands are ecologically critical water resources. Besides the glaciers and glacial lakes mentioned above, they consist of lakes, high-altitude peat lands, marshes, peat bogs, fens, mid-altitude lakes, springs, streams and rivers. A study in 2010 prepared an inventory of wetlands as given in Table 6.[22]

Table 6: Inventory of wetlands

Wetland type	Number	Total area m²	Average area m²	Largest area m²	Smallest area m²
Supra snow lake	110	52,327	475	4,759	36
Supraglacial lake	495	28,554,801	57,686	1,517,436	134
Glacial lake	637	23,230,604	36,468	878,311	115
Lake	1722	49,973,272	29,020	868,049	35
Marsh	63	497,334	7,894	63,811	126

Source: Ugyen Wangchuk Institute for Conservation and Environment, and WWF (2010)

In the absence of a detailed wetlands inventory, information on wetlands in Bhutan is scanty and incomplete.

Apart from being an important freshwater resource - for domestic use, agriculture and sustainable economic development - wetlands are recognized to provide fundamental ecosystem services. Functional wetlands support a high level of biological productivity and diversity, provide habitats for flora and fauna, including rare and threatened communities and species, maintain local and regional hydrological regimes, remove pollutants, act as storage for rain/flood water and support human activities and values. Wetlands are also integral transitional ecosystems that are vital for the sustainable functioning and maintenance of the broader ecosystem health of the entire watershed.

Bhutan's water resources are under mounting pressure from ever-increasing demand accelerated by a growing population and economy. Striking a balance between development and conservation has always been the cornerstone of Bhutan's gradual and steady growth into the 21st century. Though Bhutan is well recognized for

[22] Sherub et al. (2010). *Inventory of High Altitute Wetlands in Bhutan.* Thimphu: Sherub., Norbu, N., Wangdi, N. and Lhendup, P. Ugyen Wangchuk Institute for Conservation and Environment and WWF Bhutan.

its conservation policies and its strong commitment to the promotion of Gross National Happiness, there are mounting challenges evolving with development. In the past, strong cultural and traditional ethos among the Bhutanese and the lack of modern development technology (such as for drainage and dredging) inadvertently protected the water resources.

However, in modern day Bhutan the challenges have evolved. For example, significant wetlands (large wetland areas of more than 50 ha) in and around growing towns and cities are being lost or increasingly fragmented. This has led to complaints about the available quality and quantity of drinking water.

Recognizing the importance of wetlands, Bhutan has joined the Ramsar Convention as its 161st Contracting Party in 2012. Since then, Bhutan has designated three Ramsar sites - Bumdeling in Eastern Bhutan, Khotakha and Phobji-Gangtey in central Bhutan. The Department of Forests and Park Services collaborates closely with the Convention in promoting the wise use of these wetlands.

Reservoirs

There are a number of reservoirs that have been constructed on the main rivers or their main tributaries; these were built for the purpose of flood attenuation to prevent damage to hydropower infrastructure. Most of the hydropower plants are run-of-the-river type. The live storage of these barrage-type reservoirs is modest, mostly to buffer diurnal flow variation and to trap sediments. There are existing plans to build reservoir-type hydropower stations in Amochhu, Bunakha and Sankosh. These reservoirs will be large in order to equalize the seasonal variations of the river discharge.

Groundwater

Very little is known about groundwater in Bhutan. Given the steep terrain and deeply incised valleys, it is generally believed that there is no real groundwater aquifer to mention, although subsurface flow through fluvial deposits is believed to occur. The somewhat wider and flatter valleys of, for example, Paro, Punakha, Thimphu and particularly Samtse, Phuentsholing, Sarpang and Samdrup Jongkhar bordering the plains in India may well have groundwater reserves that could be exploited. Indeed, groundwater is being tapped in these areas on an individual basis but the government is generally reluctant to develop groundwater as a resource as long as the sustainability of its use has not been assessed.

3 Water-related issues

This chapter gives an overview of water-related issues identified through surveys of water issues at Gewog levels and technical assessments of climate and water resources. Details are provided in the standalone documents supporting the plan, while the results and main conclusions are briefly presented in the following sections.

3.1 Multi-sectoral coordination

Many different agencies are involved in or concerned with the management of water resources. So far, the approach to management has largely been sector-based, but efforts for better coordination have been made. The Water Policy (2003), Water Act (2011) and Regulations (2014) paved the way for adopting IWRM. The Water Act of 2011 is explicit in empowering the NEC as the apex body for all matters related to the water resources of Bhutan. Hence, it has the responsibility of coordinating the efforts of competent authorities and line agencies in managing the water resources of the country.

The current level of coordination is not adequate to fulfil the requirements of the Water Act and its regulations. Water-related agencies pursue their own agendas and priorities for the use and management of water. Defined mechanisms need to be put in place to coordinate and enhance cooperation among water-related agencies/authorities and other environmental organizations. Efforts have been made by the government to foster coordination through the establishment of a water board comprised of director-level officials from various agencies. However, the board does not meet regularly and it is not clear how it fits within the overall coordination role and mandated functions of the NECS.

The NECS is in the process of strengthening its role of coordinating water resource management as per the provisions of the Water Policy, Water Act and Regulations. The Water Resources Coordination Division (WRCD) is the entity within the NECS that is responsible for implementing the Water Act. The NIWRMP addresses this NEC priority to strengthen the overall institutional arrangement and capacity building of players in the water sector to plan, implement and monitor water management in a coordinated matter. Chapter 7 is dedicated to this priority.

3.2 Spatial and seasonal water availability

Bhutan has high per capita availability of water when assessed at the level of basins and districts. However, most of the abundantly available water resources vary immensely over time.

The climate of Bhutan is distinctly seasonal, with monsoon rains occurring between April and October. Other months of the year have low or no precipitation. Given the rugged terrain, there is a high proportion of runoff into small streams and rivulets. These discharge into tributaries and rivers that are characterised by steep gradients and narrow stream beds that have very little storage. As a result, surface water is quickly evacuated from the river basins. Whatever water is available during the lean winter season is the result of subsurface base flow – and this is marginal. Furthermore, access to water stored in mountain lakes is very difficult.

Bhutan's high per capita water availability thus must be considered in the light of there being much water at the wrong time and the wrong place. The ensuing shortages can be mitigated by retaining water through watershed conservation measures and maintaining forest and/or ground cover to intercept rainfall, hold the water and promote infiltration. Erosion gullies which make the water run faster down the slopes should be controlled.

3.3 Limited managed water storage

Water shortage is particularly predominant in the winter season and in higher elevations. This may be attributed to a lack of intervention to harness the abundant water from monsoon rains. Managing the excess of water during the monsoon to provide supply during the lean season must be explored. Apart from watershed conservation, water outflow can also be slowed-down artificially in the form of storage structures. Higher on the hillsides, many small rainwater harvesting structures can store small amounts of water for domestic use. Lower down the hillsides, check dams may be somewhat larger and store water for domestic and irrigation uses, and perhaps for micro-hydropower generation. Large reservoirs could be built in the tributaries and/or main rivers, but in these locations water is not scarce. Such reservoirs could level-out the strongly seasonal flow fluctuations for the generation of hydropower, but would contribute little for domestic use and agriculture.[23] Currently, there are no retention structures that can be managed to store water for provision during times of need.

Various sites were identified for small hydropower stations in 2003.[24] More recently, other sites have also been identified for micro-hydropower stations.[25] Potential sites for multi-purpose reservoirs need to be explored to provide water for various purposes such as drinking water supply, irrigation, flood mitigation and hydropower generation.

Preliminary studies done during the preparation of the NIWRMP found four locations that may have potential for building reservoirs. These are in Haa, Burichhu, Yunari, and Nikachhu as shown in Figure 14. Details can be found in the standalone report on Database and GIS.[26]

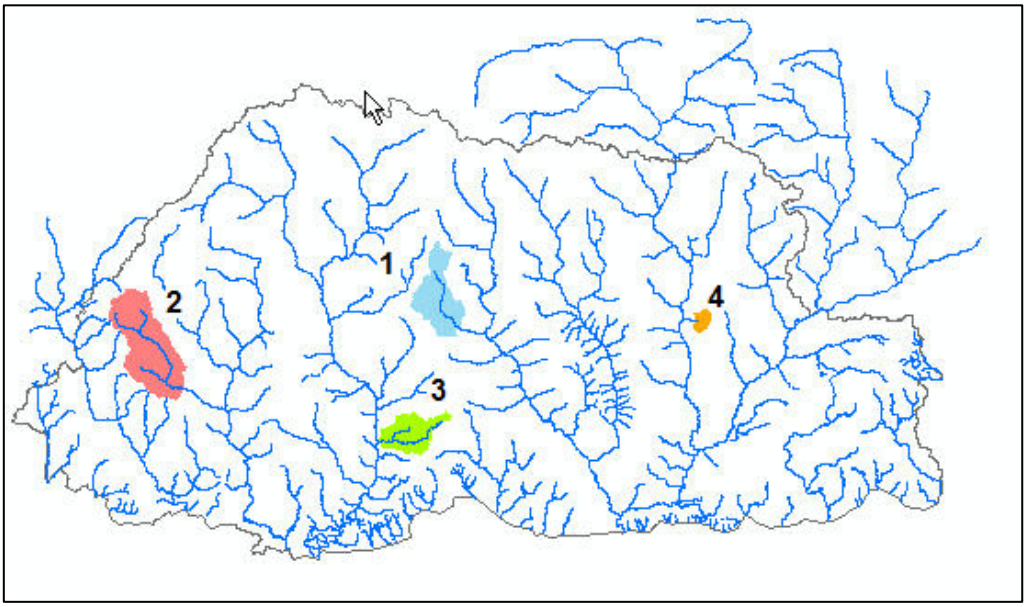


Figure 14: Potential sites for multi-purpose reservoirs

1= Nikachhu; 2= Haachhu; 3= Burichhu; 4= Yunari. The shaded areas represent the respective catchment areas.

[23] Unlike Nepal, Bhutan does not have a Terai – large areas that could be irrigated with river water regulated by reservoirs.
[24] Power Systems Master Plan, MoEA, RGOB, 2003
[25] Data collection survey on renewable energy in the Kingdom of Bhutan, JICA-DRE MoEA, 2013
[26] ADB-CDTA Bhu-8623, 2016

3.4 Potential water shortage

There are many reports of local water shortages, especially during the lean season. These have been investigated in the context of the NIWRMP by means of hydrological modelling. Water availability and demand have been calculated in order to establish monthly water balances at the level of basins, sub-basins and districts.[27] This procedure allowed for an assessment of areas that may have (potential) water scarcity along three criteria:

- Falkenmark index: the amount of water available per capita per day (l/c/day)
- Water balance: the total net amount of water available in million m^3 in a given time period
- The demand ratio: the percentage of water available used for future consumption

The results are summarised in Table 7.

Table 7: Summary of districts with potential water shortage by 2030

Method	Basin	District	JAN	MAY	JUN
Falkenmark	Punatsangchhu	Thimphu	Scarcity	-	-
Water balance	Wangchhu	Haa	Stress	-	-
	Punatsangchhu	Thimphu	Absolute. scarcity	Scarcity	Stress
	Aiechhu	Zhemgang	Scarcity	Stress	-
Demand ratio	Amochhu	Samtse	OK	-	-

Note: *OK means that water availability is currently below the threshold for water stress with possibility of developing water stress in the future.

The following districts are ranked in decreasing order of potential water scarcity: Thimphu-Lingshi, Zhemgang, Haa, and Samtse.

This assessment is based on 80% dependable water generated within the districts.[28] If inflow from upstream areas is taken into account, all districts have ample water supply when considering the additional water demand for domestic, irrigation and industrial use until the year 2030.

3.5 Water availability versus accessibility

Bhutan's water balance does not show any water scarcity at the national, basin, or district level when considering time periods of one month. But this does not exclude the possibility that *within* the districts there can still be areas with temporary water shortages. The primarily rugged terrain and altitudinal variations over small distances make certain places have too much water while adjacent areas experience shortage. Most of the communities that are located along slopes depend on smaller streams, springs and lakes for drinking and irrigation. The abundant water is largely available in the form of major rivers and tributaries flowing in low lying river valleys and deep gorges. For example, some housing blocks in Thimphu city located near the perennial

[27] For details on the hydrological modelling and water balance studies conducted in support of the NIWRMP preparation, refer to the standalone supporting documents entitled: (i) *Hydrological Modelling and Assessment for Bhutan* and (ii) *Water Balance Calculator Users Manual*.

[28] 80% dependable flow is the amount of water available 80% of the time. Example of 80% dependable flow for the month of January is eight out of every ten months of January.

Thimphu river have piped water supply that is only operational for a few hours every other day. This shows that the occupants of the housing block have limited access to water even though the river is flowing right past them.

Likewise, a local water source may temporarily run dry, leaving irrigated fields without a supply of water, even while large volumes of water run down a stream slightly further away. This aspect is depicted in Figure 15.

These examples show three aspects:

- District-level water balances have been assessed but they have little relevance at the household or farm level. Household or farm-level studies are possible. However, these are best undertaken on a case-by-case basis.
- Water may be available but not accessible in the absence of investment in equipment (storage reservoirs, pumps) and operations (diesel or electricity cost of pumping, maintenance). It is not a problem of water *shortage*, but a problem of water *management*. This aspect is compounded by the low-density of the rural population living in highly dispersed settlements on hill slopes.
- Managing water at the local level cannot be done from the centre. This is particularly true in Bhutan because of its large altitudinal variations and difficult terrain.

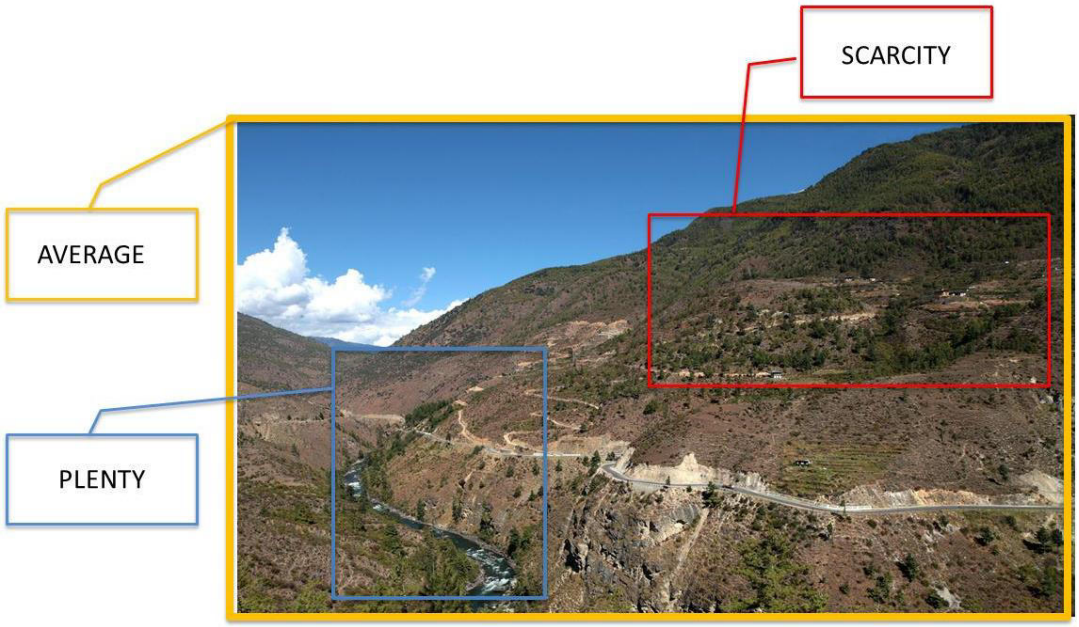


Figure 15: Schematic presentation of water availability

3.6 Demand management

When confronted with (potential) water scarcity, one often looks at supply-side solutions like augmenting the water supply or accessibility in the form of putting up retention reservoirs, tapping new (remote) water sources, or using groundwater.

However, one may also try to contain or reduce the demand for water in order to reduce the water stress. Examples of demand management measures can be grouped in two categories, as given below.

Higher agricultural productivity

- Timely land preparation (power tillers) and transplantation of paddy
- Different crops and varieties (short season, HYV, requiring less water to grow, resistant to pest/ disease)
- System of Rice Intensification
- Drainage of excess (rain) water
- Reduce pre/post-harvest losses
- Integrated Pest Management

Higher water use efficiency

- Use of mulch or plastic sheets to reduce evaporation
- Better irrigation scheduling to prevent over-irrigation
- Better puddling of paddy fields to reduce seepage losses
- Piped/lined supply channels to reduce conveyance losses
- Replace surface (basin or furrow) irrigation with sprinklers or drip systems
- Trashing/mixing plant residues in soil to improve water-holding capacity
- Water pricing

3.7 Water as a common pool resource

Water is used by everybody to meet personal needs, but it is also used in many ways for economic purposes, such as irrigation, hydropower generation, commercial car wash, chip-board industry, water bottling, and more. With everybody having access to water, this can lead to competition. As such, water is a common pool resource. Everyone who utilizes a common pool resource is inherently dependent on everyone else who has access to that same resource. Individuals tend to maximize their own returns from using the common resource rather than work towards collectively beneficial outcomes – a situation referred to as the "tragedy of the commons".

Nevertheless, properly designed collective action systems have successfully managed common pool resources for hundreds of years. Examples are traditional rainwater harvesting structures in Rajasthan, as well as common grazing areas in dry parts of Africa. In Bhutan, water resources are degrading both in quality and quantity from use and discharge of effluents into water bodies. With water as state property, institutional mechanisms to monitor compliance and impose sanctions remain ineffective. The capacity of NECS and line agencies need to be strengthened to establish and update water quality standards and to regularly monitor compliance. At the local level in Bhutan, Water Users Associations can play an important role in managing water resources as a common pool resource.

3.8 Vulnerability to floods

Climate change projections reveal increased intensity of monsoon rainfall. Areas prone to monsoon floods have been investigated in the context of the NIWRMP. The results are shown in Figure 16.[29] The red areas are prone to flooding, and the figure gives the surface area in hectares. It should be noted that the method of investigation

[29] The justification can be found in the standalone supporting document entitled: *Hydrological modelling and water resources assessment*.

(using GIS) is less suitable in flatter areas (like in the southern belt of the country) where flood-prone areas may have been under-estimated.

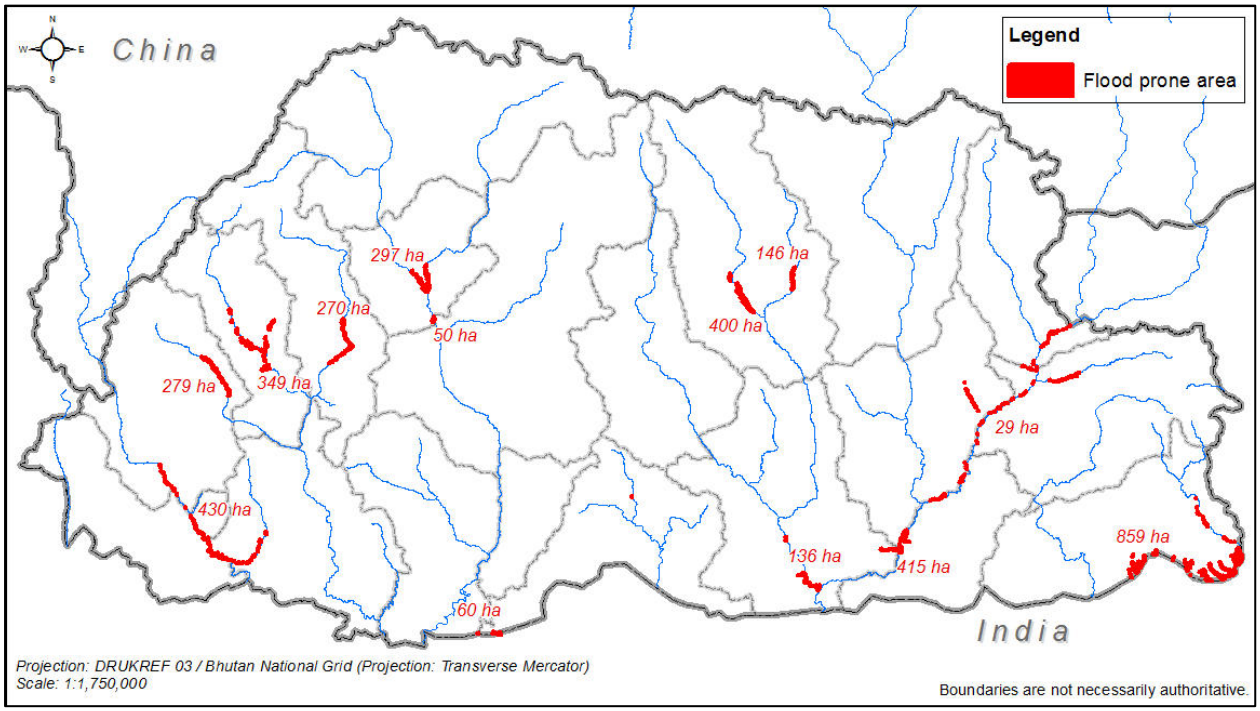


Figure 16: Map of areas prone to monsoon flooding

If in the future storage dams are constructed in Bhutan to even out variability in river flows (which climate change is projected to worsen), they need to be accompanied by measures to minimize not only their environmental impacts but also the safety-related risks of downstream flooding. Hydropower dam operators naturally aim to maximize power generation by keeping reservoirs full. However, if a storm is approaching, the reservoirs have to be emptied rapidly to make room for incoming floodwater. If such sudden releases of stored water are uncoordinated and wrongly timed, they could worsen flooding downstream. Flood level monitoring and public warning systems, including the provision of an adequate number of river gauging stations are, therefore, vital components of flood management.

Preventive measures to reduce vulnerability to floods include controlling built up areas along river courses, ensuring adequate space for rivers to move naturally, and implementing river training works in priority areas.

3.9 Glacial Lake Outburst Floods

Glacier Lake Outburst Floods (GLOFs) occur when the moraine dams at the outlet of a glacier lake suddenly give way to the hydrostatic pressure created by the high water level in the lake itself, or due to melting of the frozen compacted moraine dams. Of the 2,674 glacial lakes, some 24 lakes have been identified as posing a GLOF threat.[30] These are shown in Figure 17.

[30] Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods, Monitoring and Early Warning Systems in the HKH Region (Bhutan). Pradeep K. Moool, Dorji Wangda, Samjwal R. Bajracharya, Karma Kunzang, Deo R.Gurung and Sharad P. Joshi. ICIMOD, Kathmandu, Aug 2001.

Glacial lakes are classified according to their outburst risk. A zonation is done in downstream areas, distinguishing zones of high or low risk of flood damage in case of an outburst. Human settlements and economic development should be located in areas safe from GLOF risks.

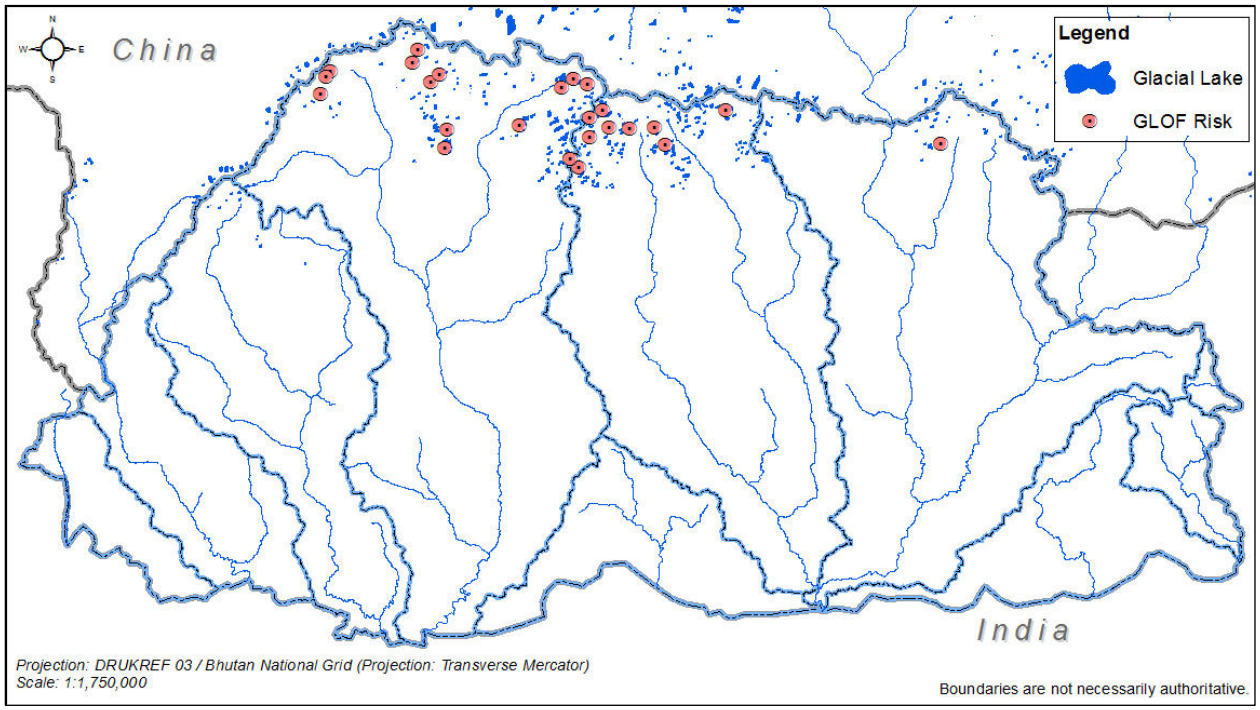


Figure 17: Map showing glacial lakes at risk of an outburst (Mool et al., 2001)

3.10 Unreliable or insufficient water supply and sanitation

The most important use of water resources is for human drinking, and it has been given the highest priority in the Water Act. Potable water is usually tapped from wells, springs and small rivulets on the hill slopes upstream of dwelling areas. These sources are not always reliable, and therefore alternative sources are often being sought at relatively great expense. Drinking water for larger cities is mainly abstracted from perennial streams where the supply is more secure throughout the year.

Bhutan has made considerable progress in terms of coverage for both rural and urban water supply and sanitation in the last two to three decades. Improving public health by reducing the incidence of water-related illnesses through the provision of safe drinking water and improved sanitation facilities is actively being pursued. According to a UN/WHO country report for 2014, the water supply infrastructure both in rural and urban areas needs to be upgraded. Data from this report indicate that more than 50% of the urban population has intermittent water supply. In rural areas only about 69% of rural water supply schemes are reportedly functional. Delivery of water supply services in rural areas is based on source protection specified in water safety plans, but there are no treatment systems in place.[31]

[31] UN Water and World Health Organization. Bhutan Sanitation, Drinking Water and Hygiene Status Overview. Global Analysis and Assessment of Sanitation and Drinking Water. 2014 Update.

Rural sanitation facilities consist predominantly of pit toilets, followed by pour flush toilets and others. Except in core areas of major cities, septic tanks are the most common sewage treatment facility in urban areas. Although construction regulations require septic tanks to be equipped with soak pits, there are many substandard systems leading to the discharge of effluents directly into the environment.

3.11 Unreliable or insufficient irrigation water supply

Agriculture is the biggest consumer of water through irrigation. Most fields are fragmented and scattered on the hillsides, where water is tapped from springs and rivulets. Local and/or temporary shortages of irrigation water occur frequently. Tapping alternative sources is generally expensive because of the topography. There are some larger irrigation schemes in the southern foothills. The National Irrigation Master Plan has been elaborated in order to increase food production and self-sufficiency.[32] The impact of increased irrigation water demand is addressed in section 3.13.

