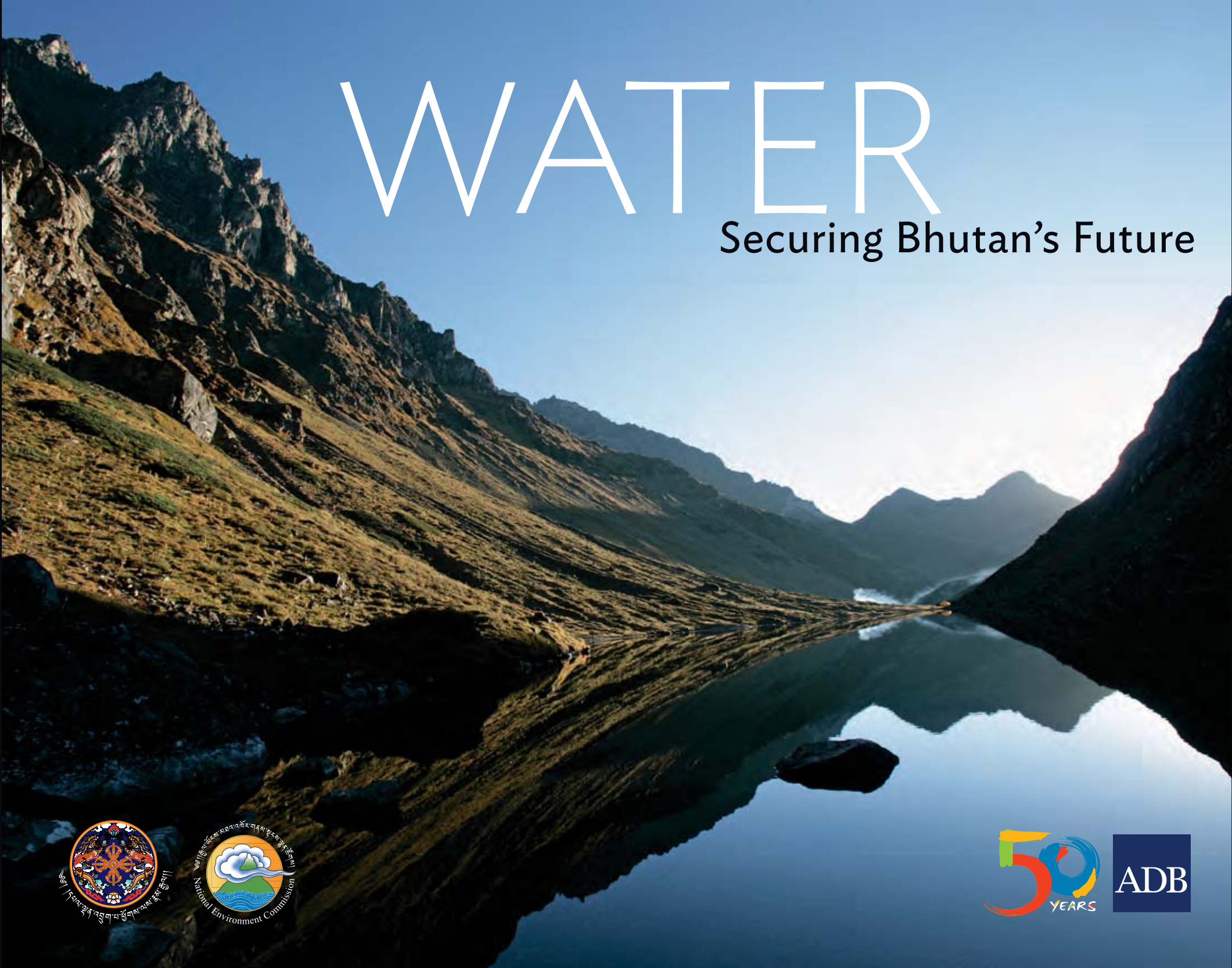

WATER
Securing Bhutan's Future
National Environment Commission
50 YEARS
ADB

Water is the most important natural, economic, life sustaining resource and we must ensure that it is available in abundance to meet the increasing demands. Present and future generations will have assured access to adequate, safe and affordable water to enhance and maintain the quality of their lives and the integrity of natural ecosystems.

"Bhutan Water Vision, 2008"

United Nations 2030 Agenda for Sustainable Development Goals

Goal 6: Ensure availability and sustainable management of water and sanitation for all

TARGETS

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, 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 globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

Source:
https://sustainabledevelopment.un.org/?menu=1300

WATER

Securing Bhutan's Future

WATER

Securing Bhutan's Future

Edited by Yeshey Dorji

Asian Development Bank
National Environment Commission
Royal Government of Bhutan

First Edition 2016
Published by the Asian Development Bank/National Environment Commission
Royal Government of Bhutan
Thimphu : Bhutan

www.adb.org/ www.nec.gov.bt

ISBN: 978-99936-865-3-8

Designed by Tania Das Gupta, New Delhi
Printed at the Pragati Officer, Hyderabad
All photographs are copyrighted to Yeshey Dorji

Funded in part by:

From
the People of Japan

Produced in collaboration with:

egis

In association with:
Royal Society for Protection of Nature
&
Bhutan Water Partnership

MIX
Paper from responsible sources
FSC® C018531
www.fsc.org

Printed on FSC® certified paper
from responsibly harvested sources

CONTENTS

དཔལ་ལྡན་འབྲུག་གཞུང་།

Royal Government of Bhutan

PRIME MINISTER

8 March 2016

FOREWORD

The Kingdom of Bhutan is richly endowed with abundant water resources. Under the wise and farsighted leadership of our Monarchs and the people's reverence and respect for nature, we have always treasured water. Today, Bhutan is among those nations of the world with high per capita availability of water. Although, much of it is inaccessible, the communities have traditionally enjoyed abundant water for drinking and farming. With modern development and changing climate, water security has become a primary concern for the Royal Government and the people. It is in this light that the government has put in place the necessary policy and legal framework for a coordinated approach to water resources management. The government is fully cognizant of the importance of managing water resources in a way that meets the socio-economic needs of its people while ensuring future sustainability of the resource.

I am deeply appreciative of the technical assistance that the Asian Development Bank (ADB) has provided to Royal Government of Bhutan for formulating the plans for a water secure future. This book 'Water: Securing Bhutan's Future' provides picturesque views of water resources of Bhutan while presenting the government's commitments, plans and efforts towards water security. I am confident that the book will enable readers to appreciate our pristine water resources while inspiring them to work together in preserving this valuable natural resource.

On behalf of the National Environment Commission and the Royal Government of Bhutan, I would like to express my deepest gratitude to the Asian Development Bank for its continued support to the Royal government and the people of Bhutan.

(Tshering Tobgay)
Chairman,
National Environment Commission

FOREWORD

Director
Asian Development Bank

On behalf of the Asian Development Bank, I convey our appreciation and strong endorsement of this informative and colorful book about Bhutan's rich water resource endowment, and how its people and institutions are preparing in earnest to tackle important water management challenges, including those arising from climate change.

Water is Bhutan's essential natural capital and it is fundamental to the country's economic, environmental and social prosperity. ADB is proud to support Bhutan in sustainably managing and developing this most precious resource. We are supporting the government in improving water governance and water-based infrastructure, in particular for drinking water supply, irrigation and hydropower.

Under its guiding policies and strategy, ADB recognizes that water resource management starts with sound principles of water governance and stakeholder involvement. Rapid economic development, increased urbanization and a growing population all continue to drive up water demand. On the other hand, water resources which are already under pressure to deal with diminishing availability and increasing pollution now face another important challenge - that of imminent climate change. This is evidenced by increasing variability of rainfall, the depletion of snow and glaciers, and uncertainty of water availability.

Water is the main entry point for addressing the chain of effects that climate change will bring about in Bhutan. Climate change highlights the interdependence of water, food and energy. Managing this interdependence and the increased future competition for scarce water is fundamentally a governance challenge, one that ADB sees as best dealt with through an integrated water resource management approach, the essence of which is captured well in this colorful book. It is imperative that such an integrated approach to managing water resources be embedded in developing transformational water agendas and programs, and I am pleased to note that such an approach is being actively pursued in Bhutan.

I wish to congratulate all those who have contributed to the publication of this book. May it serve to enrich understanding and further strengthen our collective motivation to work together in order to sustainably develop and protect Bhutan's rich but delicate water resource endowment.

TAKASHI MATSUO
Director
Environment, Natural Resources and Agriculture Division
South Asia Department
Asian Development Bank

PREFACE

Water has been sculpting Bhutan's landscape for millennia, flowing down from majestic alpine mountains to the narrow valleys and deep gorges that make up the country's iconic landscape before spreading out toward the southern plains. Indeed, water has also shaped the traditions and culture of the Bhutanese people. The dwelling places of deities are often associated with water bodies. Water is used as a symbol in most spiritual cleansing and ritual ceremonies. The cooperation norm that is so evident in the character of the Bhutanese people has in many ways been forged by centuries of communal water sharing and collective management practices.