3.12 Hydropower generation

Hydropower development plans

As far as hydropower is concerned, Bhutan has so far developed only about 1,500 MW out of the economically feasible 24,000 MW of hydropower. The 10th and 11th FYP expressed the intention of developing over 10,000 MW hydropower potential as given in Table 8 and Figure 18.

Table 8: Hydropower projects scheduled for construction in the 10th and 11th FYP periods

Nr.	Project name	Capacity (MW)	Construction period
1	Punatshangchhu-I	1,200	2008-2019
2	Punatshangchhu-II	1,020	2011-2018
3	Mangdechhu	720	2011-2018
4	Kholongchhu	600	2015-2022
5	Nikachhu	118	2016-2020
6	Bunakha	180	2017-2022
7	Wangchhu	570	2017-2024
8	Chamkharchhu-I	770	2017-2025
9	Sankosh	2,560	2017-2026
10	Kuri-Gongri	2,640	2018-2027

[32] Refer to standalone supporting document entitled: *National Irrigation Master Plan.*

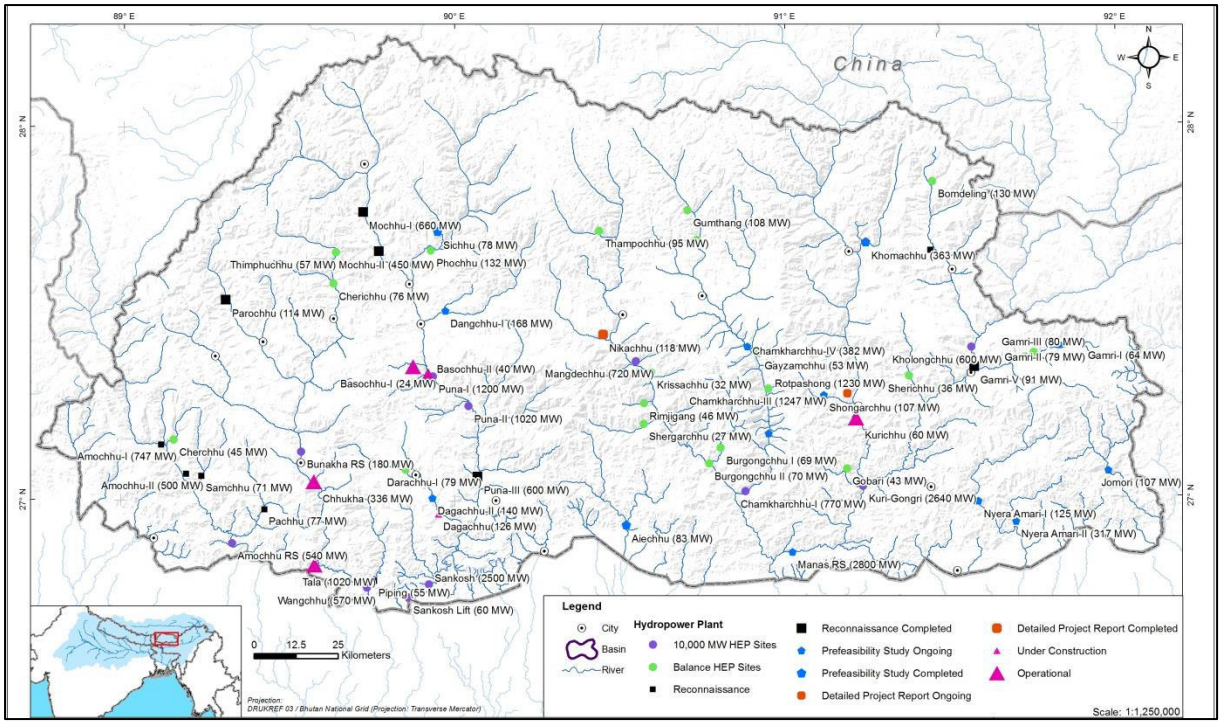


Figure 18: Map showing location of existing and planned hydropower stations

The planned hydropower development is graphically presented in Figure 19.

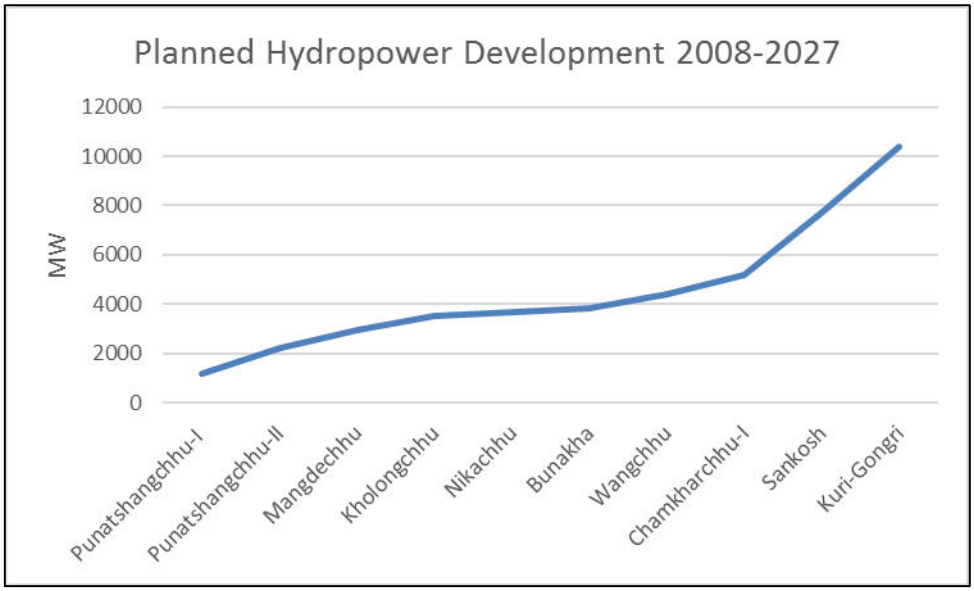


Figure 19: Planned cumulative hydropower development until 2027

Currently, construction of the 1,200 MW Punatsangchhu phase I, the 1,020 MW Punatsangchhu phase II, and the 720 MW Mangdechhu Hydroelectric Projects are on-going. All three projects are scheduled to be completed by 2018-19. The construction of other projects to generate 10,000 MW hydroelectricity by 2027 is planned to

start during the current 11th FYP period. The construction period ranges from 8-9 years. The pipeline projects are listed in Table 9 below. In addition, small hydro-projects shall deliver some 8,000 KW.[33]

Table 9: Pipeline hydropower projects in the 11th FYP

Nr.	Project	Capacity (MW/GWh)
1	Sankosh	2560/ 6216
2	Kuri-Gongri	2640/ 10056
3	Chamkharchhu-1	770/ 3249
4	Bunakha	180/ 1669
5	Wangchhu	570/ 2526
6	Kolongchhu	600/ 2599

The Environmental Impact Assessment (EIA) reports related to planned hydropower plants refer to a bilateral agreement between RGOB and India signed in 2009, whereby India would buy 10,000 MW by the year 2020. Whereas most of the hydropower stations in Bhutan are run-of-the-river types, some of the planned stations are reservoir-types to flatten the hydrograph and make more efficient use of generators. The changes in downstream water flows are not expected to have an impact on drinking water supply or irrigation. However, large dams and reservoirs may cause a loss of agricultural land due to inundation. EIAs treat the loss of arable land as a loss of income for farming families, for which compensation is proposed. Such potential loss of farm land needs to be put in the context of RGOB's policy objective of achieving food self-sufficiency.

Hydropower uses a very large proportion of the fresh water resources of Bhutan, but it is not consumptive use. Hence, the hydropower use of water is not included in the calculation of water balances for the NIWRMP. Management issues relevant to hydropower development are highlighted below.

Environmental and climate change impacts

The impact of hydropower on the environment is addressed in all EIA reports that are prepared before the construction of plants. For the run-of-the-river systems[34] the impacts are local and relate mainly to land acquisition and temporary disturbance caused by construction works. Remedial measures for negative impacts have been proposed, but their implementation is not closely monitored. Moreover, the *cumulative* impacts of hydropower plants are not being studied.

Climate change is predicted in models to cause marked changes in seasonal water availability, which could have adverse consequences on hydropower generation. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicted that negative mass balance in Himalayan mountain regions may eventually lead to the disappearance of glaciers with subsequent large impacts on the seasonality and volume of stream flow. In Bhutan, where snow and ice melt from glaciers is often a significant contributor to dry season flow, there are indications that climate change might have serious effects on the amount of snow and ice available for glacial-fed flows. This in turn could cause reductions in dry season runoff, which could seriously affect hydropower production as plants in Bhutan are typically run-of-river types with little or no storage. Projected increases in monsoon rainfall due to climate change would increase the sediment load and flooding debris in rivers, and these can also affect the operation of hydropower plants.

Environmental flows

The Water Act and Regulation prescribe that environmental flow shall be maintained in the river sections that are by-passed by the head and tail race tunnel of hydropower plants. Such mandated environmental flow shall be 30% of the lean period flow – unless otherwise proposed and approved in the concerned EIA. Indeed, various

[33] 11th FYP, Royal Government of Bhutan

[34] Run-of-the-river system is a type of hydroelectric generation plant whereby little or no water storage is provided. Run-of-the-river power plants may have no water storage at all or only a limited amount of storage.

EIAs apply different methodologies for assessing environmental flows. Enforcement of environmental flows is presently weak in Bhutan. A study looking at environmental flows has started recently.[35]

Competition for land

Hydropower generation is often equated with big dams, inundated areas, and the resettlement of communities. In Bhutan, however, all power plants are run-of-the-river systems (defined earlier). They divert water locally from the river so that no storage reservoir is involved (i.e., only a barrage structure) and, consequently, no land is lost to inundation. Thus, run-of-the-river systems cause relatively less environmental damage except for the reduced flows in the river stretch between the head and tail race tunnel of the dam. The disadvantage is that power generation fluctuates with the strongly seasonal flow of the river.

There are plans to build hydropower stations in the future (such as Bunakha and Sankosh) that incorporate storage reservoirs to avoid seasonal fluctuation and optimize electricity production. If land is lost to inundation due to these reservoirs, such loss would mainly be forest land, as settlements and agricultural fields are located on hill slopes and not in the river gorges. There might only be a few exceptions when people are affected and need to be relocated and compensated.

3.13 Competition for water

Potential competition for water use between irrigation hydropower has been investigated.

Hydropower generation takes place in the main rivers or main tributaries. Water is only used to drive the turbines and then flows back to the river, so hydropower generation in its present form in Bhutan does not actually consume water. By contrast, evaporation in irrigated agriculture does consume water that is generally tapped from the higher order tributaries – hence upstream of the hydropower plants. Therefore, irrigation water demand affects hydropower in Bhutan, but not the other way round.

The self-sufficiency level in paddy is presently about 50%. The amount of water needed to achieve full self-sufficiency has been estimated and compared with the amounts of water available in the basin. The figures are presented in table 10 below. The percentage of water used in other months is lower.

Table 10: Percentage of available water used to increase cereal production to full self-sufficiency

Basin	Amochhu	Wangchhu	Punatsangchhu	Mangdechhu	Drangmechhu
% water to be used for irrigation	9.4 %	3.7 %	5.5 %	1.5 %	2.8 %
Month	January	January	May	May	May

Thus, the percentage of available basin water to be used to achieve self-sufficiency in paddy production represents a corresponding reduction of water available for hydropower generation.

One has to bear in mind the following points:

- Peak hydropower production is unlikely to be affected by increased paddy production because rainfall in the months of July-August largely satisfies the crop water requirements (hence little or no irrigation water demand), and there is already more discharge in the river than used by the hydropower stations.
- Increased rainfall resulting from climate change may (partially) compensate for the reduction of the amount of water available for hydropower generation.

[35] Work for the Study on Minimum Environmental Flow for Hydropower Projects in Bhutan. Funding Agency: Austrian Development Agency. Duration: November 2015-October 2017.

- The use of more-efficient irrigation methods shall reduce the consumption of water for irrigation and therefore leave more water for hydropower generation.

3.14 Impact of climate change

Rainfall is expected to increase in the future, particularly in the south of the country, and specifically during the monsoon period when water is already abundant. This will increase runoff as well as discharge and sediment load in the rivers during summer. The sediments will settle along the river when the flow rate reduces towards the lean season, which may increase flood hazards during the next monsoon. Greater variability and uncertainty are also expected. There would be a greater chance of extremely high river discharge during the wet season, calling for new design procedures and standards for water works. The traditional approach for determining design floods based on observed return-periods would grossly under-estimate the future river discharge and levels, as shown in Figure 20.[36]

As can be seen, by the middle of the century (2045), the flow for a return period of 50 years may increase by around 26% in Wangchhu, about 7% in Punatsangchhu, and up to 38% in Mangdechhu and Drangmechhu.

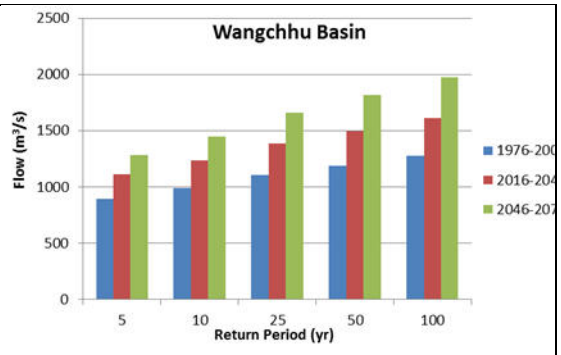
There also is an expected trend towards lesser river flows in winter, although no change in minimum flows.

However, it should be noted that the climate change assessments were constrained by a shortage of data. Available data have limited spatial representation and often cover less than the minimum requirement of thirty years of observations. Hence, the projections become less realistic when magnifying resolution from regional into smaller areas such as districts and Gewogs.

Wangchhu

Return Period (yr)	Flow (m^3/s)		
	1976-2005	2016-2045	2046-207
5	895	1112	128
10	987	1233	144
25	1103	1385	166
50	1189	1498	181
100	1275	1611	197

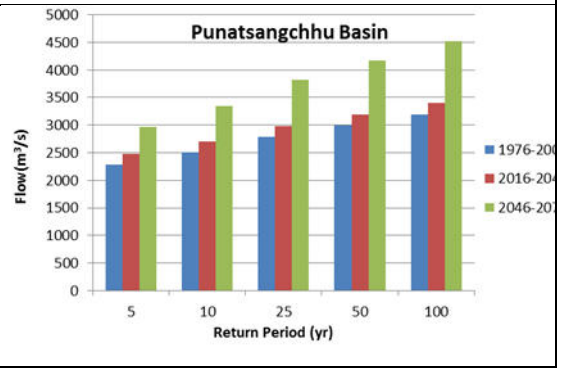
Flow increase 50 year return period till 2045 = 26%



Punatsangchhu

Return Period (yr)	Flow (m^3/s)		
	1976-2005	2016-2045	2046-207
5	2281	2479	29(
10	2503	2703	33
25	2783	2985	38
50	2991	3195	41
100	3198	3403	45

Flow increase 50 year return period till 2045 = 7%

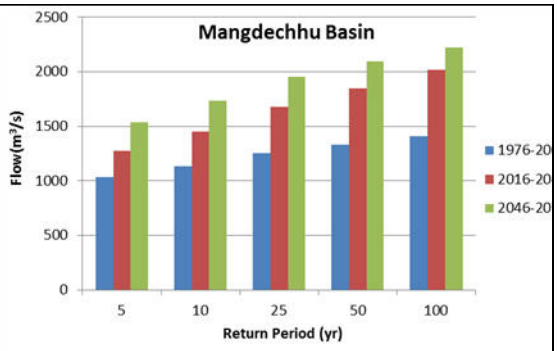


[36] For detailed descriptions on the climate modelling procedure and results, refer to the standalone supporting document entitled: *Climate Modelling and Assessment for Bhutan*.

Mangdechhu

Return Period (yr)	Flow (m^3/s)		
	1976-2005	2016-2045	2046-207
5	1035	1274	15
10	1134	1451	17
25	1252	1676	19
50	1334	1845	20
100	1412	2015	22

Flow increase 50 year return period till 2045 = 38%



Drangmechhu

Return Period (yr)	Flow (m^3/s)		
	1976-2005	2016-2045	2046-207
5	2291	2813	33
10	2536	3227	38
25	2849	3803	44
50	3086	4272	48
100	3324	4776	53

Flow increase 50 year return period till 2045 = 38%

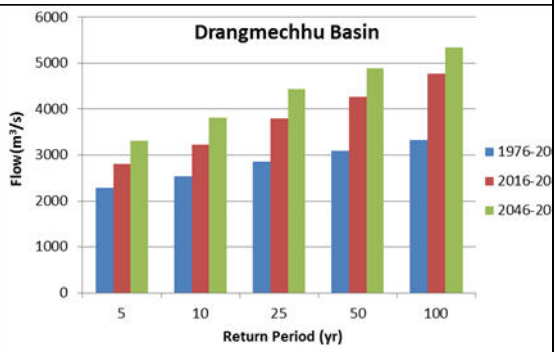


Figure 20: Basin outflows and their return periods

In climate models, future decades are to have drier and warmer winter months and wetter and warmer summer months. Under such a warming climate, river flows will become more erratic as rainfall is rapidly converted to runoff instead of being stored as ice. In turn, a combination of steep topography and the projected increase in summer rainfall and river flows in the coming decades pose major water-related hazards. Accelerated glacier melting is already increasing the number and size of glacial lakes and the risk of catastrophic flooding if these lakes are breached.

In South Asia, half of natural disaster events have been due to floods and landslides associated with extreme weather events. Climate change is predicted to make such extreme weather events more destructive, in particular through the intensified Asian monsoon system. The Himalayan region in particular has become even more vulnerable to natural disasters spawned by melting glaciers, which form high-altitude lakes that can suddenly breach and cause catastrophic flooding downstream.

3.15 Water sources drying up

There are frequent reports of water sources drying up. This appears to be at odds with predictions of increased rainfall caused by climate change. Investigation has shown that rainfall has in fact declined over the last two decades in a number of stations spread over the country – without a discernible spatial trend (see Figure 21).[37] Plotting rainfall figures over longer time periods tends, however, to conceal this observation, and shows an increasing trend instead. This shows how delicate it is to draw conclusions in relation to climate and climate change when data remains limited!

[37] Refer to standalone supporting document entitled: *Hydrological modelling and water resources assessment*

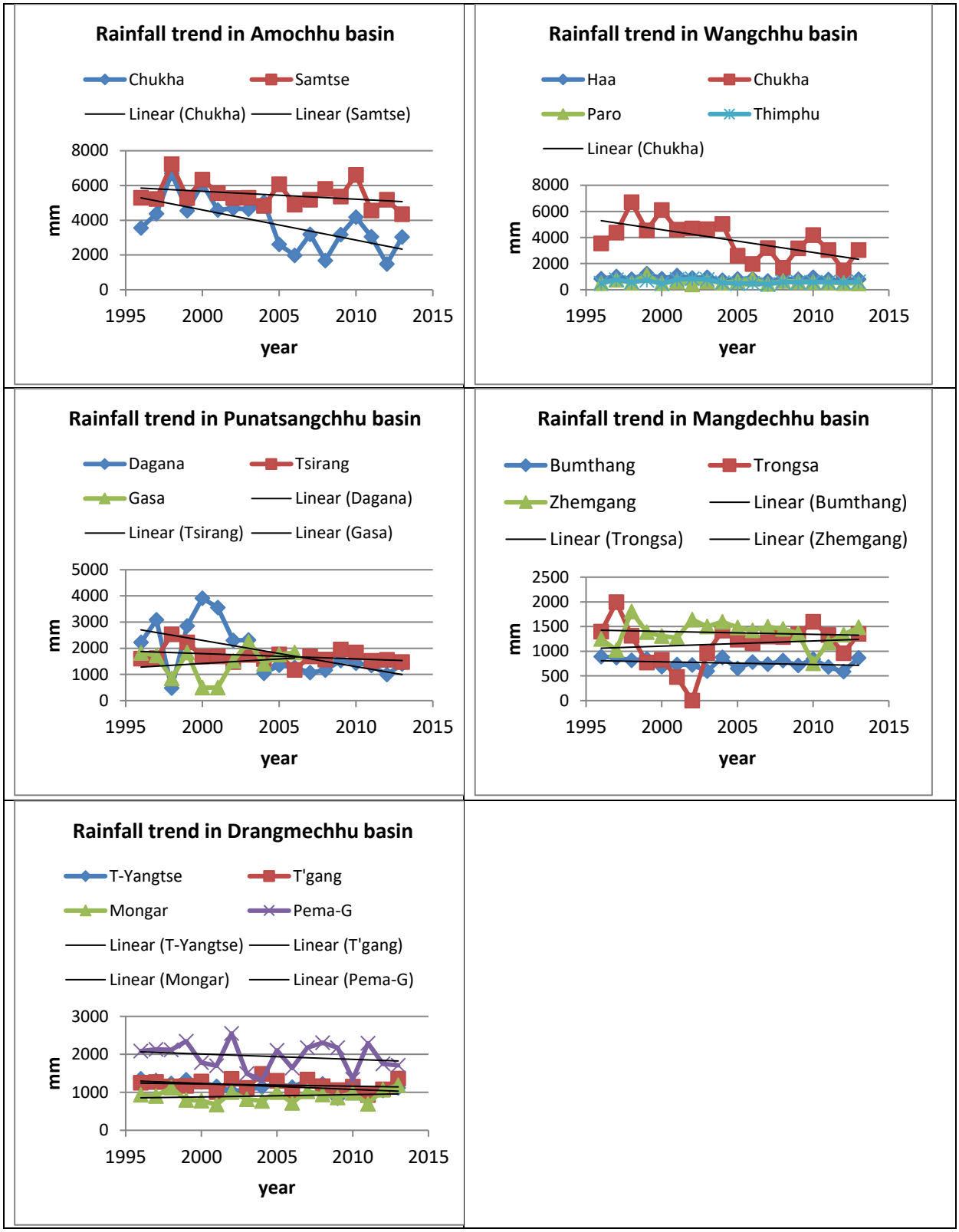


Figure 21: Recent rainfall trends in different basins

3.16 Pollution and water quality

Water quality is believed to be generally very good in Bhutan, especially in upstream areas and away from population pressure. But there is increasing concern that population growth, burial customs, and rapid urbanisation will outpace the installation of sewerage treatment and solid waste collection, thus threatening water quality.

Deforestation and land degradation from over-grazing by livestock contribute to soil erosion and increase the sediment load in the rivers during high water flows. High sediment loads in water are detrimental to the turbines in hydropower plants and increase demand on management. Many small piped water systems for domestic water supply are also often blocked by sediment during the monsoon period.

Water quality is currently being monitored, although measurements are not systematic or regular. Water quality standards are being reviewed and additional priority parameters are being incorporated.

3.17 Land-use related issues affecting runoff

Loss of agricultural land

Agricultural land has been under pressure with increasing population, economic development and urbanization. Reportedly, land owners are increasingly trying to change the status of Chhuzing (Irrigated paddy land) into dryland to grow more lucrative cash crops instead of paddy, or in order to circumvent the ban on building on Chhuzing land. From the Statistical Yearbooks, it was reconstructed that the area of paddy land has decreased from 62,360 acres in 2006 to 48,361 acres in 2013 (23% reduction). The area planted with maize was reduced from 75,800 acres in 2005 to 58,338 acres in 2013 (25% reduction). The area under wheat was reduced from 21,900 acres in 2005 to 5,560 acres in 2010, which is a significant 75% decline.[38] Such decreases in arable areas reduce crop water demand, but puts food self-sufficiency in jeopardy.

Landslides

Landslides are a common feature in Bhutan, especially during the rainy season. Their frequency has increased with the construction of (farm) roads due to steep cuts into the hillsides and the weight of construction spoil materials deposited on the lower slopes. The areas that are most prone to rainfall-induced failures are heavily fractured and weathered rocks of *phyllites*, slates and schists that contain high amounts of clay minerals that occur in the southern part of the Lesser Himalayas.[39]

The Department of Geology and Mines has been involved in preparing hazard maps along some of the existing highways and important sites of new towns. The Department of Roads has re-aligned some roads on the basis of these hazard maps, or applied environment-friendly road construction methods. This method applies flatter cuts into the hillsides (resulting in more-stable slopes), provides better drainage, and removes spoil, but is very expensive.

Different geological settings cause different types of landslides calling for different mitigating measures, like avoidance, stabilization, prevention or no action. Some of the common strategies to stabilize, control or prevent landslides include (sub-) surface drainage, retaining walls, reinforced earth and bioengineering of the disturbed slopes.

[38] Refer to supporting standalone document entitled: *National Irrigation Master Plan*
[39] Rapid classification of watersheds in the Wangchhu basin, SNV-WMD, DOFPS, MOAF, 2011

Over-grazing

Most of the pasture grasses are perennial, with root rhizome growth in the top 6" to 9" layer of the soil. These grasses bind the soil particles and make a good ground cover by their spreading habit and thus reduce soil erosion from wind and water. There is little registered pasture land and cattle are allowed to graze freely in forest areas. Repeated browsing, nibbling, and uprooting of saplings and trampling of the soil hinders natural regeneration, especially when the same areas are grazed twice per year - by yaks in the winter and by cattle during the summer.

Forest fires

Forest fires are one of the prominent causes of forest degradation in the country,[40] and lead to more runoff. The forest department in the last four years (2010-2014) recorded an average of 45 forest fire incidences damaging about 19,844 acres of forest annually. Helicopters can be used effectively for fire-fighting if there are ponds throughout the country that can be used to refill their water containers.

3.18 Limited technical and database management capacity

Climate change and hydrological assessments are essential in generating the information required for planning water resource management. Currently, the Royal Government's need for modelling services is neither streamlined nor well developed. The NECS and DHMS have been carrying out climate change and hydrological modelling to a limited extent and with externally funded inputs. The main application by DHMS in the past was for hydropower development. In recent times, weather forecasting has also been included. NECS is using modelling results for a wider overview of water resources and their spatial distribution and water availability. Though encouraging results have been obtained, the modelling work is generally constrained by data availability. The weather and river discharge monitoring stations are un-evenly distributed over the country, and do not yet have a minimum required observation period of thirty years. Consequently, modelling results become increasingly unreliable when zooming-in and downscaling to smaller areas – where most of the water-related problems occur.

Technicians require software and reliable instruments to generate the information required to plan, implement and monitor water-related programs and activities. Design and planning rural and urban drinking water supply, urban sewer and drainage systems, irrigation, hydropower, etc. require various types of software, equipment and instruments. Although it is efficient and cost-effective to consolidate such services in the light of limited human and financial resources, different sectors are pursuing development of such capacity for their own sector. As a result, data sharing and management is also sector based, not regularly updated and often inaccessible.

[40] Bhutan Renewable Natural Resources Statistics, 2015

4 Water Governance Framework

This chapter first describes how the approach to tackling water-related issues has changed over time, and then presents the status of the current institutional environment. It continues with a description of the national planning process followed by a description of the institutional framework and stakeholder analysis. This chapter also looks at tools available for IWRM, presents the results of a training needs assessment carried out during the preparation of the NIWRMP, and finally describes an inter-agency coordination framework based on the Bhutan Water Security Index.

4.1 Evolution of water management approaches

Approaches to water resource management and corresponding institutional setups worldwide have evolved over many decades. Early water resource management, which continued up to the 1960s, addressed mainly single-purpose endeavors that pursued an engineering agenda linked primarily to dam-building and water engineering works (for flood control, drainage, irrigation and water supply). Technocratic solutions dominated this era of top-down water resource management, and water management entities were principally instruments of the national government.