The water cycle is also reflected in Bhutan's strongly held Buddhist notions of interconnectedness, impermanence and adaptation to change. Water comes in various changing forms. It is fundamentally life-giving because it nourishes the land so that life can flourish, providing the lifeblood of entire ecosystems and indeed of the whole biosphere. It can be harnessed to benefit humans in many ways, including to grow food, recycle waste, and generate electricity. Water is Bhutan's most important natural resource. Yet water can also be destructive, swelling rivers, eroding soil, and breaching glacial lakes to cause massive flooding and damage. For the Bhutanese, this destructive power is just another manifestation of water's changing nature.

Water needs to be managed well, and in an integrated and adaptive way. This kind of management is very challenging because it involves many actors and stakes. Water is not a sector in the traditional sense. Rather, it is a complex fabric—particularly in Bhutan—of interconnections between agriculture, ecology and energy that need to be recognized and managed as a system. This view of water management gives coordination a central role. Bhutan's framework for integrated water resource management (IWRM) adopts coordination as its core management principle. It builds on a strong Bhutanese tradition of water sharing and collective management, examples of which are illustrated in this book.

This integrated and cooperative approach to managing water is now confronting an imminent challenge—that of global climate change. As the global climate ultimately drives the local water cycle, global climate change will have important and long-term consequences for Bhutan, including in the way water is shared and allocated. With climate change comes the risk of increased water supply variability and future seasonal shortages, much of which cannot be precisely predicted in advance. This book also gives visual examples of what climate change may have in store for Bhutan.

Recognizing that the water system is the inevitable entry point for addressing climate change, IWRM serves as a foundation upon which the planning and implementation of climate resilience is being pursued in Bhutan. The goal is to achieve sustainable water security for the benefit of all stakeholders. Key dimensions of water security are described in this book.

Overall, this book aims to give the reader a nontechnical, though nevertheless substantive, appreciation of Bhutan's rich water resource endowment and management challenges, primarily through photographs that convey the awe and reverence with which the Bhutanese people regard water—shown here in the context of their water traditions, cultural practices and beliefs. The book then goes on to give the reader a sense of how Bhutan's water management system is evolving to embrace science and modern management principles, and to face the challenges presented by looming climate change and the ever increasing need to coordinate the many water uses and users to achieve water security.

ACKNOWLEDGEMENTS

This book is the result of the ADB funded technical assistance project titled 'Adapting to Climate Change through Integrated Water Resource Management'. The publishers would like to thank the following entities and individuals for their expertise and contributions:

Technical contents of the book:

ADB Technical Assistance (TA 8623) carried out by EGIS Eau, France in joint venture with Royal Society for Protection of Nature and Bhutan Water Partnership. Thierry Delobel, Egis Project Director; Lam Dorji, Team Leader; Robert Roostee, Deputy Team Leader/IWRM Specialist; Ramon Abracosa, Institutional Strengthening, Capacity Development, and Communications Specialist; Chhimi Dorji, River Basin Modeler; Luc Verelst, GIS Specialist.

Tenzin Wangmo, Chief, WRCD, National Environment Commission Secretariat.

Jigme Nidup, Deputy Chief, WRCD, National Environment Commission Secretariat.

Lance Gore, Senior Water Resources Specialist, South Asia Department, Asian Development Bank.

Editing:

Yeshey Dorji

Grace Delobel

Layout and design:

Tania Das Gupta

Photographs:

Yeshey Dorji

Thierry Delobel: Pages 24 (bottom), 30 (bottom), 36 (top), 55 (bottom), 58 and 64 (top)