Beginning in the 1970s, concern about environmental and social impacts, including worsening water quality, paved the way for multi-purpose water resource management that also saw the beginnings of a river basin approach (usually within an “integrated area” development context). Multi-stakeholder participation was introduced. Watershed protection gained prominence, and procedures for environmental impact assessment requirements expanded the scope of water development concerns to include social and ecological aspects. Nonetheless, river basin organizations still treated water as a separate sector and lacked a multisectoral and integrated approach to addressing water-related concerns.

In the 1990s, the shift to a sustainable development vision paved the way to adopt a comprehensive system of water resource management, one that emphasized coordinated development and the management of water, land and ecological resources. The Dublin principles of 1992 recognized increasing water scarcity as a result of conflicting uses and overuses of water. Importance was put on holistic approaches that sought to integrate management of water resources within a broader socio-economic and institutional framework. During this period IWRM became the dominant paradigm. It considerably expanded management challenges, for it often requires balancing competing sector needs and establishing governance mechanisms for coordinating various entities involved in water management (and which are not used to such coordination, or resist coordination). The introduction of IWRM also came with sector-wide policy reforms and decentralization of governance, and along with these the challenges of effective coordination. A strong focus was given to the river basin as the logical (hydrological) unit for management, which remains to this day.

Over the past decade, the management scope for water resources has further expanded to include concerns over the impact of climate change. This was to be expected since climate is the main supply driver which ultimately determines how much water is available, and because managing extreme events associated with climate change (droughts and floods) is fundamental to water resource management. Apart from this development, there is increasing acknowledgment that, as with the environment, water is not a sector. Rather, water is part of a nexus involving in particular agriculture, ecology and energy. Drivers of change in the water sector often arise from activities in these other sectors. This latest evolution of the water management paradigm has put *coordination* in an even more central role.

In Bhutan, the WRM institutional framework already adopts coordination—embodied in the mandate of the NEC--as the core management principle (in other words, Bhutan is on the “right” track). For the institutional

design of IWRM in Bhutan, corresponding emphasis is on enhancing *coordination* at both the national and river basin level. The following definition of coordination is used to guide the IWRM mission in Bhutan: Coordination is a situation in which policies and programs of government and its agencies are characterized by *minimal redundancy, incoherence and gaps*.

In addition, the coordination model of WRM in Bhutan should be framed/designed more specifically to address effectiveness and efficiency aims.

4.2 Overview of policies and legal framework

The following paragraphs summarize the steps that the government has already taken towards adopting IWRM in the national policy documents and the national legal framework (see the standalone report on 'Legal aspects of IWRM in Bhutan').

Overview of policies

Vision Statement 1999

In 1999, the Planning Commission issued a Vision Statement for 2020. Part-1 stated that the vast hydropower potential should be developed, yet it emphasized the need for environmental conservation, and warned that the progressive removal of vegetation cover, especially in critical watershed areas, was beginning to affect the hydrological balance, leading to the localized drying up of perennial streams and flash flooding.

It also mentioned the challenge to increase efficiency and to widen the opportunities of the decentralized administrative system. Hence, people at the *Gewog* level should have more influence in decision-making that has a direct bearing on their lives and livelihoods and the future of their communities.

Greater priority also needed to be accorded to the development of the information systems required for informed decision-making and development planning.

Part-2, which dealt more with goals, objectives, strategies and milestones, emphasized the need for sustainability. It stated that sustainability had many dimensions - social, financial, economic, cultural and environmental - and they were all of critical importance in Bhutan since they all impacted, directly and indirectly, its sovereignty and security. It distinguished five thematic headings to steer the process of change: human development, culture and heritage, balanced and equitable development, governance, and environmental conservation. One of the milestones mentioned for planning (for 2007) was the preparation of watershed master plans: a prelude to the river basin management plans that are presently foreseen under the Water Act and Regulation.

Bhutan Water Policy 2003

In April 2003 the Bhutan Water Partnership prepared the Bhutan Water Policy (BWP). The government approved the document in 2006. The BWP is a reflection of the government's commitment to the conservation, development and management of the country's water resources. It recognizes that water is a precious natural resource and a heritage important to all aspects of social, economic and environmental wellbeing. As a result, the policy recognized that every individual has the right to safe, affordable, and sufficient quantity of water for personal consumption and sanitation.

With regard to uses of water, the BWP stipulated three main principles:

- Water is a common good. Its uses are open to all legitimate users under the provision of the water act.
- The policy sets priority for all legitimate uses of water. The first priority goes to drinking and sanitation, which are essential for human survival. The allocation of water for irrigation, hydropower generation, industrial uses, recreation and other uses are to be guided by national and local priorities.

- The policy also recognizes the importance of water for agriculture and food production. The policy thus emphasizes that the allocation of water to the agriculture sector must be compatible with the objective of national food security.

The BWP adopted the principles of IWRM. It stated that water resources in the country would be managed based on natural river basins. Accordingly, the policy emphasized establishing institutions based on river basins.

Overview of the legal framework

Water Act 2011 and Water Regulation 2014

The Water Act of Bhutan 2011 (Water Act) is an important milestone in the development of the legal framework regarding the water resources in Bhutan. It is the first act that addresses water resources in an integrated manner. Until then, management of water resources was fragmented, addressed in different laws, and focused only on the operational level.

The Water Act is also an important milestone in the implementation of the concept of IWRM in national legislation. It is also in line with the national concept of Gross National Happiness. Both concepts are expressed in the preamble of the Act and elaborated in broad terms in the various chapters. In brief, the Act aims to advance a coherent, integrated and open approach to the different aspects of water resource management in a sustainable way and with the river basin approach as a leading principle. To achieve this goal, the Act provides for a number of organizational and substantive facilities. The first aspect concerns the formulation of the distribution of authorities and responsibilities between the various governmental bodies involved in water management. The second aspect is aimed at providing the competent authorities with strategic and operational legal instruments to enable them to perform their tasks properly.

Some notable characteristics of the Water Act are:

- The Water Act is a true management law. It is not primarily about the development of water infrastructure (including irrigation networks), but about creating conditions for the responsible and sustainable management of water resources.
- The scope of the Water Act covers all aspects of water management: surface water and groundwater, both in quantitative and qualitative terms. It also covers the infrastructure dimension: river basins, irrigation systems, dams, water supply systems, etc. In other words, it provides a coherent and integrated approach. The integrated approach is also manifested in the emphasis on the importance of the basin approach. Water systems (river basins and groundwater basins) with their functional relevant environments are the frame of reference.
- Water management is based on a structural (long term) approach. For that reason, a strategic plan must be drawn up for every river basin in which all relevant aspects should be considered and weighed in relation to each other. The river basin management plan is the reference for all types of operational activities.
- Local communities and other stakeholders involved in water management are given the opportunity to participate in all stages of the decision-making process.
- Alongside the social function of water (expressed in the Act through the stipulation that every individual shall have access to safe, affordable and sufficient water for basic daily needs), the economic function of water is also underlined. Water use (abstraction/discharge) and water services are chargeable following the ‘user pays’ principle and the ‘polluter pays’ principle. This expresses the fact that water is a scarce commodity, which has to be paid for.

- The Water Act has a close relation with the National Environmental Protection Act 2007 ("NEP Act"). This act has a broad scope, covering the environment in all its dimensions, including water. The relation between the Water Act and the NEP Act has an institutional and a substantive dimension. The former concerns the regulation of the tasks and powers of the NEC, while the latter is related to the various rules about the protection of the environment.
- A final characteristic of the Water Act is its framework dimension. The topics covered by the Act are only provided for in broad terms. They need to be elaborated in one or more implementing government regulations. To ensure as much integration as possible, the government of Bhutan has decided to cover all issues in one integrated regulation, which was done through the Water Regulation 2014 (Water Regulation).

Addressing the different types of issues in the Water Act in one integrated regulation was a complex, challenging and time-consuming operation. Therefore, the preparation took quite some time but the Water Regulation of 2014 (Water Regulation) came into effect in January 2015. However, not all issues are addressed in a sufficient manner. Based on practical experience, the Water Regulation will need to be updated.

Water Related Acts

As mentioned above, until the Water Act the management of water resources was fragmented, addressed in different laws, and only focused on the operational level. The most important acts that contain water related provisions are acts pertaining to land, forestry and nature conservation, mines and minerals management, electricity, waste, and environmental assessment and protection:

- Land Act 1979 and the Land Act 2007
- Forest and Nature Conservation Act 1995, and Forest and Nature Conservation Rules 2006
- Mines and Minerals Management Act 1995
- Electricity Act 2001
- Waste Prevention and Management Act 2009
- Environmental Assessment Act 2000
- National Environmental Protection Act 2007

It is important that the Water Act and the water related acts (as well as their underlying implementing regulations) are sufficiently harmonized to avoid overlaps, contradictions or gaps. The Water Act addresses the relation with existing acts only in broad terms. Its Article 3 stipulates that: "*This Act hereby repeals the provisions of any Acts/regulations and administrative instruments which are inconsistent with this Act*". To avoid misunderstandings and confusion in practice when inconsistencies arise, the above mentioned existing water-related acts and regulations need to be assessed, which has been done. The overall conclusion of the assessment is that the Water Act and the existing water related acts (and regulations) are harmonized. Most issues are addressed in the acts consistently, though in some cases there are inconsistencies that may cause confusion.

Observations regarding the legal framework

The Water Act is the first act that addresses water resources in an integrated manner and is therefore an important milestone in the implementation of the IWRM concept in national legislation. All relevant issues are addressed in the Water Act and elaborated on in the Water Regulation. Given the absence of experience with IWRM in practice, most issues are addressed conceptually in the new legal framework and have not yet been elaborated in sufficient detail to guide the full implementation of the new legislation in practice. This section

provides some examples following a thematic approach. The 'observations' made in this section are not exhaustive. Furthermore, some of them, such as the institutional framework, are discussed in more detail in other sections of this NIWRMP.

Institutional framework

A clear and transparent institutional framework, taking into account the river basin approach and the decentralization concept, is essential. The division of tasks between the various competent authorities needs to be addressed in a clear manner to avoid misunderstandings about the question of who is responsible for what, and which is the competent authority to take decisions (such as issuing a license and imposing administrative sanctions). Unfortunately, this is not always done adequately. This is particularly the case for the NECS, the River Basin Committee (RBC), and the Water User Association (WUA). Furthermore, the decentralization approach needs further attention. The essence of this approach is: decentralize what is possible, centralize what is necessary. The ability of the NECS to hand over certain powers to the districts and the municipalities has so far been used in a limited way.

The issue of the institutional setup is elaborated in more detail in Section 4.5.

Planning

A structured long-term approach through planning is a key element of IWRM. The two key planning instruments in the Water Act are the National Integrated Water Resources Management Plan (NIWRMP) and the River Basin Management Plan (RBMP). In principle, these instruments are well covered. However, the relation between the RBMP and the Watershed Management Plan needs further attention. A coordination mechanism to ensure that both plans are sufficiently harmonized is missing.

Regulatory framework

The Water Act and Water Regulation, together with the Environmental Assessment Act 2000, set out a comprehensive and differentiated regulatory system for water abstraction and use. Some cases require applying first for environmental clearance while others do not require environmental clearance and only necessitate a permit. The system will need to be tested in practice and, if necessary, adjustments made to facilitate its application.

Financing

Key points of the financing arrangement in the Water Act are the establishment of fees and charges based on the "user pays and polluter pays" principles. Their elaboration in the Water Regulation is incomplete. The focus is on fees/charges in relation to the Environmental Assessment Act 2000. Criteria regarding the amount of a fee or charge for surface or ground water use are not clearly set out in these Acts.

Compensation is also an important element of the financing set up. In the event of governmental decisions causing damage, those affected have a legal right to compensation. This issue is not consistently addressed in the legislation.

Dispute resolution

An overarching feature of the dispute resolution mechanisms in the Water Act is that it is a good example of the implementation of the decentralization approach. However, issues remain to be addressed. Among other things, the current operational role of the NECS in dispute resolution needs attention. Whether this operational competence is consistent with the primary coordination task of the NECS should be reconsidered.

Enforcement

Enforcement is an important issue with a broad scope. A key element is supervising compliance with the law by monitoring and inspection, and based on that, the application of administrative and/or criminal sanctions where necessary. The administrative sanctions are set out clearly. However, that is not the case for criminal sanctions.

4.3 Overview of the national planning process and entry point for IWRM

National Development Planning Process

Since 1961, Bhutan's development has been guided by a series of five-year plans (FYP), the preparation of which is directed by the Gross National Happiness Planning Commission, subject to the National Assembly's final approval. The current FYP is the eleventh in the series and covers the period 2013-2018. The planning/fiscal year begins in July.

The planning activities for the 11th FYP started in April 2012, during which central and local government plans were prepared by local government units and central agencies. Sectoral plans were prepared nationally by the line ministries, and harmonized with the development plans prepared by local governments. At the local level, stakeholders first identify which development activities are best suited for implementation at the level of the Gewog, at the level of the Dzongkhag, or that of the sector (national level).

This mode of decentralized planning, down to the level of the Gewog, was first introduced during the 9th FYP. In the 10th FYP, planning processes continued to be further decentralized, giving greater autonomy for sectors and local governments to formulate strategies and to select priority programs (subject to budget resources available through their respective annual grants).

Beginning with the 10th FYP, and continuing through the 11th FYP, a results-based planning framework was adopted that identifies clear outcomes and outputs to be achieved. Outcomes are defined as Key Result Areas (KRAs) at the national, sectoral, and Dzongkhag level, which are categorized under each of the four GNH pillars and were set after extensive stakeholder consultations spanning 2 years. At the national level, 16 KRAs have been identified. At the sector and Dzongkhag levels, there are more than 300 KRAs aligned with the 16 national KRAs. The performance of all government agencies towards the delivery of KRAs is measured through corresponding Key Performance Indicators (KPIs) consisting of baselines and targets.

The result-based planning is essentially meant to ensure that sector and agency plans contribute to the attainment of clearly stated results, the latter defined as outcomes of the specific development activities (program and project levels). The result-based planning framework was also meant to ensure that planning and budgeting processes are able to anticipate emerging challenges in the country's socio-political and development context in coming years.

Since the 10th FYP, the planning and budgeting timeframe for implementing programs and projects has been changed to 3 years from the original 5 years in the previous FYPs. The FYPs continue to provide the medium-term outlook in identifying priorities and monitoring results, but these plans are operationalized through multi-year rolling plans of three years (1+2) which are rolled over from year to year based on annual work plans. This system allows for improved predictability and realism in the budgeting process.

A 1+2 rolling plan refers to a plan for the coming year, plus two years in advance. That is, central and local governments prepare annual plans with additional 2-year projections on program activities and budgetary targets.

Development plans at both the national and local level are consolidated under either infrastructure or non-infrastructure categories. The infrastructure items are required to be based on master plans that serve as road maps for infrastructure development, and which are then implemented on the basis of 3-year rolling plans.

Possible entry point for IWRM integration in development planning

The five-year planning process provides an entry point for incorporating IWRM into development planning, i.e., by preparing for the next FYP to systematically integrate IWRM in the medium-term development planning and resource allocation via the policy and planning guidelines that can be used as a basis in the next (12th) FYP, possibly with an initial focus on irrigation infrastructure if it is prioritized by the government (see Figure 22).

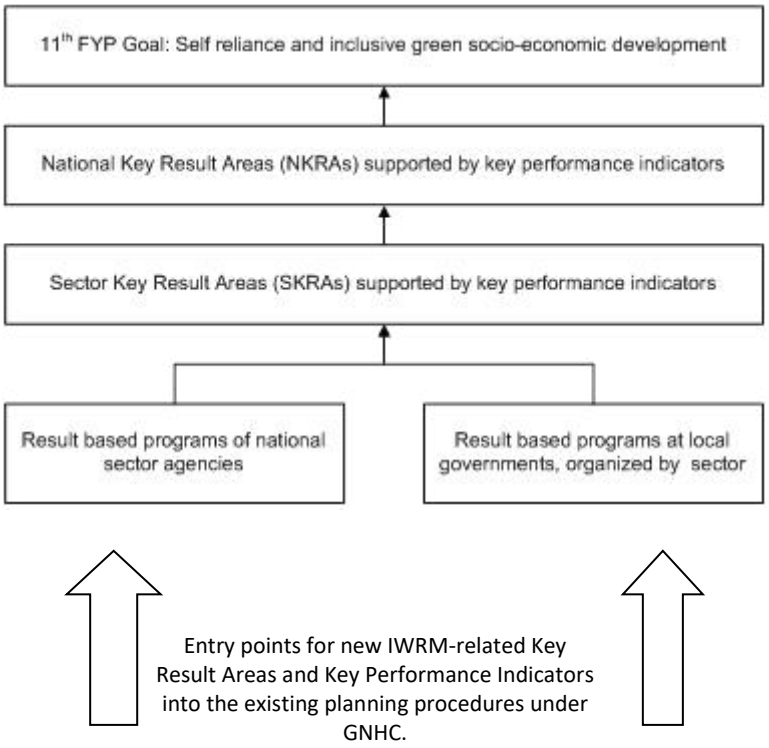


Figure 22: Diagram of the national planning process under GNHC

A way to incorporate IWRM in the the 12th FYP is to introduce KRAs for water security along the five dimensions of rural water supply provision, urban water supply and water quality security, economic water security for agriculture and hydropower use, sustainable environmental flows, and climate change resilience.

Medium-term sector planning starts about midway through the current FYP guided by results of the mid-term review of the current plan implementation. After extensive consultations are held with stakeholders at local up to central levels, the identified development gaps and priorities (as "key interventions") are sorted out according to how they should be pursued: as local activity at the Gewog or District level, or as part of a wider sector plan.

Guidelines for FYP planning are then drawn up by the Gross National Happiness Commission (GNHC), wherein core sector objectives, priorities and strategies are set out. The guidelines serve as basis for the sector agencies to formulate their respective sector plans (and also for the local governments). Such plans are expected to clearly articulate expected results and ways to monitor progress of achievement (through sector KRAs and performance indicators)

The main sector interventions, KRAs and KPIs are compiled based on the extensive consultations conducted with stakeholders, and which are consolidated and presented formally to the GNHC prior to adoption and publication in the guidelines. Medium-term sectoral plans are developed based on the key interventions, key result areas and performance indicators that are specified in the planning guidelines.

Although sector agencies are given flexibility to modify the interventions in preparing their respective sector plans based on the GNHC guidelines, changes in KRAs and KPIs have to be cleared with the GNHC. Detailed specifications of each sector's programs and projects are finalized after the resource allocations for all sectors are set by the GNHC based on the fiscal projection. Each sector plan's specifications of programs and projects

are accompanied by a "responsibility framework" that identifies the level of implementation (national or local) and the allocation of budget resources between the central sector agency and the local governments. The responsibility framework is issued by the GNHC as an attachment to the planning guidelines.

An envisioned entry point for IWRM mainstreaming in Bhutan's development planning system is to influence the GNHC planning guidelines so that these adopt the water security KRAs and KPIs derived from the NIWRMP, which also serves to guide preparation of basin plans. And following the "strong coordination" model described above for IWRM, water concerns—that are spread out across various agencies—built into the national planning system will help ensure such coordination (including synergy among interventions). The NEC should then resolve any gaps in addressing various water concerns.

Following the mainstreaming approach, strategic water security interventions, KRAs and designated competent authorities--derived from the NIWRMP--will be coordinated by the WRCD and presented by the NECS (through the NEC) to the GNHC, after which these are proposed to be formally adopted and published in the medium-term planning guidelines that guide FYP preparation. Specific plans at the national and local levels are to be developed based on these medium-term planning guidelines. Plans formulated will be reviewed by the GNHC Secretariat for conformity with the water security KRAs and KPIs.[41]

Detailed specifications of programs and projects are finalized after the resource allocations for all sectors are set by the GNHC based on the budget projection. The plan specifications are accompanied by a "responsibility framework" that identifies the appropriate level of project implementation (national or local) and the allocation of budget resources between the central sector agency and local governments. The responsibility framework is issued by the GNHC as an attachment to the planning guidelines (and incorporated in the compact signed by the executing agencies and the government). The role of the River Basin Committees (RBCs) is primarily to help coordinate between line agencies when preparing and implementing projects and programs.

The RBCs would use the RBMP as a tool for coordinating between line agencies and local governments on projects and programs that affect the basin. For instance, the RBC shall ensure that district-level plans do not adversely compete for water and that they remain within the total water available within the basin. If development plans are set to draw more water than is available, the RBC can flag the issue to NEC and GNHC – which in turn could reconsider certain plans so as to remain within the water available. The RBC would also highlight any proposed interventions in the RBMP that are not being considered by the line agencies and local governments, so that these can be attended to by the NEC and GNHC. Overall, the main aim of coordination through the RBCs is to ensure that policies and programs in their respective basins—involving multiple agency players and stakeholders--are characterized by minimal redundancy, incoherence, conflict and gaps. Over time, and with the NEC's mandate, the role of the RBC could be strengthened to extend beyond advisory and coordination functions, but also to approve/disapprove any activity that affects the river basin environment.

In the current 11th FYP for the renewable natural resources (RNR) sector, for instance, the water-related KRA is stated as "enhanced sustainable forest, land, water and biodiversity resource management" for which the identified key intervention is to "conduct inventory of important water catchment areas and effectively manage critical catchments." For the next FYP, it is expected that water security KRAs and KPIs proposed in the NIWRMP will be incorporated into the plan.

At the basin level, with the RBC providing coordination through the river basin management plan, water-related plans will be prepared by the Dzongkhag and Gewog administration units (through their respective development councils). This will be done with reference to technical guidelines issued by competent water-related agencies/authorities, as designated by the NEC. Each local plan will identify which strategic element under the GNHC FYP formulation guidelines are to be implemented at the local level and, following the budget system, are to be funded through allocations from central agencies in the form of grants earmarked for those activities.

[41] For details on the mainstreaming of water security KRAs and KPIs into the planning process, refer to standalone supporting document entitled: *Integrated Water Resource Management in Bhutan: Possible entry points in Development Planning and Budgeting System*.

According to the Water Regulation, every Dzongkhag Administration will prepare an Integrated Water Use Management Plan for the Dzongkhag based on the NIWRMP for adoption by the Dzongkhag Tshogdu. Every Thromde Administration will develop a water management/safety plan based on demographic projections for at least the next ten years to ensure efficient water supply and effluent disposal, including drainage systems, in its jurisdiction.

4.4 Water-related goals in the Vision, Policy and Planning

The water-related priorities given in the Vision and Policy statements, and formulated as Key Result Areas in the 11th FYP, are summarized in Table 11. These priorities are grouped according to the five key dimensions of the water security index system (described further in Chapter 5):

1. Rural household water security
2. Economic water security
3. Urban water security
4. Environmental water security
5. Resilience to climate change and water-related disasters

Current policies and 11th FYP goals already incorporate water security indicators under these five dimensions, even as these indicators can further be enhanced in subsequent FYPs. Measuring the status of water security according to these five dimensions allows capturing the inherent tension that emerges among water resource users as future competition for water increases. Indeed, managing these five key dimensions of water security while adressing the specifities and needs of the concrend stakeholders in a context of climate change is what constitutes IWRM.

Table11: Goals in planning

Dimension	Source	Domain	Goal	Indicator
Rural household water security	Water vision goals	Health	Reduction in water-related diseases	
	Policy statements	Drinking water and Sanitation	• Universal access and water quality standards • Conservation of sources for drinking water supply	
	11th FYP	Human settlement	• Improved quality of infrastructure facilities and services • Millennium Goals achieved • Incidence of communicable disease reduced	• % of population with access to safe and reliable drinking water and sanitation • Improved sanitation facilities and hygienic use increased from 58% to >80% • Diarrhoea incidence per 10,000 children under 5 (2428)
Economic water security	Water vision goals:	• Agriculture • Aquaculture	• Increase food production/ irrigation • Develop fish farming	

Dimension	Source	Domain	Goal	Indicator
		• Hydropower • Industries • Recreation	• Tap potential • Adequate water allocation • Develop water bodies	
	Policy statements	Agriculture Industries	• Irrigation water supply as per national objectives (food security) • Minimize pollution from agro-chemicals • Production of bottled water/ clean water products promoted • All commercial abstractions to be licensed • Sustainable development of hot springs	
	11th FYP	Energy	Energy security enhanced	• Installed capacity of Hydropower plants to be raised from 1,500 to 4,500 MW • Installed small Hydropower plants capacity 12,150 KW
Urban water security	Water vision goals	Drinking water	No explicit urban goals (other than drinking water supply and sewerage)	
	Water policy	Drinking water	No explicit urban plans (other than drinking water and sewerage)	
	11th FYP	Drinking water	No explicit urban plans (other than drinking water and sewerage)	
Environmental water security	Water vision goals	Environment	• Conservation of nature • Water quality monitoring	
	Policy statements	Industries Environment	Proper waste water disposal Preservation of river habitat	
	11th FYP	Renewable Natural Resources	Enhance conservation of plant and animal genetic source	Increase number of protected RAMSAR sites from 0 to 5.
Resilience to climate change and water-related disasters	Water vision goals	Resilience	Forecast, prevent, mitigate disasters	
	Policy statements	-	No policy statement formulated	
	11th FYP	Conservation and sustainable utilization of environment	Climate change induced GLOF risk mitigated	Maps of dangerous glacial lakes updated

4.5 Institutional framework and stakeholder analysis

This section gives a short overview of the main stakeholders in IWRM. Appendix 2 gives a more detailed description of the primary mandate of each of these institutions and their specific IWRM roles under the Water Act with regard to: (i) policy and planning, (ii) coordination and regulatory powers, (iii) water services delivery, and (iv) information management/reporting and capacity building. Specific tasks under these four roles relevant to each organization are described below and further elaborated in Appendix 2.[42]

- *Ministry of Agriculture and Forests*. MoAF is responsible for irrigation development, watershed and wetland management. The Engineering Division of the ministry provides engineering services to local administrations for design and development of irrigations systems. The Watershed Management Division (under the Department of Forest and Park Services) is tasked to categorize watersheds, prepare management plans, and implement them in collaboration with stakeholders.
- *Ministry of Economic Affairs*. Through MoEA's Department of Hydropower and Power Systems, it has the responsibility of promoting sustainable hydropower development for Bhutan. The Department of Renewal Energy (DRE) is responsible for identifying and planning small hydroelectric power projects (below 25 megawatts). Through the Department of Hydro-Met Services, it provides weather, water, climate, and other related environmental services to various sectors.
- *Ministry of Education*. MoE does not have direct water management and service delivery mandates specified in the water law and regulations. Its main role, as one of the competent authorities mentioned in the Water Act, is to promote awareness of water-related issues among the general public.
- *Ministry of Health*. MoH is responsible for the overall planning, implementation and management of infrastructure for drinking water supply and sewage management for all rural areas, which it undertakes in collaboration with local governments. It is also mandated to monitor the quality of drinking water.
- *Ministry of Home and Cultural Affairs*. MoHCA, through its Department of Disaster Management, is involved in the water sector in terms of disaster mitigation and relief, especially in water-related disasters such as Glacial Lake Outburst Floods (GLOFs).
- *Ministry of Works and Human Settlements*. MoWHS is responsible for the overall planning, implementation and management of infrastructure for drinking water supply and wastewater for urban areas in collaboration with Thromdes and local governments. Like the Ministry of Health, it is mandated to mainstream water resources management into its policies, plans and programs.
- *National Environment Commission*. Under the Water Act, NEC serves as the apex authority for the purpose of developing policies, coordinating plans, programs and monitoring water resource management in the country. The members are appointed by the Commission.
- *National Environment Commission Secretariat.* NECS carries out the day-to-day functions of the National Environment Commission. The Secretariat assists the NEC in administering the provisions of the Water Act, and a Water Resource Coordination Division was set up in May 2010 for this purpose.
- *Gross National Happiness Commission*. GNHC is the apex body for setting the development priorities and plans for the country based on the four pillars of Gross National Happiness. The Commission is comprised of government Secretaries chaired by the Prime Minister. Water security has been identified as a priority area for development.
- *Gross National Happiness Commission Secretariat.* GNHCS acts as the administrative and program machinery serving to fulfil the functions and priorities of the GNHC. Planning officers across the country support the Secretariat with planning and monitoring progress of local and sectoral plans. As it does for other sectors, the GNHCS works closely with water-related agencies to prioritize interventions for water security.

[42] For details of the stakeholder analysis and the communication plan to inform them on the IWRM issues, refer to supporting standalone documents titled (i) *Integrated Water Resource Management in Bhutan: Stakeholder Analysis* and (ii) *Communications Plan to Support Bhutan's IWRM Process.*

- *Civil Society Organizations*. The relevant CSOs are the Royal Society for the Protection of Nature (RSPN), the Bhutan Water Partnership (BhWP) hosted by RSPN, and the Tarayana Foundation. These organizations work closely with government agencies and local communities in education and awareness, advocacy, and livelihood enhancement programs.
- *Dzongkhag Tshogdhu (District Development Council)*. For each Dzongkhag, the council is composed of elected leaders from each Gewog in the district. Thromdes are subdivisions of the Dzongkhags that are more densely populated (i.e., urban municipalities) and have their own councils with directly elected members. District and Thromde councils are tasked with balancing socio-economic development, promoting business, protecting consumers, coordinating government agency activities, reviewing Gewog regulations and ordinances, and representing the districts in national referenda.
- *Gewog Tshogde (Gewog Development Councils)*. Each Gewog is administered by a Gewog Tshogde (Block Council or Block Development Committee), which is subordinate to the Dzongkhag Tshogdu (district council). The Gewog council is composed of a Gup (headman), Mangmi (deputy), and between five to eight elected leaders (Tshogpas) from among the constituent villages. The Gewog Tshogde is empowered to regulate resources. Gewogs are further subdivided into Chiwogs, which are the equivalent of municipalities or cluster of villages. There are generally five to six Chiwogs in each Gewog.
- *Dzongkhag Water Management Committee*. Under the Water Regulation, the existing Dzongkhag Environment Committee (DEC) is mandated to function as the district water management committee (DWMC).
- *River Basin Committees*. The Water Act mandates that such committees shall be set up for the "purpose of proper management of water resources." Functions described in the Water Act pertain to community participation, preparation of the River Basin Management Plan (RBMP), monitoring and reporting to NEC, data management, and resolution of cross-sectoral and transboundary water management issues. The Water Act gives prerogative to NEC to direct or mandate RBCs to perform additional functions, as needed.
- *Water Users Associations*. Except in Thromdes, water users of a common water facility are to be established. The term "water user" for the purpose of forming a WUA means a household using water from a registered facility or source. Any new water user duly admitted to an existing facility will automatically be a member of the WUA.

Observations with respect to the institutional framework

The role and functions of the various institutions at the central, district and local levels as outlined in the table above shows that many institutions are involved in water management. However, most of them are only involved in some tasks or specific aspects of water resource management. One of the main goals of the Water Act is to create the conditions for a shift from a fragmented approach to an integrated water resource management approach. To ensure effective coordination between the involved institutions, the Water Act establishes two coordinating apex bodies: the NEC (and its Secretariat) at a national level, and the River Basin Committee (RBC) at a river basin level. The NEC(S) was established in the early 1990s and legally embedded in the National Environment Protection Act 1997. The RBC is a new institution required under the Water Act and is without any prior experience. Therefore, the RBC does require a secretariat, a role of which can be fulfilled by NECS as an interim measure.

The institutional model for the management of water resources is a complex model. It is based on the idea that the water management tasks have to be carried out as much as possible by existing government agencies and that the two apex organisations, NECS and RBC, ensure that the line agencies carry out their water-related tasks in an integrated manner. An effective application of this institutional model requires that the role and functions of all institutions concerned are clearly set out in the legislation to avoid misunderstandings, duplications, or even contradictions. The following sections attempt to determine in broad terms if this is the case for the newly established organisations: NEC(S), RBC, and WUA in relation to existing government institutions.

NEC Secretariat (NECS)

One of the main functions of NECS is the preparation of the NIWRMP in consultation with the relevant stakeholders. The NIWRMP is a crucial coordination instrument at the national level, as is the RBMP for the basin level. The approval power of the NECS is essential to ensure that a RBMP is in line with the NIWRMP. Both coordination instruments are undisputed. The NECS also has more operational tasks to perform like monitoring the state of water resources, the development and maintenance of a National Registry on both drinking and irrigation water resources, and the development and maintenance of inventories on river hydrology, aquatic habitat, river ecology and morphology. It also is the competent authority for issuing clearance certificates and is the appeal body in water disputes. It is questionable if all of these operational tasks are typical coordination tasks that need to be carried out by the NECS. The Water Act creates the possibility for the NECS to hand over one or more functions to other agencies. This opportunity should be considered to ensure that the NECS can focus on essential strategic coordination tasks.

River Basin Committee (RBC)

The RBC is a new institution with the purpose of ensuring proper management of water resources within the basin. Given the choice that water tasks have to be carried out as much as possible by existing government institutions, the RBC has mainly a coordination function. The most important coordination task is the preparation of the RBMP. Other more operationally oriented tasks include promoting community participation, monitoring and reporting to the NEC, collecting and managing data, and helping resolve cross-sectoral and district trans-boundary issues. It is noted that the RBC does not have regulatory functions such as the issuing of water permits, carrying out inspections, and imposing administrative sanctions. These are typical competences of the district and local government agencies. Under the proposed coordination model, the RBC should be limited to coordination tasks only.

Water Users Association (WUA)

WUAs have existed since the 1980s when the irrigation systems were constructed (or rehabilitated) by the Department of Agriculture (DoA). As part of its irrigation development policy, the DoA required users of an irrigation system to form a water users association before the system is turned over to them. Most WUAs that have been formed so far to manage irrigation systems operate informally, and arrangements for cooperating on canal repairs and for contributing to a maintenance fund are governed by customary rules rather than codified by-laws. That has now been done in the Water Act. The Water Act stipulates that (except in urban areas) users of a particular water source or facility (such as for irrigation) are to be established as WUA for the promotion of present and future water security interests. A WUA has to register with the local administration but the Water Regulation does not set out provisions that ensure a uniform system of registration. Such a system has been developed in the guidelines for WUAs, which will be finalized and approved by NECS.[43]

4.6 Training Needs Assessment

A training needs assessment (TNA) was carried out in the context of preparing this NIWRMP. The objective was to assess existing knowledge and capacity and identify role-specific short-term and long-term training needs among the various IWRM stakeholders identified, and to prepare a consolidated plan for training. The training plan is a priority recommended for implementation under the NIWRMP. An overview is given below. [44]

Training needs were identified in relation to the four categories of IWRM roles and functions noted earlier in

[43] Refer for details to the standalone supporting document entitled: *Guidelines for registration of Water User Associations under The Water Regulations of Bhutan 2014.*

[44] For details, refer to the standalone supporting document entitled: *Capacity Development and Training Needs Assessment.*

Section 4.5, namely: (1) policy and planning, (2) coordination and regulation, (3) water services delivery, and (4) information sharing and capacity development, including research. An inventory of subject matters relevant to these roles and functions was prepared. Ten subject matter headings were considered, under which a total of 58 specific topics were identified. A survey was carried out to gather baseline information on the current knowledge of stakeholders in relation to these IWRM-related topics, based on which the training plan was prepared. Training needs were identified for specific stakeholders based on the roles and subject matter pertinent to fulfilling those roles properly. The structure of the TNA is given in Table 12.

Table 12: Structure of the training needs assessment

IWRM Role	Subject Matter	Specific Topics
Role 1 IWRM Policy and Planning	IWRM principles and practices	IWRM history/rationale IWRM principles and practices Multi-disciplinary, multi-stakeholder context of IWRM River basin as basic unit for IWRM Conducting water resources inventory IWRM planning and implementation steps
	Climate change and hydrological assessments	Global climate change issues Interpreting regional climate change projections Managing uncertainty in climate projections Climate change vulnerability and impact assessment Identifying and assessing disaster risks Hydrological analysis Delineating watershed boundaries Assessing water availability in ungauged basins Statistical methods in hydrology Watershed and river modelling
	River basin planning	Conducting basin situation assessment Formulating vision and objectives Developing basin strategies Preparing detailed basin implementation plan Integrating strategic components of a basin plan: - Water resource protection and conservation - Water uses and allocations - Water-related disaster risk management - Climate change adaptation tools and practices
	IWRM Economics and Finance	Payment for ecosystem and water services Economic principles in pricing of water Trading of water rights and permits Polluters pay principle and pollution charge system Water development cost recovery and financing schemes
Role 2 Coordination and Regulation	Administration and institutional coordination	Institutional and organization management Decentralized and results-based planning Budgeting procedures and controls Organizational and coordination set-up for IWRM Stakeholder perspectives and interests
	Regulatory Enforcement	National water policy and regulatory framework Compliance monitoring and enforcement Environmental impact assessment and safeguards Social impact assessment and safeguards Setting minimum environmental flows
	Socio-political considerations of IWRM	Negotiation and conflict management Trans-boundary water issues (Bhutan-India) Socio-politics of water in Bhutan Role of women in IWRM Stakeholder mapping and analysis

IWRM Role	Subject Matter	Specific Topics
	Monitoring and assessment of water security	Monitoring and evaluation (MandE) frameworks Results-based MandE Performance indicators and benchmarking Geo-spatial data systems (GIS, remote sensing) Management information system and data portals Concept of water security and its dimensions Measuring water security (e.g., AWDO indicators) Media outreach and public communication
Role 3 Water utilization and services delivery	Water Utilization and Services Delivery	Assessing crop water requirements Assessing hydropower generation potential Assessing domestic water supply requirements Conducting engineering surveys Designing irrigation and drainage structures On-farm water management Rain water harvesting techniques Project cycle management Water quality analysis Contract management and procurement
Role 4 Information management and Capacity Development	Information Building and Sharing, Reporting and Networking	Managing IWRM as a learning process International IWRM applications and support networks Knowledge networks (Internet resources) Geo-spatial data systems (GIS, remote sensing) Management information system and data portals Media outreach and public communication

In carrying out the TNA, the roles of stakeholder groups were classified under the four categories above comprising: (1) policy and planning, (2) coordination and regulation, (3) water services delivery, and (4) information sharing and capacity development, including research. An inventory of *subject matter* relevant to IWRM then was prepared in which items were classified under the four IWRM role categories. Trainings on specific subject matters directly or indirectly relevant to fulfilling the agency roles were identified.

An online survey was deployed to gather *baseline* information on the current knowledge of stakeholders in relation to the inventory of IWRM-related topics, and also to gauge their perception of the topics' relevance to their work and their interest in acquiring training. Survey responses were gathered particularly among the TAC members who are based in various competent authorities with formal IWRM roles under the water law and regulation. Respondents were asked to indicate, on a scale of HIGH-MEDIUM-LOW, their individual rating of knowledge on each topic, perception of relevance to their present and future work, and their interest in training.

Under the 4 subject matter headings related to IWRM **policy and planning** (i.e., IWRM principles and practices, climate change and hydrologic assessments, economics and finance, and river basin planning), 60 to 80% of the respondents rated their present knowledge as *low*. Seventeen to 37% rated their current knowledge as *medium*. Only 1 to 3 % rated their current knowledge as *high*. The need for training is strongly indicated in the relatively high ratings given by respondents on the relevance of the topics to their present and future work, as well as their interest in receiving training.

For the 4 subject matter headings related to **coordination and regulation** (grouped under subject matter headings of water resources administration and institutions, regulatory enforcement, socio-politics, and monitoring of water security), 37 to 72% of the respondents rated their present knowledge as *low*, with the lowest rating (72%) given to monitoring water security. Twenty-six to 54% rated their current knowledge as *medium*. The highest percentage (54%) in this *medium* rating of existing knowledge was given on regulatory enforcement; the lowest (26%) again on water security monitoring. Ten percent of respondents rated their knowledge of regulatory enforcement as high. But on the remaining topics, only 1 to 3% rated their current

knowledge as *high*. The percentage of respondents who rated this group of institutions-related topics as being highly relevant to their present work ranged from 43 to 62%; those who rated present relevance as medium ranged from 25 to 41%. Future relevance to work was rated even higher. At least 69% of the respondents gave high ratings on their interest in receiving training.

For the subject matter related to **water utilization and water services delivery** (including irrigation), 79% rated their present knowledge as low. Forty-one percent rated the relevance of the topics to their current work as high, 36% as medium and 23% low. Seventy-one percent rated future relevance to work as high, 21% medium. Seventy percent of the respondents gave a *high* rating on their interest in receiving training on the topics.

A similar pattern was found for the topics on **information management**. Seventy-three percent of respondents rated their present knowledge as low. Sixty-one percent rated the relevance of the topics to their current work as high, 16% as medium and 8% low. Seventy-six percent rated future relevance to work as high, 16% medium. Seventy-five percent of the respondents gave a high rating on their interest in receiving training on the topics related to this subject matter.

A consolidated training plan, covering the above mentioned grouping of training topics, has been prepared, which also gives information on participants, timeframe, cost estimate, and logistic requirements. The training items are more technically specialized or management/coordination-oriented, and are proposed to be covered as part of the IWRM plan implementation. Refer to Appendix 3.

4.7 Water Users Associations

Basis for WUAs in the Water Regulation

According to Chapter III of the Water Regulation 2014, WUAs are to formulate and enforce their own rules for managing water sources, and for protecting the sources themselves. Furthermore, there are new expectations regarding the role of WUAs that are stated in the Water Regulation (Chapter III, Section 36). Notable are two expanded functions:

- Determine and adopt water user fees that are commensurate with the water services rendered, i.e. the fees can be charged in proportion to the surface area (acreage, decimal or square feet) of the irrigated land. The fees can also be differentiated between dry land, wet land and for other activities whether commercial or non-commercial, which require water; and
- Exercise such other powers and functions as may be delegated to it by a Competent Authority (Dzongkhag Administration or River Basin Committee) within the jurisdiction of the WUA.

According to the Water Regulation, WUAs are expected to become more involved in coordinating with local administrations and river basin authorities, thereby extending their role beyond coordination of water allocation and collection of fees. For instance:

- WUAs can request the Gewog or Dzongkhag Administrations to provide technical assistance in determining water availability, which will be used as basis for admitting new water users (e.g., in cases where the irrigation system is being expanded), or as basis for allowing non-irrigation water uses (e.g., livestock water use), and as basis for water sharing when water supply is scarce.
- WUAs can also be held accountable by the Gewog Administration in cases where “undue” development activities are encountered that pose a threat to the water source and its catchment (e.g., riverbank and watershed disturbances).

- From time to time, the WUAs may need to invite resource persons from the local administrations (e.g., district forest officer, district rural engineer) to attend WUA meetings in order to provide technical support or advice.

One of the coordination tasks of WUAs under the Water Regulation is that of federating with other WUAs to improve the water resource management of a common source. In particular, within the context of integrated catchment or basin management that aims to minimize upstream and downstream water use conflicts, federating WUAs would also be necessitated by the possible consolidation of adjoining irrigation systems as part of a system modernization or rehabilitation.

WUAs will also increasingly be involved in resolving disputes over water allocation. At present, water disputes have to be brought to the attention of the Gewog chief for resolution. As envisioned in the Water Regulation, WUAs could appoint one or more negotiation facilitators to settle disputes amicably, and if necessary render a decision by casting votes among the WUA members.[45]

Other expected roles of WUA as mandated by the Water Regulation are to:

- Decide on punitive actions for members failing to comply with the standing rules of the association;
- Hear and decide on disputes among its members relating to water and infrastructure use;
- take necessary measures to ensure efficient use of water, and
- Employ or appoint a water guard or *Chhusup*.

Administrative roles of the WUAs are also being expanded, including:

- Keep records of irrigable land holdings among WUA members;
- Maintain records of minutes of meetings and decisions taken;
- Maintain books of accounts on money received (e.g., from user fees) and disbursements made;
- Submit reports and exchange information with the WUA federation; and
- To acknowledge customary practices of water allocation, which are fair and equitable and do not result in the denial of water to any individual or community.

Legal Framework for WUAs registration system

It has been studied whether the responsibilities of Water Users Associations (WUAs) under the Water Act and Water Regulation are adequate in fulfilling the aims and objectives of the NIWRMP and overall plans and policies of the government in the management of water in the country. In this regard, the focus has been on the conditions and procedures for the registration of WUAs including the requirement of registration application forms and formats, which would enable the relevant authorities to properly regulate the WUAs as per the Water Act and Water Regulation. The proper registration of WUAs will also formalize the existing WUAs and will encourage the formation of new WUAs. The established system will provide the legal status to the WUAs for formation, registration and dispute settlement mechanisms, which will build confidence and relationships amongst the people at a grass root level who are the end users and beneficiaries of the laws, policies and systems of the government. The uniform system will also bring peace and harmony to the society, which is important in fulfilling the principles of Gross National Happiness.

[45] For additional details on resolving water allocation disputes at the community level, refer to the standalone supporting document entitled: *Social Aspects of Water Resource Management in Bhutan.*

On reviewing the Water Act, it was established that the provisions are indeed provided, but only in broad terms. Details of procedures are given in the rules and regulations. But these were found to be too summary and there is no proper system or procedure for regulating WUAs.

Therefore, guidelines have been developed which provide detailed procedures and forms for the registration process, and a dispute mechanism procedure that will give the affected parties an opportunity to appeal if not satisfied with the decision of the registrar or any competent authorities.

The guidelines also address the requirement of a constitution or memorandum of agreement containing the full names and signatures of the founding members which must be submitted to the registrar for the purpose of registration. The constitution or memorandum of agreement will be the governing document for WUAs. The said guideline will be finalized separately later in consultation with NECS.

As per section 32 of the Water Regulation, the Gewog Administration is responsible for registering WUAs, but there are no provisions for the appointment of the Registrar and corresponding responsibilities and procedures for registration. These provisions have also been elaborated in the guidelines, along with procedures for issuing certificate of registration, change in the constitution, and name or names of the office bearers of WUAs, amongst others.

The Registrar may refuse to register the WUAs based on various grounds. In such a case, there has to be a procedure for the refusal and procedures for appeal against the refusal. These are also included in the guidelines.

Registration of WUAs

The Chairperson and Office Bearers of the WUA will complete the documents and fill in the forms necessary for registration, where necessary assisted by relevant Competent Authorities from the Gewog or the Dzongkhag Administration

The documents and forms will contain the name and address of the WUAs, names of the Chairperson and office bearers, list of the water users, length of canal and the flow volume of the water, date of construction of the water facility, name and location of irrigation or drinking water source, whether the Association is for irrigation, drinking water, or both, or for any commercial purpose.

The Chairperson of the WUA will apply for registration with the concerned Gewog Administration. In case the water users comprise two or more Gewogs, the Association will be registered with the Gewog Administration that has the majority of water users. As per the guidelines, the founding members have to frame a Constitution or Memorandum of Agreement consisting of a full description of the functioning of the WUA along with the full names and signatures of the founding members. All of these relevant documents must be submitted to the registrar when applying for registration. The constitution and other documents framed by the founding members or any subsequent constitution and documents are the governing documents with respect to the functioning of the WUA. The Association will not operate contrary to its constitution and governing documents.

The registrar at the Gewog Administration will register eligible WUAs in the Gewog registry and maintain a register of WUAs, keep records and reports of WUAs and enquire into any matter regarding the performance of activities and management of WUAs. He or she shall ensure that information and other records on the operation of WUAs are made available to the government and public reference.

After being fully satisfied that all necessary information and relevant documents are provided, the registrar of the Gewog Administration will issue a certificate of registration under the sign and seal of the Gup, which will contain the name and address of the Association, the area of operation and such other terms and conditions, in respect of which the certificate is issued. The certificate will be issued as per the prescribed form in the guidelines. The copy of the registration certificates and a list of registered WUAs maintained with the Gewog

Administration will be sent annually to the Dzongkhag Administration with a copy to the relevant Competent Authorities for updates. There shall be registration fees chargeable and payable upon any application for a certification of registration, which shall be determined by the Gewog Administration.

The certificate of registration shall be the conclusive evidence of the WUAs to operate as specified in the Constitution or Memorandum of Agreement and in the certificate of registration.

If the required conditions are not fulfilled, the registrar will refuse to grant a certificate of registration and the aggrieved person can appeal to the Dzongkhag Water Management Committee (DWMC), which will decide the matter according to the proposed guidelines. In such a case, the registrar will inform the applicant of the reason behind the decision as per the form provided in the guidelines.

Changes and suspension of the WUA

Whenever there are any changes in the Constitution or Memorandum of Agreement in the name or names of the office bearers of the WUAs, the respective chairpersons shall notify the registrar of the concerned Gewog within three months of such changes in a manner prescribed in the form of the guideline. This is for the purpose of updating the records of the Association.

The registrar after receiving the notification shall enter into the register all changes as submitted in the notification and whenever necessary issue new certificate of registration and remove from the register the particulars of the Association as may be necessary. After the changes have been made in the register in respects of the particulars of the Association, he or she shall inform the Dzongkhag Administration and competent authorities of updates.

The certificate of registration may be suspended by the registrar if he or she is convinced that the terms and the conditions prescribed in the certificate have been violated, the WUA has ceased to exist, the WUA operates in variance to its constitution, or any interested person has submitted to the satisfaction of the registrar a recommendation for its suspension or cancellation. In such a case, the WUA will be notified in the prescribed form of the guideline and order it to stop its operations or remove the name of the said WUA from the register. Upon the receipt of the notice of suspension of certificate of registration, the holder of the certificate can make representation in writing for remedying or rectifying the default and where such a request is not entertained by the registrar, he or she can appeal to the DWMC for a review of the decision to suspend the certificate of registration. Thereafter, if not satisfied with the decision of the DWMC, appeal can be made to NEC. The appeal before the competent court of jurisdiction is the last resort.

For the purpose of registration procedure, different forms have been developed, which are provided as annexes in the proposed guidelines.

5 Bhutan Water Security Index

The basis for designing a coordination mechanism among the water-related agencies is provided by the Bhutan Water Security Index (BWSI) concept. The BWSI determines the extent to which water resources and their related services are developed, as measured over five key dimensions:

1. Rural drinking water supply, sanitation and hygiene
2. Economic water supply for agriculture, industries and hydropower
3. Urban water supply, sanitation and drainage
4. Environmental water security
5. Disaster and climate change resilience

These five key dimensions comprise 11 sub-dimensions and 57 indicators. These have been adapted from the Asian Water Development Outlook (AWDO) 2013 through a consultative process involving the Technical Advisory Committee represented by stakeholders and competent authorities. The dimensions and indicators make up the BWSI, which provides the framework for planning, monitoring and interagency coordination.

This chapter introduces the BWSI, which is a tool that provides a benchmark of Bhutan's water security. It will be regularly updated and used to coordinate water resource planning and performance monitoring across various agencies.

5.1 Concept

The concept of a water security index was introduced by ADB in its publication "Asian Water Development Outlook" (AWDO) for the Asia-Pacific Water Summit in 2007 in Japan. With the objective to provide a broader perspective on water management than (traditional) sectoral approaches, it aimed at comparing the status of water management and its delivery services in a number of Asian countries.

The concept was revised in 2013 and is being revised again to include quantitative measurements, and to provide direction for governance, investments, capacity-building, monitoring/ reporting.[46]

The concept was accepted for elaboration in Bhutan in a meeting of the NIWRMP Technical Advisory Committee (TAC) in December 2014. The indicators were adapted to Bhutan conditions in a national IWRM workshop held in March 2015. The results of the workshop were endorsed by the TAC in May 2015. Slight modifications were approved by the TAC in November 2015 to make the BWSI more practical.

5.2 Description

Societies can enjoy water security when they successfully manage their water resources and services to:

1. Satisfy household water and sanitation needs in all communities;
2. Support productive economies in agriculture, industry, and energy;
3. Develop vibrant, liveable cities and towns;
4. Restore healthy rivers and ecosystems; and

[46] Asian Development Bank, 2013. Asian Water Development Outlook 2013: Measuring water security in Asia and the Pacific.

5. Build resilient communities that can adapt to change.

UN-Water defines water security as "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

Five key dimensions have been designed to enable assessment of progress towards the goal of national water security. Some key dimensions are directly calculated from a set of indicators, while other key dimensions are composed of sub-dimensions each containing a set of indicators. Indicators may contain more than one parameter; see Table 13.

Table 13: Structure of the BWSI

Key dimensions	Sub-dimensions	Number of Indicators[47]
1. Rural household	-	3
2. Economic	1) Agric. Resilience 2) Agric. Water utilization 3) Industrial water security 4) Hydropower water security	12
3. Urban	-	5
4. Environment	1) Watershed disturbance 2) Pollution 3) Water resources management 4) Biotic factors	12
5. Resilience	1) Hazards and threats 2) Sensitivity to exposure 3) Coping and adaptive capacity	25
Total	11	57

Detailed description of Bhutan Water Security Index is given in Appendix 3.

5.3 Computation of water security scores

The set of indicators developed for each of the five dimensions provides the measure to assess progress in achieving water security. The indicators are numerically aggregated into an index score for each dimension of water security. Water security in any given dimension is measured as an aggregate of the indicators for the component. The rural household water security index, for example, is an aggregation of three component indicators covering the extent of access to piped water supply, access to improved[48] sanitation, and level of hygiene.

For each water security dimension, the resulting aggregated index is scaled from 1 to 5,[49] where a score of 1 represents the lowest level of security, and 5 represents the highest level, as shown in Table 14. By connecting the security index scores for each dimension, a pentagram can be derived—the size and shape of which is a good

[47] Refer to Appendix 4 for the definition of the 57 BWSI indicators.
[48] Improved sanitation is defined as toilets with a water seal that stops flies entering and smell spreading.
[49] The values of the BWSI cannot be compared with those determined by AWDO because the calculation method is very different.

representation of the water security of the country or river basin. The scores of the BWSI are given in Table 15 and can be visualized as described in the next section.[50]

Table 14: Water security index stage and criteria (after AWDO, 2013)

Index	Stage	Criteria
5	Model	Sustainable financing for water security, environmental protection and management already established
4	Effective	Water security is given high priority in the national agenda; appropriate public investment in water security; effective regulation and enforcement; public awareness and on-going behavioural changes apparent
3	Capable	Increasing levels of investment and strength of regulation and enforcement; water security and environment recognized as priorities in the national development agenda; improving technical and financial capabilities in addressing water-related issues
2	Engaged	Need to invest in water security recognized, including investment in capacity-building programs; on-going institutional development and strengthening; improving policy environment in which water-related issues are addressed
1	Hazardous	Inadequate levels of investment in water-related infrastructure and poor quality regulation and enforcement result in hazardous levels of water security

Table 15: Scores of the BWSI

KD\ Area	Amochhu	Wangchhu	Punatsangchhu	Mangdechhu	Drangmechhu	National (By district)
1 (Rural Household)	4.5	4.5	4.6	4.3	4.5	3.5
2 (Economic)	2.3	2.1	2.4	2.3	2.4	2.0
3 (Urban)	3.1	2.8	2.6	2.7	2.3	2.8
4 (Environment)	3.9	3.4	3.3	3.5	3.4	4.0
5 (Resilience)	3.6	3.9	3.2	3.7	3.4	3.1
Overall	3.48	3.34	3.22	3.3	3.2	3.08

The detailed computation is contained in a separate document titled **'Bhutan Water Security Index: Dimensions, Indicators and Computations**', a copy of which is included in the Volume 2 of this final report.

5.4 Visualisation of the BWSI

The scores of the key dimensions of the water security index can be visualised in a spider web diagram with five corners (or a pentagram). The baseline values obtained for 2015, with an overall average of **3.06**, are given in Figure 23. [51]

[50] For additional details, refer to the standalone supporting documents entitled: (i) *Bhutan Water Security Index System: Software Requirements Specification* and *(ii) Bhutan Water Security Index System: User's Manual*

[51] For some of the indicators, values were estimated when the exact figures were not yet available from the district-level sources. It is expected that, over time, the database on the indicators will be improved.

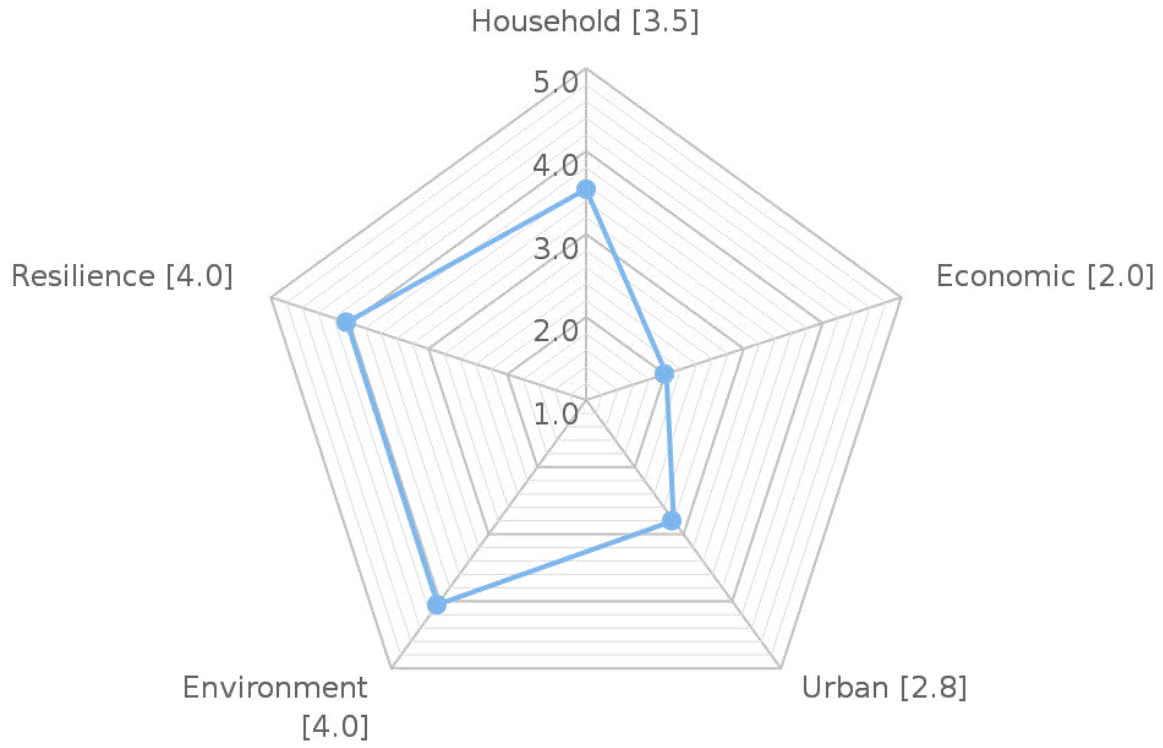


Figure 23: Visualisation of the national BWSI baseline scores for 2015

The size and shape of the diagram provide a good representation of the water security level in the country or concerned basin, and can be tracked over time in accordance with the evolving IWRM process, which is represented in Figure 24 as a spiral.

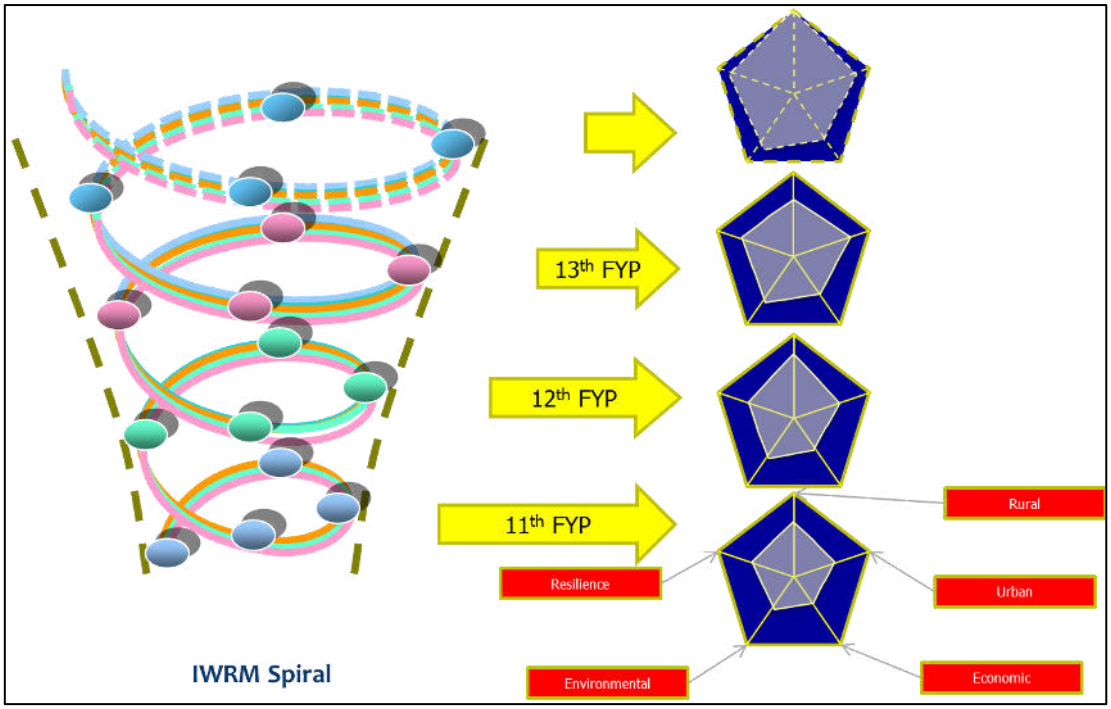


Figure 24: Tracking the BWSI over time

5.5 Key Result Areas, Key Performance Indicators and Strategies

The NIWRMP should be seen as a framework document with tools for the purpose of water-related planning and coordination. More concrete planning shall be done through the river basin management plans for which the NIWRMP aims to provide guidelines.

The goal of the National IWRM plan is to achieve water security for Bhutan. This is to be accomplished by better coordination between the water users and key agencies that are managing the water resources. The Bhutan Water Security Index is the mechanism proposed to be used for the envisaged coordination in planning and management. In line with the GNHC terminology in the FYPs, Key Result Areas (KRAs), Key Performance Indicators (KPIs) and Strategies have been identified along the structure of the BWSI. In other words, it is proposed that the water security be adopted as National Key Result Area in addition to the 16 KRAs that have already been defined under the planning mechanism established under the Gross National Happiness Commission. The BWSI has 5 Key Dimensions, which would translate into 5 Sectoral Key Result Areas that would be added to the 300 Sectoral Key Result Areas that are already in use in the FYPs.

The objectives of the NIWRMP are based on the five key dimensions of the BWSI. They correlate with the Sectoral Key Result Areas in the FYPs and the extent to which the objectives are being accomplished are measured by indicators. The KRAs and indicators are mostly self-explanatory and briefly explained below. The strategies explain how the objectives of the key dimensions would be realized. A number of strategies are identified for each Key Dimension, but the list is not meant to be exhaustive. Some duplication is unavoidable. Some indicators in the BWSI are god given and not manageable, like rainfall variability. For planning purposes, these have been

replaced with indicators for which management interventions and targets can actually be set. The results are presented in Table 16.[52]

Table 16: KRAs, KPIs and strategies against the BWSI

Key Result Areas	Key Performance Indicators	Strategies
Rural Water Security		
Improved drinking water supply, sanitation and hygiene in rural areas	• Percentage of population with piped potable water supply • Percentage of population with improved (sealed) sanitation • Reduction in incidence of diarrhea	• Improve the condition of catchment areas and water sources (reforestation and conservation measures) • Improve access to alternative drinking water sources (water harvesting, groundwater development) • Move human settlements on hill slopes to lower elevations (for better water supply) • Improve management and maintenance of rural water supply systems (strengthen Water Users Associations) • Carry out health campaigns (public awareness)
Economic Water Security		
Enhanced resilience of agriculture sector to adverse effects of climate change, notably rainfall variability	• Percentage of cropped areas irrigated from water impoundments/reservoirs	• Increase number/ volume of water retention structures • Groundwater exploitation • Adopt agricultural adaptation measures (water-efficient crops, increase water use efficiencies)
Increased agricultural water utilization/efficiency and contribution to GDP	• Agricultural contribution to GDP • Percentage of arable land that is irrigated	• Crop diversification, especially favoring high-value crops • Increase coverage of irrigation • Reduce water losses in agriculture/irrigation
Increased water utilization efficiency in industry	• Revenue generated from water-based industries • Reduced water use intensity of industrial activities (i.e., volume of water abstracted per monetary unit of output)	• Expand water-based clean industries • Shift to high-value production
Enhanced contribution of hydropower industry to the national economy	• Percentage of potential hydropower capacity that is installed • Percentage of hydropower contribution to total energy consumption • Revenue derived from hydropower (as percentage contribution to GDP) • Increased hydropower efficiency (as weighted average of annual plant load factor)	• Increase hydropower development • Conservation of catchment areas to dampen seasonal flow variation and to reduce sediment load of the water (both expected to worsen under climate change) • Increase number and volume of water retention structures/ reservoirs to dampen seasonal flow variation and to reduce sediment load of the water
Urban Water Security		

[52] For details on how these KRAs and KPIs are to be incorporated into the national planning and budgeting system, refer to the standalone supporting document entitled: *Integrated Water Resource Management in Bhutan: Possible entry points in Development Planning and Budgeting System.*

Key Result Areas	Key Performance Indicators	Strategies
Improved/protected urban drinking water supply	• Percentage of urban population having potable piped water supply • Percentage of urban water supply loss (un-accounted for water)	• Improve access to alternative drinking water sources (water harvesting, groundwater development) • Improve design, maintenance and management of urban water supply systems (strengthen responsible agencies)
Improved coverage and effectiveness of urban sanitation and drainage	• Percentage of urban population with improved sanitation • Percentage of urban population with (at-least weekly) waste collection and disposal service • Reduction in damage from urban flooding	• Improve the condition of catchment areas and water sources (reforestation and conservation measures) • Water metering and pricing • Improve urban drainage systems • Remove settlements from flood-prone areas • Improve solid waste collection and disposal services • Carry out publicity
Environmental Water Security		
Watersheds protected and conserved, and existing degradation reversed	• Reduction in rate of forest land conversion to cropland and other land uses including cattle grazing • Area of natural wetlands placed under sustainable management • Area of degraded forest lands placed under sustainable management	• Watershed conservation programs, particularly in areas marked as 'critical' • Reduce the loss of natural watershed areas to the extent possible (under economic development) • Control drainage and erosion from disturbed land surfaces • Environment-friendly road construction • Control number of livestock that is roaming free (by stable feeding) • Protect natural wetlands • Control forest fires • Control (illegal) logging
Reduced water quality degradation	• Reduction in total suspended solids in rivers tapped for hydropower • Reduction in organic loading (specifically biological oxygen demand)	• Watershed conservation programs to control run-off and erosion, and to keep sediment loads in the water down • Expand and improve coverage of sewage treatment • Enact/enforce regulations relating to pollution
Water resources protected and utilized/managed on a sustainable basis	• Number of major river basins with updated water resources assessments (incorporating projected impacts of climate change) • Number of rivers in which minimum environmental flows are enforced/maintained • Number of urban centers with water use efficiency and conservation plans • Number of river basins with functioning river basin committees • Number of functional Water Users Associations	• Maintain ecological flows • Plan water-consuming activities (urban centers, irrigation and industries) in those areas where water availability is good • Reduce water demand (increase water-use efficiency, water-efficient crops, etc.) • Improve water balance assessments (better quality and coverage of climatic and stream flow data) • Formulation/ updating and implementation of (comprehensive) river basin management plans

Key Result Areas	Key Performance Indicators	Strategies
		• Re-align district and Gewog boundaries to match hydrological boundaries
Biota of river ecosystems protected	• Number of river systems with completed biotic studies and conservation plans	• Monitoring of fish (aquatic) species
Disaster and Climate Change Resilience		
Reduced risk of exposure and sensitivity to climate change hazards and threats	• Number/percentage of glacial lakes assessed for GLOF hazards • Area coverage of database on climate change hazards, particularly regarding changes in rainfall intensity and drought frequency • Number of additional weather monitoring stations established and operational • Number of flood monitoring warning systems established • Percentage of national area covered by hazard zonation maps • Number/area of reforestation activities to prevent flooding and to increase groundwater recharge	• Strategies for adaptation to extreme weather events • Update inventory of GLOFs and design/ implement mitigating measures • Improve weather forecasting system (expand/ improve weather and flow monitoring stations) • Design/ implement early warning systems for floods
Increased capacity to cope and adapt to impacts of climate change	• Number of district-level emergency response units established/functional • Number of river basin management plans, incorporating climate resilience components, approved for implementation • Number and storage capacity of water retention and water harvesting structures constructed • Number/length of river training works completed • Length/capacity of urban drainage systems improved	• Drainage improvement/ river training works • Watershed conservation and re-forestation • Improve reach/ effectiveness of emergency response mechanisms • Increase number/ volume of water retention/ infiltration structures • Maintain updated flood/ drought hazard zonation maps • Expand/ improve early warning systems • Identify/ implement flood mitigation measures • Pursue literacy and general education • Promote access of communities to TV, radio and mobile phones • Reserve emergency funds

5.6 Interagency Coordination Framework based on BWSI

Some 22 different agencies are involved in generating information for the BWSI, and five of them are primarily responsible for generating and yearly updating the input data for the BWSI. These are the Ministry of Economic Affairs, Ministry of Agriculture and Forestry, National Statistics Bureau, and the Ministry of Health.

It follows that these agencies are 'bound together' in this concept, although they remain sovereign within their own domain. NECS is custodian of the water security system, and hence the coordinator for inputs by the respective agencies. In essence, the water security dimensions and indicators provide the platform for assessing

the contribution of the agencies towards each of the dimensions as well as the overall national and basin-level water security. The computed scores presented in the spider web diagram allow planners and decision makers to visualize sectors contributions to the water security index thereby providing them with the basis for prioritization in the planning.

The IWRM planning and coordination framework is given in full in appendix 4.

6 Management Framework for IWRM

IWRM is applied at the river basin level. It is therefore necessary to describe the management framework for IWRM at the basin level in a separate chapter.[53] This chapter starts with the delineation of the IWRM *management* basins. This is followed by a detailed description of the River Basin Committees (RBCs) to be formed, along with their roles and responsibilities, see also Section 4.5. The chapter ends with a description of the River Basin Plans to be prepared.

6.1 Delineation of management units for IWRM

The hydrological river basins have been described in Section 2.6. From a practical administrative viewpoint, it is not desirable to have too many basins, especially when five out of the 10 basins are relatively small. Therefore, the hydrological basins of Bhutan have been grouped together into five *management* units as presented in Figure 25 and Table 17. Amochhu has been grouped with Jaldakha, Punatsangchhu with Aiechhu, and Drangmechhu with Nyera-Amori, Jomori/Dhinsari, and Merak Sakteng. This may seem at odds with the principle of IWRM, but it is important to also take into account the practicality and cost-effectiveness of implementing the concept. For instance, the delineated five management units will reduce the number of new institutions (RBCs) to be established and hence ease the coordination role of NECS.

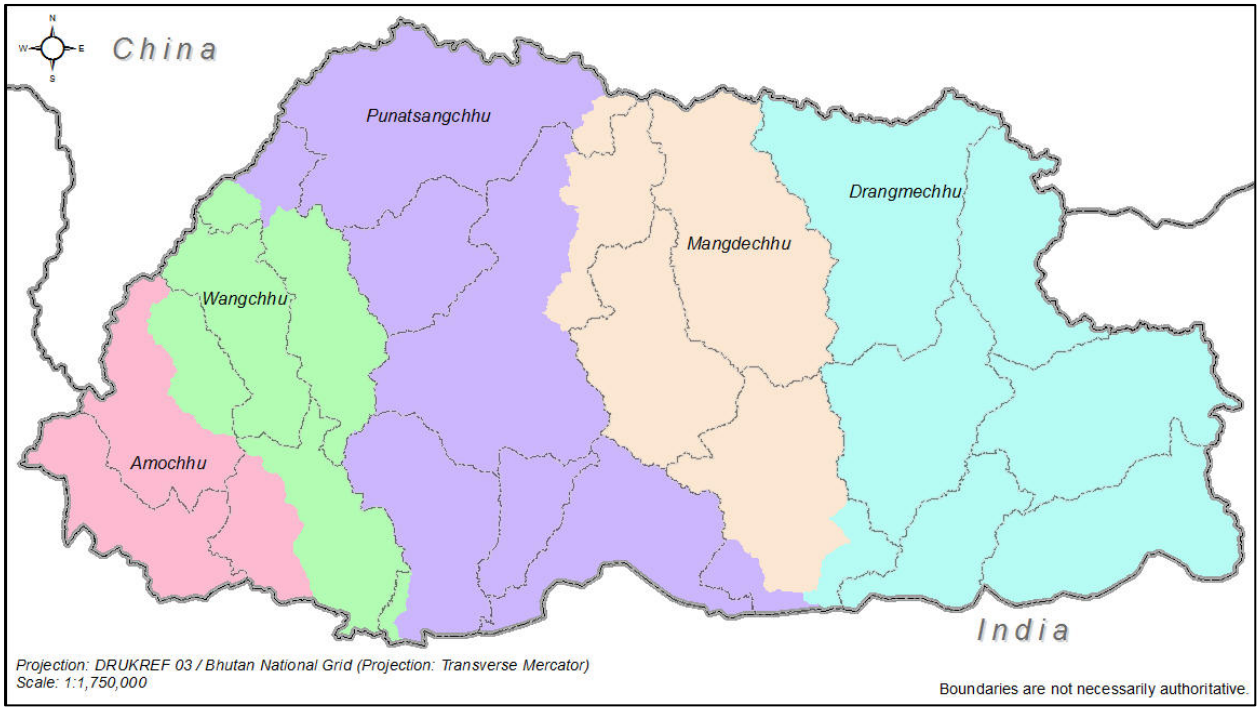


Figure 25: Delineation of river basins for IWRM planning and management

As shown in Figure 24, parts of some districts spread over two basins. The assessed areas under each hydrological basin and annual flow (MCM) for the management basins are given in Table 17.

[53] Some overlap with the description of the institutional framework at the national level is inevitable.

Table 17: Grouping of hydrological basins into management basins

Management basin		Hydrological basin		Area (km2)	Annual flow (MCM)
1	Amochhu	1	Amochhu	2310	9,375
		2	Jaldakha	942	
2	Wangchhu	3	Wangchhu	4596	5,209
3	Punatsangchhu	4	Punatsangchhu	9645	19,130
		5	Aiechhu	1937	6,989
4	Mangdechhu	6	Mangdechhu	7380	11,797
5	Drangmechhu	7	Drangmechhu	8457	13,569
		8	Nyera Amari	2348	4,507
		9	Jomori/ Dhinsari	642	
		10	Merak-Sakteng	137	
			Total	38,394	70,576
			Flow in m3/s		2,238

6.2 River basin committee and its functions

The philosophy in designing Bhutan's institutional set-up for IWRM at the basin level is to use and build on existing administrative institutions as much as possible. That is a key reason the RBCs are based on the coordination model.

It is neither necessary nor politically realistic to create unitary basin organizations to replace the role of water resource management from existing administrative institutions. Standalone basin organizations would also be against the concept of cross-sectoral 'integration' and holistic views propagated by IWRM.

The RBC framework and functions have been elaborated based on guidelines in the Water Act and Water Regulation, and have been approved by NEC in their meeting held on 25 June 2015. It should be noted that an RBC, which will be formed for each of the five management basins, may have sub-committees looking after minor hydrological basins, or even at specific activities in sub-basin areas.[54]

The RBC will be supported by a Secretariat. From time to time, the RBC may summon for consultation a "council" consisting of invited representatives from Gewog-level administrations, NGOs, state enterprises, and other relevant stakeholders to discuss specific issues or concerns.

The RBC for each management basin will be established officially by the NEC through the NECS. This has already been done for the Wangchhu basin. The RBC will have a broad mandate to *coordinate* policies and actions concerning basin plan coordination and management of water resources, including preparation and periodic updating of the river basin management plan. From within the basin, it will be composed of incumbent chairpersons of the district development councils (Dzongkhag Tshogdus*)*, district governors (Dzongdags), Mayors (Thrompons) and district environment officers (DEOs) who, in accordance with the Water Act, are responsible for water concerns.

[54] For additional details on the institutional set-up for forming the river basin committees, refer to the standalone supporting document entitled: *Coordination Framework and Terms of Reference for River Basin Committees.*

The position of RBC chairperson will be rotated *annually* among the district governors covered by the basin, and a staff member of the NECS-WRCD will be designated as permanent member secretary.

According to the Water Act (Chapter 6, Section 27) , members of the River Basin Committee (RBC) may broadly be drawn from Water User's Associations or Federation of Water Users' Associations, hydropower generation agencies, industries, drinking water supply and sanitation service providers, recreation and tourism operators, registered environmental non-governmental organizations, traditional communities with particular regard to those engaged in subsistence farming, and the Department of Forest and Park Services. However, these stakeholders need not all be regular members of the committee so as to avoid overcrowding the RBC membership. Individual stakeholders shall be invited by the RBC during deliberation of matters relevant to the stakeholders' specific concerns.

A diagram showing the structure and position of the River Basin Committee is shown in Figure 26.

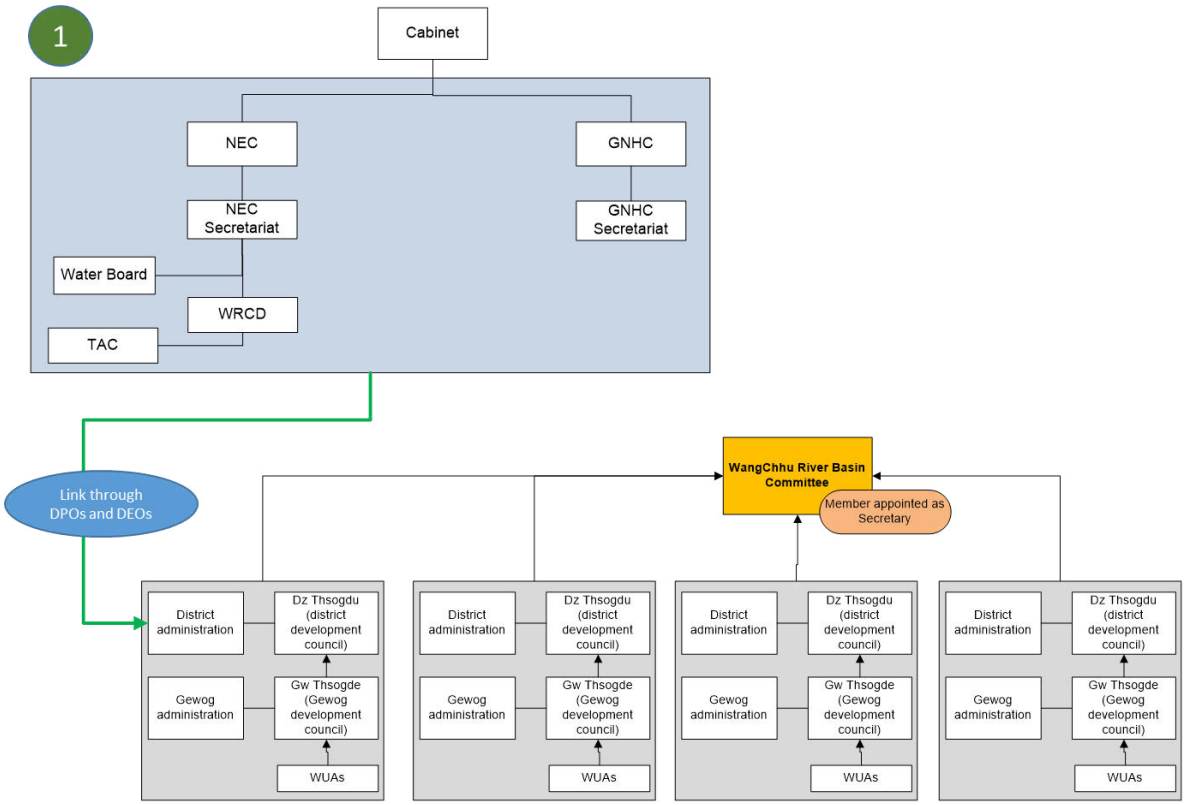


Figure 26: Structure and position of River Basin Committee

Ideally, the RBC shall meet at least three times a year. Notices of meetings are to be sent out two weeks in advance, and one week in advance if the meeting is urgent. The required quorum for meetings is two-thirds of the RBC members. Two consecutive absences of an RBC member shall be grounds for reporting of such absence to the NEC. Committee members may send representatives to attend RBC meetings, but not for two consecutive meetings during the year. The RBC chairperson, upon advice of the Secretariat, may invite specific stakeholders or resource persons to attend meetings if their participation is relevant to the meeting agenda (but they cannot vote). Bi-annual reports to the NEC/NECS shall be submitted by each RBC on the 30th of June and 31st of December.

Functions of the River Basin Committee

With reference to the Water Act, the specific functions of the RBC are as follows:

1. To promote community participation in the protection, use, development, conservation, management and control of water resources in its area of operation through education and other relevant activities:
    a. Formulate rules and procedures for the establishment and operation of community-level Water Users Associations
    b. Promote and reward positive behavioural changes toward efficient water use and protection/maintenance of water sources
    c. Raise community awareness on water-related issues, such as wasteful water consumption, unhygienic sanitation, improper disposal of solid and liquid wastes, water-borne diseases, and environmental damage
    d. Raise awareness on the various technical options of efficient water distribution and avoidance of losses
    e. Encourage users to pay for water-related services within the scope of existing regulations
    f. Promote adherence to directives from the RBC in resolving water-related disputes
    g. Provide regular platform to inform and hear from stakeholders on matters related to water management in the basin
    h. Develop and implement programs for local capacity-building in IWRM
2. To prepare a River Basin Management Plan together with the NECS
    a. Assemble information required to prepare the basin plan
    b. Consolidate water resources management plans prepared at the district level, including those of sectoral agencies involved in water management, and ensure that these are reflected in the basin plan (i.e., checking that the plans do not draw more water than is available)
    c. Provide detailed specifications of programs and projects incorporated in the basin plan, including a proposed "responsibility framework" that identifies the appropriate level of plan implementation (i.e., by national agency or local administration)
    d. Ensure that the basin plan is consistent with the principles and objectives of the National Integrated Water Resources Management Plan (NIWRMP), and that the *water-related Key Result Areas (KRAs) and Key Performance Indicators (KPIs)* incorporated in the GNHC's medium term planning guidelines are reflected in the basin plan
    e. Identify potential sources of funding for the proposed basin programs, including from international development assistance organizations, and develop proposals accordingly
    f. Mobilize and allocate funds secured that are intended for implementing IWRM activities intended for the whole basin (i.e., programs identified through the RBC and covering multiple districts)
3. To monitor and report to the Commission on the effectiveness of policies and action in achieving sustainable management of water resources in its area of operation
    a. Review the district-level integrated water use management and safety plans prepared by the respective Dzongkhag administrations based on the basin plan, and monitor their implementation for reporting to the NEC
    b. Review the management/safety plans prepared by Class A Thromde Administrations in the basin to ensure efficient urban water supply and effluent disposal, including urban drainage systems, and monitor their implementation for reporting to the NEC and the Ministry of Works and Human Settlements
4. To collect, manage and share such data as are necessary to properly manage the basin in coordination with the Commission

a. Establish baseline data on the water security indicators for the basin, following the framework set up by the NEC and GNHC for a national water security indicator system

b. Based on the basin plan implementation reports of the Dzongkhag and Thromde administrations, consolidate data to periodically update the water security indicators for the river basin, and report these to the NEC and GNHC, as well as to the basin consultative council

c. Facilitate the exchange of data and information among agencies operating in the river basin, and among the district and Gewog level administrations

5. To help resolve cross-sectoral and Dzongkhag trans-boundary issues relating to water resources in the basin

    a. Serve as forum through which issues/disputes related to water sharing and distribution among districts within the basin can be discussed and resolved in an informed and consultative manner

    b. Establish procedures/rules for hearing and resolving trans-boundary water allocation issues

    c. Monitor and report to the NEC on adherence of parties to agreed trans-boundary water resources sharing

6. To perform any such additional functions as the NEC may direct, related to water resources management concerns in the basin.

Secretariat of the River Basin Committee

A permanent Secretariat for each RBC will be established. NECS shall facilitate the setting up of the RBC Secretariats and serve as the interim RBC Secretariat with support from the District Environment Officers (DEOs) in each management basin. An independent Secretariat will take over responsibility from NECS-WRCD when suitable provisions are available and with the agreement of NECS and the particular RBC.

The secretariat shall prepare the meeting agenda for the basin committee, gather information needed to brief the committee on issues to be tackled, document proceedings, and consolidate the water management plan for the basin (derived from the district and Gewog plans). As mandated by the RBC chairperson, the secretariat may summon representatives from the sectoral competent authorities to serve as resource persons. The latter shall give advice on technical matters, and ensure coordination of the basin plan with sector-level plans and programs for water resources development and management. The Secretariat will draw support from sectoral Competent Authorities on technical matters.

The RBC secretariat shall also act as an administrative support unit to the RBC. It will be responsible for following through and monitoring implementation of measures authorized or directed by the basin committee; it will also work with the district and Gewog administrations to monitor water use/issues in the basin, including water infrastructure activities and related programs in the basin (in coordination with sectoral competent authorities). The DEOs of respective districts in the basin will assist in carrying out Secretariat functions.

Under the supervision of the RBC, the Secretariat shall perform the following tasks:

1. Assist the Chairperson of the RBC in preparation of annotated agenda of RBC meetings, draft minutes of the meetings and maintain records of RBC meetings.
2. Prepare and propose annual work plan and operational budget for the RBC, seek RBC approval and submit to WRCD, NECS for timely inclusion in the annual budget proposal.
3. Assist the RBC in applying the water security performance indicator system for the basin.
4. Coordinate with the concerned district administrations and national sectoral agencies to ensure that basin plan items are being implemented.

5. Advise the RBC in evaluating impacts of development plans or actions proposed by local administrations and national sectoral agencies operating in the basin.
6. Assist the RBC in preparing water security and water-related reports to the NEC and GNHC.
7. Facilitate conveyance of advisories or directives of the RBC to the district and Gewog administrations, as well as collate responses.
8. In coordination with the NECS, maintain a water database for the basin, and coordinate the updating of information collected by local administrations and sectoral agencies operating in the basin.
9. Establish a "knowledge hub" for matters pertaining to basin water resources management and coordination.
10. Document successful IWRM interventions in the basin for reporting to the RBC, as well as dissemination to national policy-makers, stakeholders and the media.
11. Facilitate networking and partnerships with NGOs, communities, state enterprises and private organizations operating in the basin.
12. Identify needs and facilitate training and capacity building (with assistance from the NECS) among local administration staff on integrated water resources planning and management.
13. Coordinate with the district and Gewog administrations to collect, compile, check, sort and analyse data about the status of water resources in the basin, and the on-going implementation of basin plans.
14. Prepare necessary Monitoring and Evaluation forms and formats to collect data and information on the status of water resources and water security in the basin.
15. Monitor performance of local administrations in implementing their assigned roles under the river basin plan, and report to the RBC.

A proposed staffing of the Secretariat, which identifies positions and tasks, is provided in the RBC framework.[55]

6.3 River basin management plans

Preparation of River Basin Management Plans

The Water Act requires that a River Basin Management Plan (RBMP) be prepared for each basin and mandates the NEC, supported by the RBCs concerned, to prepare such plans.

The Water Act states that:

- A National Integrated Water Resources Management plan shall be formulated for coordinated development, management, conservation and efficient use of water resources.
- The NEC-Secretariat, assisted by competent authorities, shall prepare and periodically update a River Basin Management Plan for each river basin.
- The NIWRMP shall provide binding guidelines for the preparation of RBMPs.

The Water Regulation adds that NECS, with the Competent Authorities, shall ensure that the NIWRMP is mainstreamed into national and sectoral policies, plans and programs for the efficient, effective and sustainable management of water resources, including watersheds and wetlands.

It also stipulates that NECS will designate major river basins for the purpose of preparing the RBMP for its implementation by respective Competent Authorities. The NECS shall review and adopt River Basin Management Plans and forward them to the Gross National Happiness Commission for mainstreaming into national plans.

[55] Refer to supporting document titled *Coordination Framework and Terms of Reference for River Basin Committees.*

The Water Regulation also states that the Secretariat shall conduct an inventory of water resources, identify and demarcate the river basins, identify water resources for drinking, irrigation, energy, industry or other uses, and identify critical issues, gaps, and socio-economic concerns for the protection and conservation of water resources.

Contents of the River Basin Management Plan[56]

The Water Act states that the RBMP shall contain at least the following elements:

- Details of the water management area drawn from the NIWRMP;
- Details on Flood Risk Zones and risk management plans;
- Details on designated areas for habitat conservation and species directly depending on river water;
- A program for the monitoring of water status within the river basin area.

The Water Regulation adds that the RBMP shall contain the following elements:

- Details of the water management area drawn from the NIWRMP;
- Details on Flood Risk Zones and risk management plans;
- Details on designated areas for habitat conservation and species directly depending on river water;
- A program for monitoring of water status within the river basin area;
- Maps of the location and boundaries of water bodies;
- Compilation of water related baseline data;
- Maps of watershed areas of the river, monitoring stations, human settlements, agricultural land use, and planned Hydropower development;
- Hydropower integration with respect to watershed management;
- Impacts of human activity on the quality and quantity of water resources;
- Identification of both point source and non-point source pollution;
- Analysis of social and health impacts;
- An economic analysis of water, in particular, those with potential for competing use;[57]
- Mechanisms to control water abstraction and discharges in relation to permits and environmental clearances issued;
- A summary of the public consultation;
- Measures to prevent deterioration of water bodies, limit or control water pollutants; and
- Measures to enhance and restore polluted or depleted water bodies.

[56] For the plan prepared for the pilot Wangchhu river basin, refer to the standalone supporting document entitled: *Wangchhu Basin Management Plan 2016.*

[57] For details, refer to the standalone document entitled: *Economic Analysis*.

7 Priorities under the National IWRM Plan

The IWRM spiral illustrates IWRM as an incremental, step-by-step iterative process, and therefore provides a practical framework for looking ahead and planning for successive 'turns of the spiral' thereby gradually achieving improved status and management of the water resources. From among all water-related activities already touched upon in the NIWRMP, the following main priorities are recommended.

7.1 Adoption of water security concept for coordination in IWRM planning and monitoring

It is proposed that the goal of attaining water security be adopted as a National Key Result Area in the GNHC planning guidelines for the preparation of successive Five Year Plans, starting with the 12th FYP. This National Key Result Area is elaborated in the form of 5 objectives, 57 indicators and numerous strategies for the preparation of river basin management plans as set out in Chapter 5. The decision to adopt water security as KRA in the national planning process may be taken before the end of the 11th FYP. It is desirable that water security is adopted as a national key result area and start pursuing implementation in the remaining period of the 11 FYP.

7.2 Designation of agency roles in operationalizing the BWSI

The BWSI has been developed as a tool for coordination of agencies, whereby different agencies take responsibility for planning, monitoring and reporting on specific BWSI dimensions and indicators identified for each agency. This delineation of responsibilities is given in Appendix 4, and needs to be formalized by the government when adopting the BWSI concept. To ensure effective implementation of the responsibilities, it is recommended that the concerned Authority in the government issue an Executive Order requiring agencies listed in Appendix 4 to:

- appoint focal persons to take up the responsibility of coordinating collection and input of information pertaining to the dimensions and indicators identified for the agency;
- update the information on an annual basis.

The NECS has the responsibility of ensuring proper administration and functioning of the online Bhutan Water Security Information Management System:

- for smooth and timely data entry by designated agencies;
- to collate the updated information and prepare annual report on the status of water security;
- apprise the NEC, the Cabinet and the GNHC on the status of Bhutan's water security;
- to organize periodical platforms for the revision of the indicators to fit the country's needs over time.

7.3 Delineation of river basins for IWRM

The river basins are grouped into the following *management* units, as was shown in Figure 25 in Section 6.1 for the purpose of delineating the areas of responsibilities for each RBC and corresponding RBMP.

i. Amochhu with Jaldakha
ii. Wangchhu
iii. Punatsangchhu with Aiechhu
iv. Mangdechhu

v. Drangmechhu with Nyera-Amari, Jomari/ Dhansari, and Merak-Sakteng

The decision on clustering hydrological river basins into management units for the purposes of IWRM is expected to be taken by the NEC before the end of the 11th FYP.

7.4 Formation of successive RBCs and preparation of RBMPs

The framework and TOR for the formation and operation of River Basin Committees have been endorsed by the NEC in line with the stipulations of the Water Act. The formation of the RBC for Wangchhu, as a pilot basin, has been approved, and the preparation of the RBMP for this initial management basin is underway. Following on this initial RBC formation, it is necessary to establish River Basin Committees and finalize River Basin Management Plans for the management units of Amochu, Punatsangchhu, Mangdechhu, and Drangmechhu basins.

While it would be desirable for the remaining RBMPs to be prepared simultaneously, the task may also be sequenced on the basis of fund availability, urgency of water issues in the basins and other priorities deemed appropriate by the government.

7.5 Information gathering on fragmented water sources

At the smaller scale where water issues are acutely being felt, and based on the stipulations of the Water Regulation, the Gewogs shall systematically document information about the rivulets, lakes/ponds and wetlands with respect to: (i) location, type, and name of water source; (ii) purpose of utilization and amounts of water abstracted; (iii) importance for religion, culture and environment.

There is a need for the NECS to support the Gewogs in gathering and reporting information (discussed further in Section 7.11). It is recommended that each District Environment Officer be provided with an assistant who can facilitate support to the Gewogs.

7.6 Enhance water retention capacity

Bhutan's physical variability and dispersed settlements render it difficult for large-scale water retention structures to benefit large populations. Instead, small water impoundment systems for harvesting rainfall and trapping water behind check dams installed in small streams, combined with the restoration and protection of small natural lakes so that these can be used for water supply during lean months, should be given priority attention.

7.7 Formalisation and strengthening of Water Users Associations

The present decentralized approach in the operations of WUAs reflects observations that customary water management arrangements and non-codified community rules are effective in managing irrigation water allocations and system maintenance, including conflict resolution. However, such customary practices may be effective only as long as the water supply and irrigation systems remain traditional. If there is external intervention to expand or modernize systems as proposed in the master plan for irrigation development,[58] the

[58] Refer to the supporting standalone documents entitled: (i) *National Irrigation Master Plan* and (ii) *Irrigation Engineering Manual, 2016*.

establishment and operation of WUAs will need to become more formalized and codified. This is true especially if organized water users require financial assistance, for example micro-financing from the Bhutan Development Bank, to procure farming equipment or inputs; this requires the WUA to be a legal entity. Section 4.9 described the recommended procedures for legalizing the status of WUAs through registration. The existing and upcoming WUAs shall thus be formalized, registered and strengthened within a given time frame which is to be incorporated in the planning process.

The WUAs will need to acquire the capacity to cope with their new tasks. The role of women in the decision-making and implementation process will be enhanced. This will be reflected in the constitution and by-laws that govern the operation of the WUAs. To that effect, it is recommended that DOA provide training on improved irrigation practices, and that MoH provide training on sanitation and drinking water facilities to WUAs.

7.8 Strengthening the capacity of NECS

Given the increased work load for NECS with respect to coordinating planning and monitoring IWRM, it is proposed to strengthen its capacity to do so as described below.

To keep momentum in IWRM, and for its effective implementation, the proposed increase in capacity of NECS may be implemented by the end of the 11th FYP.[59]

Strengthening the coordination mechanism

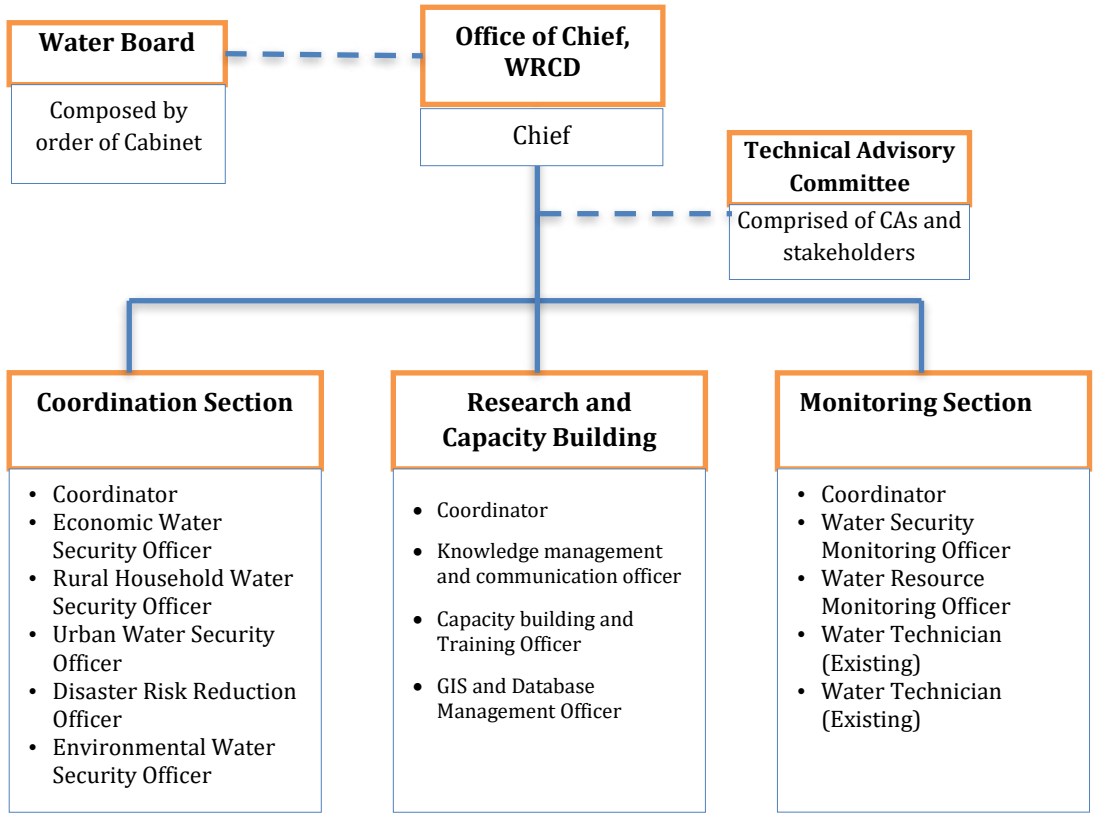
This will require the Water Resources Coordination Division (WRCD) in NECS to enhance its coordination role whereby it should create a platform for players to cooperate and interact to systematically plan, implement, maintain and update information, and report. For this, the WRCD shall be re-organised and strengthened into three major sections:

1) Coordination Section to:
    i. Develop and apply the framework for the Water Security Indicator system for Bhutan.
    ii. Facilitate a common platform for the planning and implementation of the National IWRM plan based on the water security framework.
2) Research and Capacity Building section to:
    i. Provide research services by collecting, collating, and analysing sectorial information and publish periodical water security index (preferably at Gewog, district, and national levels).
    ii. Develop and update water quality standards for different sectors.
    iii. Conduct orientation/training for District Environment Officers and RBC Secretariats on the assessment and monitoring of water resources and water security.
3) Monitoring section to:
    i. Monitor performance of government agencies with mandates under the Water Act towards the delivery of KRAs, measured through their corresponding Key Performance Indicators.
    ii. Coordinate with the GNHC on water-related aspects for the National Monitoring and Evaluation System (NMES), in particular on the M&E set-up and the operation of the web-based Planning and Monitoring System (PlaMS) to incorporate key water security indicators (adopted in the GNHC planning guidelines).

[59] For details on the organizational assessment and capacity strengthening of the NECS to plan and coordinate IWRM implementation, refer to the supporting standalone document entitled: *Strengthening of the Water Resource Coordination Division under National Environment Commission Secretariat.*

iii. Coordinate with the basin committees/secretariats to collect, compile, check, sort and analyse qualitative and quantitative data about the status of water resources and the on-going implementation of basin plans and district/Gewog level activities.

The organogram is presented in Figure 27. As can be seen a total of 10 new posts are recommended to be created.



Note: There are five existing staff members under WRCD - Chief, Deputy Chief, Environment Officer and two technicians.

Figure 27: Organogram of sections proposed under the WRCD, NECS

7.9 Strengthening the capacity of the Department of Agriculture

Water use for irrigated agriculture is an important aspect of IWRM. The NIWRMP therefore incorporates the recommendations of the National Irrigation Master Plan to increase the capacity of DOA with 20 additional staff along the lines described below. It may be realized by the end of the 11th FYP.[60]

Main Interventions

1. **Strengthening of the existing Irrigation Management Section at the central office with establishment of three sub-units**, as depicted in Figure 28. Each sub-unit will be comprised of one coordinator and two officers, in total adding 9 staff at the central office.

[60] For details on the organizational assessment and capacity strengthening of the DOA, refer to the standalone supporting document entitled: *Strengthening of the Department of Agriculture and Water User Associations.*

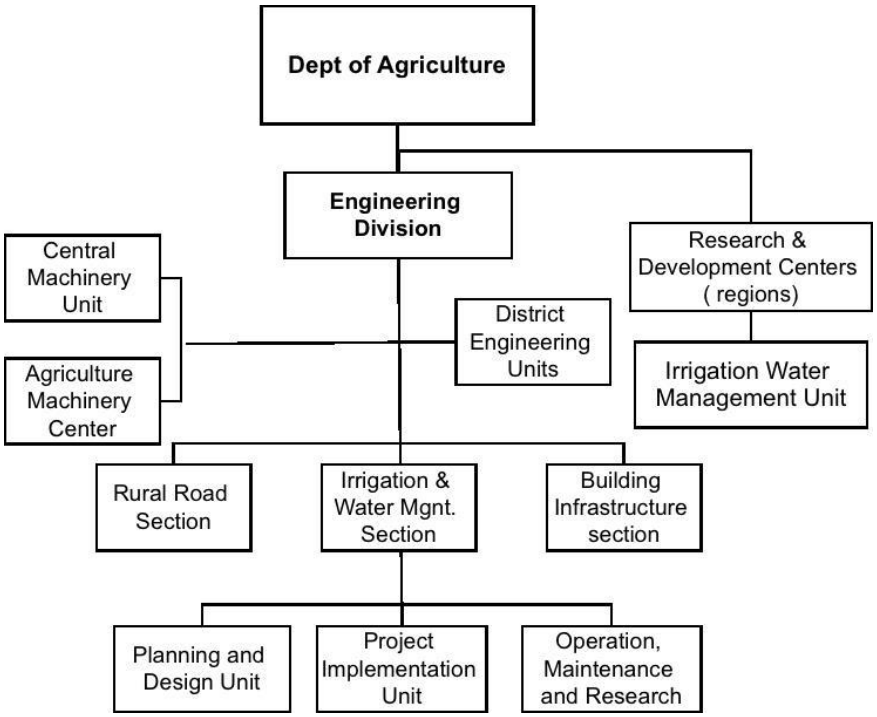


Figure 28: Proposed units under the Irrigation and Water Management Section of the DOA

2. **Designate the Research and Development Centres to specific management basins**

For the purpose of facilitating technical backstopping and coordination of planning, implementation, and monitoring operation and maintenance of irrigation infrastructure projects, it is recommended that the RDCs are designated to look after specific management basins as proposed below, see Table 18:

Table 18: Allocation of RDCs over IWRM Management Basins

Research and Development Centres	Designated Management Basins
RDC Bhur	Mangdechhu
RDC Bajo	Punatsangchhu
RDC Wengkhar	Drangme chhu
RDC Yusipang	Amochhu and Wangchhu

3. Establishment of Irrigation Water Management Units at the DoA Research and Development Centres to facilitate research on best practices for water management in irrigation systems.[61]

The 2014 Water Regulation called for setting up of irrigation water management units under the three Research and Development Centres. Specifically, the regulation mandated MoAF to "institute an irrigation water management unit under its three existing Research and Development Centres (RDC) to facilitate and support irrigation development. Currently, however, there is only an average of three DoA Engineering Division staff posted in each of the three RDCs. Setting up an irrigation management unit in four RDCs, with at least 2 personnel assigned to the unit, entails adding 8 staff to the Engineering Division.

[61] The details of the proposals are elaborated in the standalone supporting document entitled: *Strengthening of the Department of Agriculture and Water User Associations.*

4. Moreover, it is proposed to designate the 4 Research and Development Centres to specific basin management units: the new RDC in west Bhutan would look after the Amochhu and Wangchhu basins; the RDC in Bhur would look after the Mangdechhu basin; the RDC at Bhajo would take care of the Punatsangchhu-Aiechhu basin and the RDC in Wengkhar would take care of the Drangmechhu and Nyera-Amari basin.

7.10 Strengthening the weather and hydrological monitoring and forecasting capacity

It is proposed to improve the functions of the Department of Hydro and Meteorological Services (DHMS) as outlined below during the course of the 12th FYP.[62]

1. Expand and improve weather and water monitoring stations

DHMS should be able generate hydro-meteorological information that is sufficiently detailed to represent smaller geographical units (districts and Gewogs) throughout the country. Presently, 92% of the stations cover only about half of the country's land mass, i.e., areas below an elevation of 3,000 meters. Higher elevations are thus significantly under-represented.

Based on the guidelines of the World Meteorological Organisation regarding the density of meteorological stations, a mountainous country like Bhutan should have precipitation gauges for every 250 square kilometres (or approximately 15 km apart, on average). This translates to 150 such stations to cover the country, which is roughly 60% higher than the present station density.

Expanding the meteorological network to adequately cover elevations above 3,000 meters is important due to the projected increase in precipitation with latitude (particularly in Bhutan's mid-zone), and associated with the shift of the snow line northward because of global warming.

Groundwater and ambient water quality are presently not in the domain of any agency. DHMS staff would be well poised to include them in their responsibilities.

2. DHMS as broad service provider

It is proposed that DHMS will in the future provide hydrological and meteorological information to sectors other than hydropower, such as NEC (for IWRM) and Agriculture.

The current location of the DHMS within the MoEA has raised concern as to whether, under such an organizational set-up, the department is in an effective position to fulfil that role. The need to upgrade DHMS into an independent institution is being taken up by the government but not yet in place as of April 2016. The option of delinking the DHMS from the MoEA to establish it as a standalone service bureau needs to be pursued.

[62] For details of the assessment conducted on the DHMS capacity, including recommendations for strengthening, refer to the standalone supporting document entitled: *Strengthening Bhutan's Capacity for Future Climate Modelling: A Proposal for Strengthening Hydromet Services.*

7.11 Support Gewog/District administration

The Gewog and District administrations need support for registration of the WUAs and for documentation of the local water sources and their use. This support can be extended by the WRCD of NECS after it has been strengthened, or by providing one assistant to the DEO in each District. NGOs can also play a role in this context.

7.12 Implement the training plan

It is proposed to implement the training plan for government staff as summarised in Appendix 3. This plan is based on the findings of the training needs assessment described in Section 4.6 on Institutional Strengthening.

7.13 Improvement and harmonisation of the legal framework for IWRM

The Water Act of 2011 is the first Act to address water resources in an integrated manner. Previously, management of water resources was fragmented, addressed in different laws, and only focused on the operational level. The Water Act is an important milestone in the implementation of the concept of IWRM in national legislation. It is also in line with the national development philosophy of Gross National Happiness. The issues broadly covered in the Act are elaborated in more detail in the Water Regulation 2014. Some deficiencies have been addressed in the Guidelines for WUAs, which have been elaborated for this NIWRMP. These Guidelines should be approved and endorsed as a priority.

It is recommended to monitor the implementation of the new legal framework during the plan period of this NIWRMP, particularly with respect to the issues identified in Section 4.2. The NECS should guide this monitoring process in line with its overall coordination role. The yearly reports of the water-related institutions at all government levels are important inputs for the collection of information about the implementation of the Water Act and the Water Regulation. In addition, the NECS can initiate other activities such as workshops with relevant stakeholders to create consensus about issues that need further improvement in the legislation. Based on that, it would become clear which issues can be sufficiently resolved through amending only the Water Regulation, and which issues are of such an importance that they need to be resolved at the level of the Water Act itself.

Another point concerns the relation between the Water Act and other water-related acts. It is important that the Water Act and the water-related acts (as well as their underlying implementing regulations) are sufficiently harmonized to avoid overlaps, contradictions or gaps. The overall conclusion of a desktop assessment carried out in 2015 is that the Water Act and the existing water-related acts (and regulations) are in harmony. Most issues are addressed in the acts consistently, though in some cases there are ambiguities that may cause confusion – as stated in Section 5.2. On-going initiatives to revise the concerned water-related acts (such as the Electricity Act) can be used to solve the ambiguities.[63]

7.14 Study the potential for groundwater utilization

It is believed that groundwater could be a sustainable source of water that could be especially useful during the lean period. However, information on the potential of ground water has not been investigated till date. It is

[63] For additional details in the proposed harmonization of the IWRM legal framework, refer to the standalone supporting document titled: *Legal Aspects of Integrated Water Resource Management in Bhutan.*

proposed that a study is commissioned to investigate ground water. Considering that the exercise entails huge cost, it is recommended that the study be prioritized for southern foothills and the wider river valleys such as Punakha and Paro.

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Appendices

Appendix 1: Areas covered by basins

Percentage of districts in the basins, and percentage of basins in the districts

Districts	Area (Sq.Km)	Wangchhu		Punatsangchhu		Mangdechhu		Drangmechhu		Amochhu		Aiechhu		Nyera Amachhu		Total
		% of district	% of basin	% of district	% of basin	% of district	% of basin	% of district	% of basin	% of district	% of basin	% of district	% of basin	% of district	% of basin	% of district
Thimphu	1792	81.2%	31.7%	18.8%	3.5%											100%
Gasa	2951			100.0%	30.7%											100%
Punakha	1110			100.0%	11.5%											100%
Wangdue Phodrang	3977			74.3%	30.7%	26.1%	13.6%									100%
Tsirang	638			100.0%	6.6%											100%
Dagana	1713	4.0%	1.5%	95.2%	17.0%							0.8%	0.7%			100%
Trongsa	1814					100.0%	23.8%									100%
Bumthang	2667					100.0%	35.0%									100%
Zhemgang	2416					87.2%	27.6%	12.8%	3.6%							100%
Lhuentse	2851							100.0%	33.4%							100%
Monggar	1940							100.0%	22.7%							100%
Trashi Yangtse	1447							100.0%	17.0%							100%
Trashigang	2198							58.1%	15.0%					41.9%	32.9%	100%
Pema Gatshel	1022							69.2%	8.3%			30.8%	15.9%			100%
Chhukha	1,880	63.3%	25.9%							36.7%	21.2%					100%
Haa	1,905	31.0%	12.9%							69.0%	40.3%					100%
Paro	1,287	100.0%	28.0%													100%
Samdrup Jongkhar	1,877													100.0%	67%	100%
Samtse	1,256									100.0%	38.5%					100%
Sarpang	1,655											100.0%	83.4%			100%
Area / %	38395	4592.0	100.0%	9618.8	100.0%	7625.1	100.0%	8531.0	100.0%	3259.5	100.0%	1983.9	100.0%	2797.4	100.0%	

Appendix 2: Description of the institutional framework

Outline of the Institutional Framework

There are more than 15 key institutions in Bhutan which have a stake in IWRM. Their respective roles have been defined in Chapter 3 of the Water Act and in Chapter 2 of the Water Regulation. The table below briefly describes the primary mandate of each of these institutions and their specific IWRM roles with regard to (i) policy and planning, (ii) coordination and regulatory powers, (iii) water services delivery, and (iv) information management/reporting and capacity building.

Description of the institutional framework

<table>
<tr><td rowspan="4">1. Ministry of Agriculture and Forests (MoAF)</td><td colspan="2">MoAF is the Competent Authority on irrigation, watershed and wetland management. It is responsible for development of irrigation systems and management of watersheds throughout the country. The Engineering Division of the ministry provides engineering services to local administrations for design and development of irrigations systems. The Watershed Management Division (under the Department of Forest and Park Services) is tasked to categorize watersheds, prepare management plans, and implement them in collaboration with stakeholders.</td></tr>
<tr><td>WRM policy and planning role:
• Formulate, implement and periodically review a comprehensive National Irrigation Policy
• Develop and implement watershed and wetland management plans
• Identify watershed areas that require protection, conservation and management for sustainable supply of water;
• Conduct feasibility studies on new irrigation systems</td><td>Coordination and Regulatory role:
• Ensure the protection, conservation and management of watersheds to sustain water supply and other environmental services
• Promote payment for environmental services mechanism to support watershed management programs
• In consultation with NECS, develop and issue quality standards for irrigation water discharge</td></tr>
<tr><td>Water service delivery role:
• Ensure that water abstraction for irrigation is in line with NIWRMP
• Design irrigation water conveyance infrastructure and implement these optimize water use efficiency
• Ensure reliable and efficient water supply system for cropping intensification and diversification
• Ensure that the concept of eco-efficient water infrastructure is followed while developing irrigation systems
• Facilitate the formation and registration of an irrigation WUAs and monitor them</td><td>Information, reporting, research and capacity-building role:
• Develop comprehensive inventory on irrigation systems in the country and update annually
• Identify cost effective irrigation technologies and encourage adoption
• Promote cropping patterns and land use management suitable to water availability conditions
• Conduct seminars or training for members of the irrigation WUA on efficient water management
• Explore alternative water resources like rain water harvesting and hydropower reservoirs
• Involve Civil Society Organizations to</td></tr>
</table>

<table>
<tr><td></td><td></td><td>educate, inform and train farmers on watershed management practices
• Set up an irrigation water management unit under its existing Research and Development Centres
• Conduct research on best practices in water management
• Develop and implement an effective MandE and reporting system for irrigation systems
• Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met</td></tr>
<tr><td rowspan="3">2. Ministry of Economic Affairs (MoEA)</td><td colspan="2">Through MoEA's Department of Hydropower and Power Systems, it has the responsibility of promoting sustainable hydropower development for Bhutan. Its mission is to govern and facilitate integrated, regionally balanced and optimal use of water for development of hydropower with minimum environmental impacts; ensure that hydropower generates maximum revenue to the nation; ensure secure, reliable, and affordable electricity for the Bhutan; provide enabling environment for participation of the public and private sectors in development of hydropower resources; implement institutional reforms for efficient planning and management of the sector; and develop and enhance professionals for hydropower development and management. Through the Department of Hydro-Met Services, it provides weather, water, climate, and other related environmental services to various sectors. It services provided by the agency include daily weather forecast, agro-meteorological information, warnings and alerts for extreme events such as GLOF, and hydro-meteorological data. The Department of Geology and Mines, through its Glaciology Division carries out monitoring of Glaciers and Glacial Lakes, update inventory of Glaciers and Glacial Lakes, conduct research on Glacial Lakes and propose remedial measures for GLOF risk reduction, implement mitigation measures and study impact of climate change on Glaciers and Glacial Lakes.</td></tr>
<tr><td>WRM policy and planning role:
• For the NIWRMP, monitor water flows and sediments in river courses to control and mitigate adverse environmental impacts from the dam constructions, river diversions, mining and industrial activities
• Assist in developing the NIWRMP and take measures to implement it in relation to hydropower activities and river ecology
• Consider hydropower planning for multiple uses such as drinking water, irrigation and recreational purposes</td><td>Coordination and regulatory role:
• Coordinate river-related activities in collaboration with the RBC
• Ensure the effective implementation of guidelines on safety measures to be taken while planning, designing and implementing hydropower dam construction
• Ensure minimum environmental flow to be maintained in rivers while planning hydropower projects</td></tr>
<tr><td>Water service delivery role:
None</td><td>Information, reporting, research and capacity-building role:
• Monitor water flows and sediments in river courses
• Collect, analyse and disseminate data on water resources pertaining to planning and implementation of hydropower</td></tr>
</table>

		projects • Conduct studies on glacial dynamics for GLOFs • Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met
3. Ministry of Education (MOE)	The MoE does not have direct water management and service delivery mandates specified in the Water Act and the Water Regulation. Its main role, as one of the competent authorities mentioned in the Water Act, is to promote awareness of water-related issues among the general public.	
	WRM policy and planning role: None	Coordination and regulatory role: • Coordination information gathering for educational and public awareness-raising purposes
	Water service delivery role: • None	Information, reporting, research and capacity-building role: • Collect information on water resources from other Competent Authorities and incorporate these into its education programs and curriculum • Conduct educational activities to sensitize and create awareness among the general public on the importance of water resources management • Submit annual report to the NECS on implementation and enforcement of Water Act/Water Regulation, including difficulties, issues and challenges met
4. Ministry of Health (MoH)	Ministry of Health is responsible for the overall planning, implementation and management of infrastructure for drinking water supply and sewage management for all rural areas, which it undertakes in collaboration with local governments. It is also mandated to monitor quality of drinking water. MoH is mandated under the Water Act and the Water Regulation to mainstream water resources management in its policies, plans and programs. Although spring sources are to be given preference as a drinking water source, the ministry is mandated to explore alternative drinking water resources like rainwater harvesting and tapping of hydropower reservoirs.	
	WRM policy and planning role: • Review existing status of drinking water supply systems in rural areas • Develop national master plan for rural drinking water and wastewater management (with emphasis on spring sources) • Develop, issue and revise guidelines on water safety plans and “eco-efficient” water infrastructures	Coordination and regulatory role: • Assist NECS in developing and revising drinking water quality standards • Designate focal persons to monitor water quality standards in Thromde and rural areas.
	Water service delivery role:	Information, reporting, research and

	• Implement measures to ensure reliable and efficient drinking water supply systems in rural areas • Identify and provide incentives or subsidies for water saving schemes or better wastewater management for rural areas	capacity-building role: • Explore alternative drinking water resources like rain water harvesting and possible linkage to hydropower reservoirs • Maintain and periodically update records of physical, chemical and biological findings with respect to drinking water at the consumer level • Raise awareness of disinfectant mechanisms and on water borne diseases among water users • Develop training materials on water safety • Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met
5. Ministry of Home and Cultural Affairs (MOHCA)	The Ministry of Home and Cultural Affairs, through its Department of Disaster Management, is involved in the water sector in terms of disaster mitigation and relief, especially in water-related disaster such as Glacial Lake Outburst Floods (GLOFs).	
	WRM policy and planning role: • Develop system to inform the public in times of water related natural disasters	Coordination and regulatory role: • Coordinate on disaster preparedness and mitigation measures to be taken • Make local governments accountable for the protection and promotion of local cultural practices that are environment friendly and that protect water bodies recognized as abodes of deities
	Service delivery role: • Inform the public in times of water-related natural disasters	Information, reporting, research and capacity-building role: • Maintain registries on well-known therapeutically valued water bodies, and ensure their sustainable use • Discourage pollution of water bodies caused by disposing religious effigies, ritual cakes, cremation remnants, etc. • Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met
6. Ministry of Works and Human Settlements (MoWHS)	MoWHS is responsible for the overall planning, implementation and management of infrastructure for drinking water supply and wastewater for the Thromde in collaboration with local governments. It assesses strengths and shortfalls for water supply maintenance, and identifies remedial measures. It is mandated to prepare its development plans in consultation with local governments. Like the Ministry of Health, it is mandated to mainstream water resources management into its policies, plans and programs.	
	WRM policy and planning role:	Coordination and regulatory role:

	• Review existing status of drinking water supply systems in Thromdes • Develop a national master plan for the drinking water and waste water management system for Thromdes • Develop, issue and revise guidelines on water safety plans and eco-efficient water infrastructures	• Ensure proper implementation of Water Safety Plans through regular monitoring and evaluation
	Water service delivery role: • Implement measures to ensure reliable and efficient drinking water supply systems in urban municipalities • Identify and provide incentives or subsidies for water saving schemes or better wastewater management	Information, reporting, research and capacity-building role: • Explore alternative drinking water resources like rain water harvesting and hydropower reservoirs • Conduct studies on, and encourage use of, environment friendly, cost effective and water efficient technologies • Provide training on water safety plans and eco-efficient water infrastructures • Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met
7. National Environment Commission (NEC)	NEC was established in the early 1990s and acts as the highest authority and decision-making body on all matters relating to policies, plans and guidelines for managing environment and water resources. The commission derives its powers and functions from the overarching National Environment Protection Act 2007, the Environmental Assessment Act 2000, Waste Prevention and Management Act 2009, the (latest) Water Act of 2011. Under the Water Act, NEC serves as the apex authority for the purpose of developing policies, plans, programs and monitoring water resource management in the country. The NEC members are appointed by the Cabinet and comprised primarily of high-level ministerial members representing the relevant government Ministries, representatives of the private sector, Civil Society Organizations (CSOs) and an advisor to the Commission. The Prime Minister serves as the Chairperson, and the Secretary of NECS serves as the Secretary. The MoAF Minister has been designated as the Minister in-charge for NECS and serves as the vice-chairperson of the Commission.	
	WRM policy and planning role: • Implement the IWRM principles enshrined in the Water Act • Review and adopt the National Integrated Water Resource Management Plan (NIWRMP) for its incorporation into national policies, plans and programs • Review and adopt guidelines for water resource management plans including River Basin Management Plans (RBMPs) • Form River Basin Committees for preparation of the River Basin Management Plans • Review and adopt the Water Regulation	Coordination and regulatory role: • Ensure effective enforcement of the Water Regulation by Competent Authorities represented in the NEC • Institutionalize the environmental assessment process and environmental clearance system as an integral part of the water resource development planning process • Coordinate the activities of the various CAs through the NEC Secretariat

	• Protect and promote a safe and healthy environment • Prevent, control and abate environmental harm, including pollution • Ensure conservation and sustainable use of natural resources • Negotiate and enforce bilateral and multilateral agreements related to water resources • Update water law and regulation	
	Water service delivery role: None	Information, research and capacity-building role: Carried out through the NEC Secretariat
8. National Environment Commission Secretariat (NECS)	The NECS carries out the day-to-day functions of the National Environment Commission. It assists the NEC in administering the provisions in the Water Act. Headed by a Secretary (who is also a member of the NEC), the NECS is comprised of five divisions: (i) Services division providing administrative and program services, (ii) Environmental Services Division primarily dealing with Environmental Clearances, (iii) Compliance Monitoring Division, (iv) Water Resources Coordination Division and (v) Climate Change Division. Each Division is headed by a Chief. District Environmental Officers (DEOs) who are administratively under the Dzongkhag administration units carry out the functions of NECS at the district level. They report directly to the district governor, although they are also answerable to the NECS. A Water Resource Coordination Division (WRCD) was set up in May 2010 in accordance with a Cabinet Directive upon recommendation of the NEC.	
	WRM policy and planning role: • Prepare National Integrated Water Resource Management Plan • Review and adopt River Basin Management Plans and forward them to the Gross National Happiness Commission for mainstreaming into national plans	Coordination and regulatory role: • Develop appropriate standards for water regulation • In coordination with Competent Authorities, review and revise the Water Regulation • With competent Authorities, enforce water quality standards • Coordinate among Competent Authorities to develop inventories on water resources, both on quality and quantity baseline data • Assess and issue environmental clearances for projects including water related projects and programs • Issue directives that are binding on all persons and competent authorities for purposes specified in the Water Act
	Water service delivery role: None	Information, research and capacity-building role: • Monitor the state of water resources and compile, analyse and disseminate information • Collaborate with the MoAF, MoEA, and the River Basin Committees to develop

		and maintain inventories on river hydrology, aquatic habitat, river ecology and morphology to enable scientific determination of minimum environmental flow to be maintained by hydropower projects • Initiate and support research works on water related areas • Develop a reporting format to be used by Competent Authorities as general guidelines for reporting under this Regulation • Develop and maintain a National Registry on both drinking and irrigation water resources and river basin management
9. Gross National Happiness Commission (GNHC)	The erstwhile Planning Commission was renamed the Gross National Happiness Commission (GNHC) by the first democratically elected government in 2008. GNHC is the apex body for setting the development priorities and plans for the country based on the four pillars of GNH. The Commission is comprised of high level ministerial members appointed by the Cabinet. The Secretary of the Commission's Secretariat serves as the member Secretary.	
	WRM policy and planning role: • Review and endorse policies and guidelines for national planning that incorporate all sector concerns including water • Review and endorse national vision documents (example Vision 2020) and Five Year Plans that contain water related targets.	Coordination role: • Deliberate inter-ministerial coordination issues during commission meetings • Review progress reports consolidated and submitted by GHNC Secretariat • Delegate day to day coordination functions to the Secretariat
	Water service delivery role: None	Information, research and capacity-building role: Carried out through the GNHC Secretariat
10. Gross National Happiness Commission Secretariat (GNHCS)	The GNHC Secretariat is the administrative and programs machinery serving to fulfil the functions and priorities of the GNHC. Planning officers across the country support the Secretariat with local and sectoral plans.	
	WRM policy and planning role: • screen policies proposed by line agencies in the government • develop guidelines for national planning • set sector KRAs and KPIs • Review and endorse national vision documents (example Vision 2020) and Five Year Plans that contain water related targets.	Coordination role: • Consolidate plans and priorities with clearly defined KRAs and KPIs at national, district and Gewog levels • Screen and approve project proposals from sectoral agencies • Monitor progress against plans through online Planning and Monitoring System (PLaMS)[64] • Liaise with Prime Minister's Office in defining targets for annual compacts with sectors

[64] The Government Performance Monitoring System has come into practice, but PLAMS has not been abandoned.

		• Mobilize resource in collaboration with Ministry of Finance and facilitate fund flow
	Water service delivery role: None	Information, research and capacity-building role: • Repository of information on on-going and past plans of Gewog, Dzongkhag, Ministries and other governmental agencies • Conduct research to facilitate development planning • Develop monitoring and reporting tools • Build capacity of planning officers
11. Civil Society Organizations (CSOs)	The relevant CSOs are the Royal Society for the Protection of Nature (RSPN) which is hosting the Bhutan Water Partnership (BhWP), the World Wildlife Foundation (WWF), and the Tarayana Foundation. The RSPN and BhWP have been engaged in water for sustainable livelihoods program whereby they work with concerned agencies in the government to support small-scale rural water supply, sanitation, and irrigation development initiatives. Tarayana Foundation engages at the grassroots level in rural livelihoods enhancement program especially in far-flung areas. WWF Bhutan Program provides financial and technical support to the government and NGOs in ecosystem services assessment, watershed management, and river basin planning.	
	WRM policy and planning role: • Provide resources and inputs to the preparation of IWRM and RBM plans	Coordination role: • Promote public-private partnership activities to control water pollution and conserve water resources
	Water service delivery role: None	Information, research and capacity-building role: • Raise public awareness on the importance of preventing water pollution and sustainable use of water resources • Educate and raise public awareness on the use of alternative technologies for efficient water resource management; and • Inform the public on misuse or abuse of water resources by commercial entities • Conduct research and produce policy papers
12. Dzongkhag Tshogdu (district development council)	Local administrations are important players in planning, implementing and operating water projects. Bhutan's 20 administrative districts are headed by appointed governors and are further divided into 205 Gewogs. Under the Local Government Act 2009, the Dzongkhag Tshogdu (district development council) acts as the executive body of the district, although they are not empowered to pass laws. The district councils are composed of elected leaders from each Gewog. Thromdes (urban centres) are subdivisions of the Dzongkhags that are more densely populated (i.e., urban municipalities) and have their own councils with directly elected members. District and	

<table>
<tr><td></td><td colspan="2">Thromde councils are tasked with balancing socio-economic development, promoting business, protecting consumers, coordinating government agency activities, reviewing Gewog regulations and ordinances, and representing the districts in national referenda. They enforce rules on health and public safety, and regulate environmental pollution. District councils bear the responsibility for their own finances.</td></tr>
<tr><td></td><td>WRM policy and planning role:
• Identify elements under the national water sector plan that are to be implemented at the local level
• Specify KRAs to be addressed in the area development priorities (from the stakeholder consultations).
• Plan water facilities for drinking water supply and irrigation
• Incorporate the National Irrigation Plan (NIP) into its local water resources management plan
• Provide technical inputs during preliminary investigations and multi-disciplinary feasibility studies on drinking and irrigation water abstraction proposals
• Carry out detailed surveys, designs, drawings, estimates and bill of quantities of feasible irrigation and drinking water systems
• Ensure that Water Safety Plans are developed and implemented</td><td>Coordination and regulatory role:
• Coordinate/collaborate with the Dzongkhag Water Management Committee in planning water projects
• Facilitate outsourcing of drinking water and irrigation engineering services to private sector in the Dzongkhag</td></tr>
<tr><td></td><td>Water service delivery role:
• Mobilize funds and implement drinking water and irrigation projects in accordance with the NIP (and NIP operation and maintenance manual)
• Conduct tender and execute contracts for the construction of drinking water and irrigation facilities
• Supervise construction works on drinking and irrigation water facilities
• Ensure that the water supply systems are maintained regularly within its jurisdiction</td><td>Information, reporting, research and capacity-building role:
• Establish an effective monitoring and evaluation system for irrigation and drinking water supply system
• Submit reports on the progress status of water supply systems to concerned Competent Authorities
• Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met</td></tr>
<tr><td>13. Gewog Tshogde (Gewog development council)</td><td colspan="2">Each Gewog is administered by a Gewog Tshogde (Block Council or Block Development Committee), which is subordinate to the Dzongkhag Tshogdu (district council). The Gewog council is composed of a Gup (headman), Mangmi (deputy), and between five to eight elected leaders (Tshogpas) from among the constituent villages. Block council representatives serve five-year terms. The Gewog Tshogde is empowered to regulate resources, manage public health and safety, and levy taxes on land, grazing, cattle, entertainment, and utilities. The Gewog administration administers its own budget under the supervision of the Ministry of Finance. It also has jurisdiction over roads, buildings (including architecture), recreational areas, utilities, agriculture, and the formulation of local five-year development plans. However, the Gewog administration is not empowered</td></tr>
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<tr><td></td><td colspan="2">to pass laws. Gewogs are further subdivided into Chiwogs, which are the equivalent of municipalities or cluster of villages. There are generally 5-6 Chiwogs in each Gewog. The Gup and Tshogpas prepare proposals for rural infrastructure in the five-year development plans and they organize local projects. They also settle community disputes (including water-related disputes), and decide the use of community resources including land and water. A Gewog Administrative Officer (GAO) plays a key role in initiating and facilitating the annual Gewog-level planning process.</td></tr>
<tr><td></td><td>WRM policy and planning role:
• Encourage the adoption of appropriate drinking and irrigation technologies and good water management practices
• Assist communities in identifying and conducting feasibility studies on new drinking or irrigation water system or maintenance of the existing infrastructure
• Work with competent authorities in planning drinking and irrigation water projects</td><td>Coordination and regulatory role:
• Facilitate formation of WUAs and assist in their registration with the Gewog administration
• Ensure all water sources for drinking and irrigation are registered with the Gewog administration
• Provide liaising services between community and Dzongkhag Administration or Competent Authorities on planning, execution and monitoring of drinking and irrigation water systems
• Coordinate skill development activities for the members of registered WUAs
• issue permit for water abstractions and use of source within their jurisdiction not requiring an Environmental Clearance</td></tr>
<tr><td></td><td>Water service delivery role:
• Implement and monitor national drinking water and irrigation policies, following procedural manuals issued by Competent Authorities
• Ensure regular maintenance of water supply systems
• Ensure effective implementation of the Water Safety Plan
• Assist Competent Authorities in the day-to-day supervision of water infrastructure construction and maintenance works</td><td>Information, reporting research and capacity-building role:
• Monitor and evaluate drinking and irrigation water programs
• Develop and maintain separate inventories on irrigation and drinking water systems
• Compile and submit periodic progress reports to the Dzongkhag Administration on drinking water and irrigation facilities
• Maintain records of WUAs and make these records available to relevant Competent Authorities for technical or financial assistance
• Cooperate and assist other Competent Authorities in research activities on drinking or irrigation water management systems in the Gewog
• Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met</td></tr>
<tr><td>14. Dzongkhag Water Management Committee</td><td colspan="2">Under the Water Regulation, for the purpose of proper and effective protection and management of water resources at Dzongkhag level, the existing Dzongkhag Environment Committee (DEC) shall, with additional members as may be necessary, function as the</td></tr>
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<tr><td></td><td colspan="2">district water management committee (DWMC).</td></tr>
<tr><td></td><td>WRM policy and planning role:
• Provide technical determination on the issues of water volume, water sufficiency at source and the carrying capacity of infrastructure for proposed additional water users
• Determine whether an existing water supply system is sufficient at source for the planning of new or expanded water uses/users
• Provide technical advice to the Dzongkhag Administration for planning of drinking and irrigation water</td><td>Coordination and regulatory role:
• Coordinate with other competent authorities in assisting WUAs to determine whether an existing water supply source/system is sufficient for proposed new or expanded water uses/users
• Collaborate with other DWMCs in the basin, and issue recommendations to concerned Competent Authorities pertaining to inter-Dzongkhag plans and programs
• Issue permit for surface water abstraction and use of a source within their jurisdiction not requiring an Environmental Clearance
• Issue permit for groundwater abstractions (if necessary with technical assistance of NECS)</td></tr>
<tr><td></td><td>Water service delivery role:
• None</td><td>Information, reporting, research and capacity-building role:
• Determine and issue technical opinion for local authorities and concerned parties on water-related issues
• Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met</td></tr>
<tr><td>15. River Basin Committees (RBCs)</td><td colspan="2">The Water Act mandates that such committees shall be set up for the “purpose of proper management of water resources.” Functions described in the Act pertain to community participation, preparation of the RBM plan, monitoring and reporting to NEC, data management, and resolution of cross-sectoral and trans-boundary water management issues. However, the Act gives prerogative to NEC to direct RBCs to perform additional functions.</td></tr>
<tr><td></td><td>WRM policy and planning role:
• prepare River Basin Management Plans together with the NECS:
○ Consolidate water resources management plans prepared at the district level, including those of sectoral agencies involved in water management, and ensure that these are reflected in the basin plan (i.e., checking that the plans do not draw more water than is available
○ Ensure that the basin plan is consistent with the principles and objectives of the NIWRMP.</td><td>Coordination and regulatory role:
• Serve as forum through which issues/disputes related to water sharing and distribution among districts within the basin can be discussed and resolved in an informed and consultative manner
• monitor and report to the Commission on the effectiveness of policies and action in achieving sustainable management of water resources in its area of operation
• With NECS, develop guidelines for coordinate basin level registry of water</td></tr>
</table>

	○ water-related Key Result Areas (KRAs) and Key Performance Indicators (KPIs) incorporated in the GNHC's medium term planning guidelines are reflected in the basin plan • Mobilize and allocate resources for basin wide program • Establish procedures/rules for hearing and resolving trans-boundary water allocation issues	user associations (WUAs)
	Water service delivery role: • Prioritize and allocate water resources for various purposes	Information, reporting, research and capacity-building role: • Collect, manage and share such data as are necessary to properly manage the basin in coordination with the Commission - Establish baseline data on the water security indicators for the basin, following the framework set up by the NEC and GNHC for a national water security indicator system - Based on the basin plan implementation reports of the Dzongkhag and Thromde administrations, consolidate data to periodically update the water security indicators for the river basin, and report these to the NEC and GNHC, as well as to the basin consultative council. - Facilitate the exchange of data and information among agencies operating in the river basin, and among the district and Gewog level administrations • Submit annual report to the NECS on implementation and enforcement of Water Act and Regulation, including difficulties, issues and challenges met
16. Water Users Associations (WUAs)	Except in Thromdes, water users of a water facility are to be established. The term "water user" for the purpose of forming a WUA means a household using water from a registered facility or source. Any new water user duly admitted to an existing facility will automatically be a member of the WUA.	
	WRM policy and planning role: • Formulate, adopt and enforce rules for the use and management of drinking and/or irrigation water within the WUA • Protect and conserve the WUA water source	Coordination and regulatory role: • administer/coordinate admission and participation of water users in the WUAs • Acknowledge customary practices • When necessary, request Gewog Administration for the determination of

	• Ensure (enforce national policy) that every household belonging to the WUA has equitable and fair access to drinking and/or irrigation water supply and that no person is arbitrarily denied basic daily water needs • Determine and adopt water user fees that commensurate with the services rendered by its members • Exercise other powers and functions as may be delegated by a Competent Authority to the WUA	water availability to admit new water users to its Association, and if there is no such expertise at the Gewog level, it will request Dzongkhag Administration for technical assistance • Admit or decline the admission of new users to the WUA, depending on water availability at source and carrying capacity of the water services infrastructure • Issue letter of consent to temporary water users from the WUA's water facility • Request intervention of Gewog Administration when there are undue developmental activities being sighted in and around its water source • Federate with other WUAs to improve water resource management • When necessary, invite district forest officer, health worker or engineers to attend WUA meetings for technical and other support
	Water service delivery role: • Mainly through water allocation and resolution of water disputes • Appoint one or more negotiators to settle disputes amicably before considering to render decision by casting votes by its users • Decide on punitive actions for members failing to comply with the standing rules of the Association • Hear and decide on disputes between or amongst its members relating to water and infrastructure use • Allocate and maintain a water tap point, at a strategic location within a group of households, for fire emergency purposes • Take necessary measures for the efficient use of water • Appoint water guard for irrigation and/or drinking water protection	Information, reporting, research and capacity-building role: • Keep records of irrigable land holdings of WUA members and means of water distribution • Maintain records of minutes of its meetings and decisions taken by the Association • Keep books of accounts on the money received and disbursement made by the Association • Exchange information with WUA federation

Appendix 3: Bhutan Water Security Index- Description of Key Dimensions and Indicators

Key Dimension 1: Improve and protect the drinking water supply, sanitation and hygiene in rural areas

KD1 assesses the extent to which rural household water and sanitation needs are met, and improved hygiene for public health is provided in all communities. It is a composite of three main sub-indices (i) access to piped water supply (%), (ii) access to improved sanitation (%), and (iii) hygiene (incidence of diarrhoea per 10,000 people).

Indicators

1. ***Percentage of population with piped potable water supply***
   This indicator is self-explanatory.

2. ***Percentage of population with improved (sealed) sanitation***
   As above, this indicator is self-explanatory.

3. ***Incidence of diarrhoea***
   Diarrhoea is an infectious disease that is related to hygiene and thus related to proper sanitation. It is expected that the incidences of diarrhoea will reduce when a larger part of the population is using proper (sealed) sanitation.

Key Dimension 2: Maximize the economic benefit of water resources in a sustainable way

Water is an essential input to grow food and fibre, for many industrial processes, and to generate the energy required by society. The uses of water in these sectors is increasingly recognized as being closely related and can no longer be addressed in isolation from each other. Debate about the water-food-energy nexus has begun to raise general awareness about the critical interaction among water uses to support economic activities.

Economic water security measures the productive use of water to sustain economic growth in the food production, industry, and energy sectors of the economy. The indicators are aggregates of multiple sub-indicators, defined to highlight key aspects of water security in a particular sector as described in the following sections. There is debate (also in AWDO) to what extent the indicators are applicable at basin level – beside national level.

Sub-dimension 2A1: Agriculture resilience

Resilience refers to the ability to cope with the adverse effects of rainfall variability. Recognizing that agricultural water use is vulnerable to rainfall variability[65] and that water storage constitutes a viable method to mitigate the effects of that variability, a first indicator focuses on these two key issues.

Indicators

1. ***Percentage of cropped areas irrigated from reservoirs***
   Rain-fed agricultural production is susceptible to the weather conditions. The larger percentage of cropped areas can be irrigated from reservoirs, the less vulnerable the agricultural production is supposed to be.

2. ***Variability of inter-annual rainfall***
   Agricultural production depends on rainfall and/or irrigation. The larger the variation of rainfall over the years, the more vulnerable it is. Rainfall cannot be planned as such, but adaptive measures for highly vulnerable areas can be planned for. That is why this indicator has been adopted.

3. ***Variability of intra-annual rainfall***
   As mentioned above, agricultural production depends on rainfall and/ or irrigation. The larger the variation of rainfall within a year, the more vulnerable it is. Rainfall cannot be planned as such, but adaptive measures for highly vulnerable areas can be planned for. That is why this indicator has been adopted.

Sub-dimension 2A2: Agriculture water utilization efficiency

The water utilization efficiency is defined as a function of agricultural water productivity, and proportion of arable land irrigated. To characterize the productivity of water use in irrigated agriculture, we considered the monetary value per unit of water in agriculture, and the percentage of arable land that is irrigated.

[65] Other water uses are vulnerable to rainfall variability as well. Given the greater role of water in agriculture and that agriculture, after the environment, is usually the residual water user, agriculture can be considered particularly vulnerable.

Indicators

1. ***Agricultural contribution to GDP***
   Obviously a higher contribution of (irrigated) agricultural production to GDP is desirable.

2. ***Percentage of arable land irrigated***
   A higher percentage of cultivable land being irrigated will contribute to higher overall agricultural production as well as reduction of poverty

3. ***Percentage of cereal consumption that is imported out of the total cereal consumption***
   This indicator has an inverse appraisal: lower volumes of cereal imports mean higher self-sufficiency is achieved in line with the national policies.

Sub-dimension 2B: Industrial water security

Similar measures as above were applied to industrial water use. However, the number of indicators used for industry is smaller than for agriculture. The reduced number of indicators reflects both the reduced proportion of water claimed by industrial uses as well as the relative dearth of data related to water and industry. Our water-industry indicator has only one indicator and focuses on water productivity in industry.

Indicator

1. ***Revenue generated from water-based industries in million Nu/MCM (productivity)***
   Like for agriculture, a higher contribution of (water-based) industries to GDP is desirable.

Sub-dimension 2C: Hydropower water security

Given the direct linkages between water, hydropower, and energy supply in a country, this sub-dimension directly focuses on hydropower. The indicators focus on the dependence of hydropower on trans-boundary inflow into Bhutan, the proportion of a country's technically exploitable hydropower capability that has been tapped, and the relative contribution of hydropower to a country's energy supply, and the plant load factor that indicates how efficiently the turbines are used.

Indicators

1. ***Percentage of volume of trans-boundary inflow compared with total annual flow (internal renewable water resources + incoming water)***
   Hydropower generation is to some degree dependent on inflow from China in Amochhu and Drangmechhu basins, leaving Bhutan vulnerable. This aspect is monitored in this indicator. It has an inverse appraisal: the lower the value, the more secure is hydropower generation.

2. ***Percentage of potential hydropower installed***
   The RGOB aims at high development of hydropower, which is monitored by this indicator.

3. ***Percentage of hydropower contribution to total energy consumption***
   A high percentage of hydropower in total power consumption indicates less use of fuel wood or fossil fuel, and is in line with RGOB policy.

4. ***Hydropower revenue (in million Nu per amount of water used in MCM (productivity)***
   Like for agriculture and industries, the contribution of hydropower to GDP is monitored.

5. ***Hydropower efficiency as weighted average annual plant load factor***
   The plant load factor indicates how efficiently the generators are being used, or how effectively the river flows are used for hydropower generation. This is monitored by this indicator.

Key Dimension 3: Improve and protect urban drinking water supply, and improve effectiveness of urban sanitation and drainage

The urban water security indicators measure the creation of better water management and services to support vibrant and liveable water-sensitive cities. A water-sensitive city is defined as a city that integrates water supply, sewage, storm-water, and the built environment; a city that respects the value of urban waterways; and a city where citizens value water and the role it plays in sustaining the economy, environment, and society (Brown, Keath, and Wong 2009).

The urban water security index is a composite of four sub-indices relating to water supply coverage, wastewater treatment, garbage collection (to keep water ways clean) and urban flooding.

Indicators

1. ***Percentage of urban population having potable piped water supply***
   This indicator is similar to the one applied for rural drinking water supply and is self-explanatory.

2. ***Percentage of urban water loss (un-accounted for)***
   This indicator monitors the difference between the amounts of water delivered to the households and paid for, as compared to the amounts pumped into the system. Obviously, the difference should be minimized.

3. ***Percentage of urban population with improved sanitation***
   This indicator is similar to the one applied for rural areas and speaks for itself.

4. ***Percentage of urban population with (at-least weekly) waste collection and disposal service***
   When solid waste is not properly collected and disposed of, it will often end-up in the open water ways and spoil the quality of the water. This aspect is more pronounced in urban areas, where solid waste collection and disposal can be more efficiently organized than in thinly populated rural areas.

5. ***Damage from urban flooding***
   Monsoon floods can damage economic assets and property, particularly when drainage is inadequate and/or when the water ways or drains are eroding their banks. The flood dame is monitored by this indicator.

Key Dimension 4: Environmental water security

Conserve watersheds and reverse degradation that has already occurred

Rivers have become vulnerable to pressures from pollution, diminished flows, watershed deterioration, and increasing populations and industrial activities. The environmental water security indicator assesses the health of rivers and measures progress on restoring rivers and ecosystems to health on a national and regional scale. The environmental water security index is composed of four themes – watershed disturbance; pollution; water resource management; and biotic factors.

Sub-dimension 1: Watershed disturbance

The watershed disturbance theme captures the local-scale impact of land-use change and poor stewardship within catchments. Drivers include (i) conversion from natural land cover to cropland; (ii) construction of impervious surfaces; (iii) degradation of uplands and riparian zones by livestock; and (iv) disconnection of floodplains from rivers.

Indicators

1. ***Fraction of cropland relative to total area***
   Conversion of natural land cover to cropland often increases the rainfall runoff and erosion, particularly in steep sloping areas like mostly occur in Bhutan. Thus, this aspect has a negative appraisal from environmental point of view.

2. ***Fraction of impervious layer relative to total area***
   Similar to above, built area like houses, roads, parking places tend to increase the rainfall runoff and have disturbing impact on the watershed.

3. ***Livestock density***
   Free roaming cattle have a disturbing impact on the watershed by trampling and compacting the soil, browsing the vegetation and thus increasing rainfall runoff and erosion. The cattle population density is a measure to monitor this effect.

4. ***Fraction of natural wetland relative to total area***
   Natural wetlands have an important function in the watersheds in terms of their buffering effect on water flow, and natural cleaning effect of water quality, and providing habitat for a range of organisms and species. Economic development often goes at the expense of natural wetlands by draining them (and convert them into built or agricultural areas) or by cutting them off from the rivers. This type of watershed disturbance is monitored by this indicator.

Sub-dimension 2: Pollution

This sub-dimension encompasses a number of pollutants that have well known direct or indirect effect on water resources and/ or bio-diversity. Indicators include (i) soil salinization; (ii), nitrogen; (iii) phosphorus; (iv) mercury deposition; (v) pesticide loading; (vi) sediment loading; (vii) organic loading (as Biological Oxygen Demand, BOD; (viii) potential acidification; (ix) thermal alteration. As can be seen below, not all these drivers have been adopted in the BWSI.

Indicators

1. ***Total suspended solids in ppm***
   The sediment load in the rivers is a factor to be considered in hydropower generation. Sediments are detrimental to the turbines and should settle in stilling basins that are included in the design of the hydropower plant.

2. ***Organic loading/ BOD5***
   Biochemical oxygen demand is a measure of pollution in terms of the amount of dissolved oxygen utilized by microorganisms during the oxidation of organic components in the water. After incubation, the amount of dissolved oxygen consumed is obtained by titration and the results expressed as parts per million of BOD. Complete biological oxidation generally requires about 20 days at 68°F. However, the test has been standardized to be completed in 5 days, hence the term BOD5. BOD can be used as a gauge of the effectiveness of wastewater treatment plants.

Sub-dimension 3: Water resource management

The Water Resource Development sub-dimension includes a variety of ways in which people have altered the quantity of water available to human populations and providing essential ecosystem services. Indicators include (i) the density of dams within catchments; (ii) the fragmentation of river networks by dams; (iii) consumptive water loss; (iv) human water stress; (v) agricultural water stress; (vi); and (vii) flow disruption.

Indicators

1. ***Dam density***
   Dams in rivers disrupt the free movement of migrating fish species. The reservoirs change the temperature of the water as well as the sediments load. These factors have an impact on the environment. Therefore the density of dams in the river system is an indicator for water resources management. A high value has a low appreciation.

2. ***River length de-watered***
   This aspect relates to run-off-the river hydropower plants, whereby the river flow is diverted through the so-called head race tunnel to the generators of the power plant. This practice leaves the river bed with a fraction of the original water flow, particularly when environmental flow requirements are not met.

3. ***Dependable Water availability per capita during lean season (January)***
   The amount of water available per capita is a measure of water resource management. In Bhutan, this figure is only meaningful during the height of the lean season, which is January.

4. ***Relative total water consumption during lean season (January)***
   The percentage of available water used for consumption is an indicator for water stress. The irrigation demand is low in January. A high percentage has a low appreciation.

5. ***Relative total water consumption during peak irrigation demand (May)***
   The domestic and industrial consumptive water use is believed to be fairly constant over the year. But irrigation water demand varies strongly over the months within a year. Peak irrigation demand occurs in May, when land is prepared for transplanting paddy and the monsoon rains are only just starting. Like for total (drinking) water consumption in January, total (irrigation) water demand as percentage of available water is an indicator for water stress in May.

Sub-dimension 4: Biotic factors

This theme aims to capture the local and spatially-distributed impacts of changing the biota of river ecosystems. Humans have altered riverine faunas in many ways. Specific drivers include (i) the percentage of non-native fish species; (ii), number of non-native fish species; (iii), fishing pressure; (iv) and aquaculture pressure. Each of these drivers has a variety of detrimental effects on fresh waters, ranging from changes in the loading and cycling of nutrients to destabilizing food webs to altering species interactions. Since fishing and aquaculture play a minor role in Bhutan, these factors are not included in the BWSI.

Indicators

1. ***Number of non-native fish species***
   The number of foreign fish species is monitored.

2. ***Percentage of non-native fish species***
   The percentage of foreign fish species is also considered since it puts the number of foreign fish species in a context.

Key Dimension 5: Disaster and climate change resilience

Reduce socio-economic loss resulting from (climate change induced) water-related disasters, particularly GLOFs, landslides, and monsoon floods/ droughts.

There is an increasing global consensus on the importance of water-related risk management. Risk management requires quantification of water-related disaster losses at a finer temporal and spatial resolution than currently available for the analysis of trends. Such analysis will provide estimates of vulnerability and resilience and allow assessment of the effectiveness of mitigation policies and investments. The BWSI focuses on: i) Hazards and threats; ii) Sensitivity to exposure; and iii) Coping and adaptive capacity.

The complexity of assessment of water-related disasters is such that the computations of the resilience indicators are the most complex in the AWDO water security index. In fact, these could not be replicated and therefore the BWSI uses a simple linear scoring.

NB: Many of the phenomena captured in the indicators below cannot be planned as such, but their implications *can* be planned for. That is why the following indicators have been adopted in the BWSI.

Sub-dimension 5A – Hazards and threats

Disaster risk (R) is defined as an indicator of expected disaster damage per capita, taking into account the likelihood of occurrence and likely severity. Likelihood of occurrence is not measured by a strict joint probability of hazard occurrence and vulnerability but by a statistical average of hazardous phenomena, such as an area's average daily maximum precipitation. Hence, a hazard is a potentially damaging physical event, phenomenon, or human activity that may cause the loss of life, injury, property damage, social or economic disruption, or environmental degradation.

Indicators

1. ***Maximum total one-week precipitation during the year***
   Extreme high rainfall is an obvious threat and potential cause of disaster; hence it is used as an indicator.

2. ***Inventory of hazardous GLOF lakes***
   Glacial lakes at risk of having an outburst flood are also a threat. An inventory of such lakes is used as an indicator for assessing resilience.

3. ***Frequency of rainfall > 100 mm/day***
   A high frequency of high rainfall events is indicative for risk of flooding.

4. ***Maximum number of consecutive dry days (< 1 mm/day)***
   Prolonged periods of drought form the opposite risk of flooding, but put a high demand on management of the water resources. Hence, drought periods are an indicator in the BWSI.

Sub-dimension 5B – Sensitivity to exposure

Exposure relates to the people, property, systems, or other elements present in the area that may be affected by a hazard or threat.

Indicators

1. ***Dry-land (Kamzhing) as percentage of total area***
   A high percentage of dry-land of total area means that much of the agricultural land is dependent on rainfall, which amounts to a sensitivity.

2. ***Percentage (annual) change in forest cover over the last 5 years***
   This indicator measures the rate of de-forestation and the related increase in runoff and erosion.

3. ***Deviation from constitutionally mandated forest cover (60%) at national and basin level***
   This indicator monitors the deviation from the mandated forest cover as a measure of sensitivity to extreme weather events.

4. ***Population density***
   Obviously, a high population density is more sensitive to exposure to extreme weather events than a low population density.

5. ***Urban population density***
   Same as above

6. ***Urban population growth rate (Thromdes)***
   Same as above

7. ***Total population growth rate***
   A fast growing population is more sensitive to exposure to extreme weather conditions than a stable population.

Sub-dimension 5C – Coping and adaptive capacity

Coping relates to the ability of dealing with disaster in terms of preparedness and/or mitigating measures. Adaptive capacity is the ability to adjust to a changing environment. The indicators are mentioned below.

Indicators

1. ***Governance***

   Number of basins with functional RBCs with:

   - Secretariat formed
   - RBMP prepared or under implementation
   - At least one RBC meeting held /year

2. ***Poverty rate***

   Poor communities are less capable of coping with disasters and adverse conditions. Hence poverty rate is adopted as an indicator in the BWSI.

3. ***Child mortality rate (0-5).***

   The child mortality rate is a considered as an (inverse) proxy for the vitality of the population. With higher child mortality, the population is weaker and thus less adaptive to adverse conditions.

4. ***Net official development assistance as percent of gross national income***

   With high development assistance, the community is expected to cope better with disaster.

5. ***Establishment of (effective) Emergency Response Mechanisms***

   RGOB policy aims at establishing emergency response units in each district. This indicator monitors the progress.

6. ***Reservoir capacity***

   Reservoirs will dampen runoff waves in the rivers, hence a high reservoir capacity is a good way to buffer the peak flows.

7. ***Flood/ drought hazard zonation maps produced and updated***

   Maintaining updated maps of flood hazard zones is a good way of coping with flood risk.

8. Number of (identified) flood protection measures pending for implementation

This indicator assumes that the area is relatively safe from flooding if the identified flood protection measures have largely been implemented, so there are few remaining to be done. (NB: The number of flood protection measures implemented does not always mean that the area is safe!)

9. Number of flood/GLOF Early Warning Systems pending for implementation

Similar to above

10. Literacy ratio

Literate communities will be better able to cope adverse conditions because their higher level of understanding, but also because they can be informed more easily (by radio, TV, mobile phone) on what to do or not to do.

11. Education level of women for enhanced coping capacity (with CC impacts)

Similar to above. Women can direct households/ children in case of adverse conditions. A better education will enable to better cope with this task.

12. Access to information – TV, radios

TV and radio are important means to inform communities about what actions to take.

13. Access to Information – mobile phones

Similar to above.

14. Gross domestic savings relative to GDP

A larger amount of savings will enable communities to cope better with adverse conditions by investing in the necessary mitigating/ adaptation measures.

Parameters of the BWSI and agencies responsible

Key Dimension	Parameter	Agency responsible for data
KD-1	**RURAL DRINKING WATER SUPPLY and SANITATION**	
1	% of population linked to piped water supply	Department of Public Health, MOH
2	% of population with access to improved (water sealed toilets)	Department of Public Health, MOH
3	hygiene by incidence of diarrhea/ 10,000 inhabitants per year	Department of Public Health, MOH
KD-2	**ECONOMIC WATER SECURITY**	
KD-2A1	**Agriculture resilience**	
1	% of cropped area irrigated from reservoir	MoAF/DoA/Dzongkhag (DAO)/
2	variability of inter-annual annual rainfall	DHMS, MoEA
3	variability of intra-annual rainfall	DHMS, MoEA
KD-2A2	**Agricultural water utilization**	
1	Agricultural productivity - contribution to GDP in Nu/ MCM	DOA, MoAF
2	% Arable land irrigated	DOA, MoAF
3	Amount of cereals imported out of cereals consumed (MT)	NSB/ DRC
KD-2B	**Industrial water security**	
1	Revenue generated from water based industries	Dept. of Industry, MOEA
KD-2C	**Hydropower water security**	
1	Percentage annual national trans-boundary inflow	DHMS
2	% of potential hydropower capacity installed	DHPS, MOEA (> 25 MW)/ DRE (< 25 MW)
3	% hydropower contribution to total energy consumption	DHPS, MOEA
4	Hydropower contribution to GDP in million Nu/ MCM	NSB
5	Hydropower Efficiency (weighted average annual plant load factor)	DHPS, MOEA
KD-3	**URBAN WATER SECURITY**	
1	% of urban population having potable water supply- Urban	Water and Sanitation Division, DES, MoWHS
2	urban water losses	Water and Sanitation Division, DES, MoWHS
3	% of population without improved sanitation	Water and Sanitation Division, DES, MoWHS

4	% of urban population with at least weekly solid waste collection and disposal service	Water and Sanitation Division, DES, MoWHS
5	Damage from urban flooding/ capita / GDP per capita	Flood Engg Mgmt Div., DES MoWHS
KD4	**ENVIRONMENTAL WATER SECURITY**	
KD-4A	**Environment - Watershed disturbance**	
1	Fraction of land cultivated	DoA, MoAF
2	Fraction of impervious surface area.	DoA, MoAF
3	Livestock density.	DoL, MoAF
4	Natural Wetland status.	WMD, DOFPS
KD-4B	**Environment - pollution**	
1	*Total suspended solids.*	DHMS
2	*Organic loading/ BOD*	NOP, DOA, MoAF
KD-4C	**Environment - Water resources management**	
1	Dam density	DHPS, MoEA and DRE, MOEA
2	Percentage of the length of main and primary river(s) dewatered (for Hydropower)	DHPS, MoEA
3	Relative total water consumption in the lean period - January	WSD, DES
4	Relative total water consumption in the lean period - May	WSD, DES
KD-4D	**Environment - Biotic factors**	
1	Number of non-native fish species.	National Fishery Centre, MoAF
2	% non-native fish species	
KD-5	**DISASTER and CLIMATE CHANGE RESILIENCE**	
KD5A	**Hazards and Threats**	
1	Maximum total one week precipitation (millimetre)	DHMS
2	Inventory of Potential hazardous lakes for GLOF Risk	DGM, MOEA
3	Frequency (>100 millimetre/day rainfall) per year	DHMS
4	Number of consecutive dry days (< 1 millimetre rainfall)	DHMS
KD5B	**Sensitivity to exposure**	
1	Dry-land (Kamzhing) area as percentage of total area	DoA, MoAF
2	Percentage change in forest cover over the last five years	DOFPS, MOAF

3	Deviation from constitutionally mandated forest cover (60%) at national and basin level	DOFPS, MOAF
4	Population density (numbers per Km2)	NSB
5	Urban Population density	NSB
6	Urban population growth rate (Projected based on 2005 baseline data)	MOWHS/ NSB
7	Total population growth rate (projected)	NSB
KD5C	**Coping and Adaptive capacity**	
1	Governance	NEC
2	Poverty Rate	NSB
3	Child mortality rate (0-6).	Bhutan Health Mgmt Inf. System, PPD, MoH
4	Net official development assistance as percent of gross national income	DPA, MOF
5	Establishment of Emergency Response Mechanisms (EOCs/EC..)	DDM/districts/MOHCA
6	Total reservoir capacity per Districts	DHPS/DOA
7	Flood Hazard zonation maps produced and updated	FEMD, DES
8	Flood protection measures pending for implementation	FEMD, DES
9	Flood/GLOF Early Warning Systems	DHMS, MOEA
10	Literacy ratio	PPD, MoE
11	Education (enrolment ratio)	PPD, MoE
12	Information (television/Radio receivers per 1,000 inhabitants)	PPD, MOIC
13	Information (mobile phone subscription)	PPD, MOIC
14	gross domestic saving	NAPD, NSB

Grand Total=57

Appendix 4: Training plan

Short term in-country group training workshops and refresher courses

Type of Training	Topics	Participants/ Relevant agencies	Schedule	Est. Budget (US $)	Logistic Requirements
IWRM principles and practices	- IWRM history/rationale; - IWRM principles and practices; - Multi-disciplinary/stakeholder context of IWRM; - River basin as basic unit for IWRM; - Conducting water resources inventory; - IWRM planning and implementation steps.	NECS, GNHCS, MoAF, MoEA, MoE, MoH, MoHCA, MoWHS, CSOs, Dzongkhag Tshogdu, Gewog Tshogde, District Water management Committees, RBCs, WUAs. Target: 30	Once every Five Year Plan period for each river basin	25000	WRCD, NECS to prepare training plan in consultation with GNHCS, identify venue and relevant in-country resource persons.
IWRM Planning and Coordination in Bhutan	- Bhutan Water Act and Regulations; - Bhutan's IWRM Coordination set-up; - Planning: Water Security performance benchmarking and indicators (KRAs and KPIs); - Results-based monitoring and evaluation (MandE) frameworks.	NECS, GNHCS, MoAF, MoEA, MoE, MoH, MoHCA, MoWHS, CSOs, Dzongkhag Tshogdu, Gewog Tshogde, District Water management Committees, RBCs, WUAs. Target: 30	Once every Five Year Plan period for each river basin	25000	WRCD, NECS to prepare training plan in consultation with GNHCS, identify venue and relevant in-country resource persons.
Bhutan Water Security Index System	- Water security indicator system and updates if any; - dimensions and indicators of water security; - baseline and targets; - uses for planning and monitoring; - IT-based application: online data entry; - analysis and information sharing.	NECS, GNHCS, MoAF, MoEA, MoE, MoH, MoHCA, MoWHS, CSOs, Dzongkhag Tshogdu, Gewog Tshogde, District Water management Committees, RBCs, WUAs. Target: 30	Once every Five Year Plan period for each river basin	25000	WRCD, NECS to prepare training plan in consultation with GNHCS, identify venue and relevant in-country resource persons.

Regular study tour and participation in water events and forums

Type of Training	Topics	Participants/ Relevant agencies	Schedule	Est. Budget (US $)	Logistic Requirements
Participation in global and regional Water forums and conferences	Global Water Forums - World Water Forums - Stockholm Water Week - Netherlands Water Learning Week	WRCD, NECS staff (2) and selected focal persons of competent Authorities (3)	Annually	15,000	- WRCD, NECS to plan, form and lead delegation; - inclusion of stakeholder in delegation; - identify funding.
	Regional Water Forums - India Water Week - Singapore Water Week - ADB Water Week	WRCD, NECS staff (2) and selected focal persons of competent Authorities (3)	Annually	15,000	
Study tour	Study tour for selected members of the Wangchhu Basin Committee	Selected members of Wangchhu RBC (Total 14)2016	2016	32000	

Long term degrees

Type of Training	Topics	Relevant agencies	Proposed slots	Est.Budget (US $)
Doctoral Degree	Climate and hydrological modelling	College of Science and Technology	1	130,000
	Climate and hydrological modelling	Sherubtse College	1	130,000
	Agriculture and Irrigation systems in mountain areas	College of Natural Resources	1	130,000
Master Degree	Modelling and Information Systems for Water Management. Proposed topics are: - Managing uncertainty in climate projections; - Global and regional climate change (CC) issues; - Interpreting climate change projections; - CC vulnerability and impact assessment; - Hydrological impact analysis; - Delineating watershed boundaries; - Assessing water availability in ungauged basins	WRCD, NECS; DHMS, MOEA	2	140,000
	Land and Water Development for Food Security. Proposed topics include: - Assessing crop water requirements;	DOA, MOAF	1	70,000

	- On-farm water management			
	Hydraulic Engineering and River Basin Development. Proposed topics include: - Conducting irrigation engineering surveys; - Designing irrigation and drainage structures	Engineering Division, DOA, MOAF; DES, MOWHS; NECS	2	140,000
	Flood Risk Management Proposed topics include: - Flood risk assessment and forecasting; - Flood zonation mapping; - Flood prevention and management measures	FEMD, DES, MOWHS; DDM, MOHCA	2	140,000
	Ground water hydrology Proposed topics include: - ground water assessment - technologies in ground water abstraction	DHMS, MOEA; DGM, MOEA	2	140,000
	Water, Sanitation and Health engineering Proposed topics include: - Assessing domestic water requirements - Water quality monitoring	PHED, MOH; WSD, DES, MOWHS	2	140,000
	Soil, water and Environment management Proposed topics include: - Assessment of ecosystem services - Watershed delineation and classification - Watershed management - Soil and water conservation	WMD, DOFPS	1	140,000