Robert Roostee: Page 82

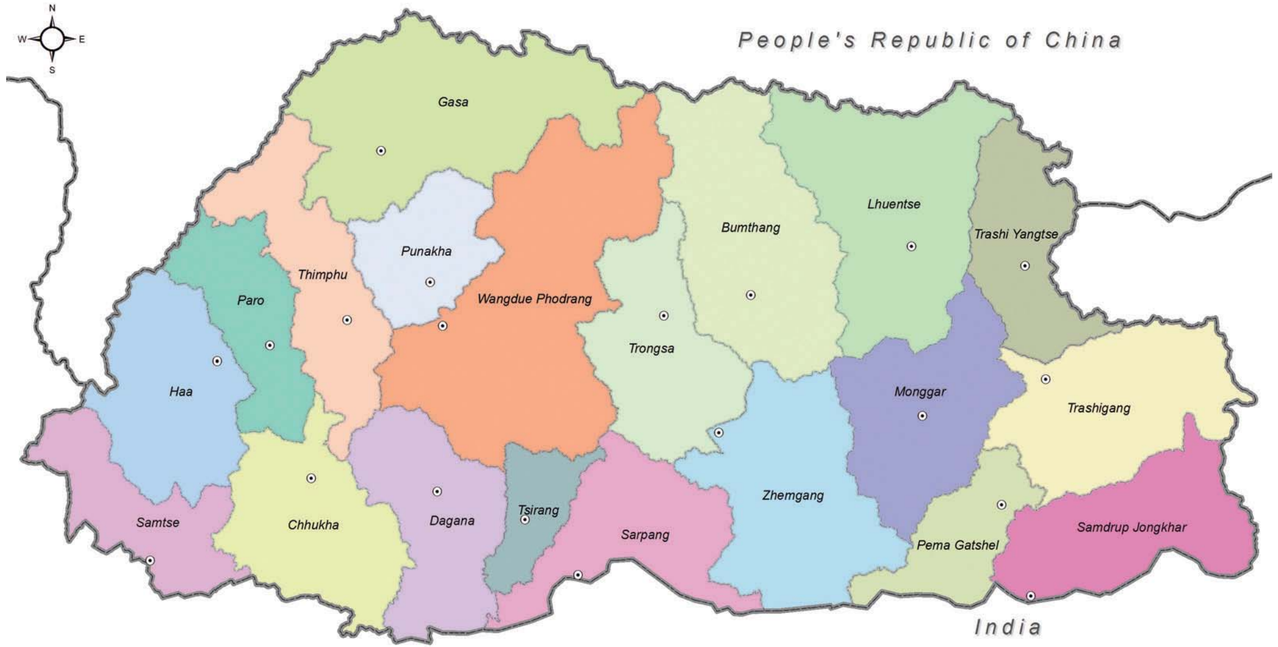
Choidup: Page 28 (bottom) and 29

Printed by:

Pragati Offset Pvt. Ltd., Hyderabad, India

I BHUTAN: LAND OF THE THUNDER DRAGON

Bhutan: Land of the Thunder Dragon



Projection: DRUKREF 03 / Bhutan National Grid (Projection: Transverse Mercator)
Scale: 1:1,250,000

Boundaries are not necessarily authoritative.

Administrative map of Bhutan

The Kingdom of Bhutan is a landlocked country located at the eastern end of the Great Himalayas between latitudes 26°N and 29°N, and longitudes 88°E and 93°E. It is bordered to the north by the People's Republic of China and to the south, east and west by India. To the west, the Indian state of Sikkim lies between Bhutan and Nepal; to the south, the country is separated from Bangladesh by the Indian states of Bengal and Assam. Its total land area is 38,394 km^2. In recent times, Bhutan has gained popularity as the country that promotes happiness as a measure of development instead of gross national product.

History and etymology

Before it was unified as a single state by Zhabdrung Ngawang Namgyal in the early 17th century, Bhutan consisted of numerous, separately controlled fiefdoms that were constantly at war with each other. Over time, Bhutan became a monarchy, with Trongsa Penlop Ugyen Wangchuck installed as the first hereditary king on 17 December 1907. To the Bhutanese, their land is known as Druk Yuel: the Land of the Thunder Dragon. Historically, the isolated yet naturally rich landscape of Bhutan was described by a variety of names, including Lho Mon ("Dark Southland"), Lho Menjong ("Southland of the Medicinal Herbs"), Lhomen Khazhi ("Southland of the Four Approaches") and Lho Tsendenjong ("Southland of the Cypress").

Bhutan was admitted to the United Nations as a member state in 1971. Bhutan is a founding member of the South Asian Association for Regional Cooperation (SAARC). It has formal diplomatic relations with 53 countries and is a member of over 150 international organizations and institutions such as the World Bank, the IMF, and the Group of 77. India is Bhutan's closest and most strategic economic partner.

Thimphu, Bhutan's largest city, is also its capital and the seat of the King, the Chief Abbot (the Je Khenpho), and the government.

Official language

Bhutan's official language is Dzongkha, originally spoken in the western regions of the country. Close to two dozen other languages also are spoken in Bhutan, such as Dzala, Tshangla, Khengkha, Gongduk, Lhakha, Brokkat, Kurtoep, Olekha, and Lhotsamkha, among others.

National Flag

Bhutan's earliest national flag was designed by Mayum Choying Wangmo Dorji in 1947, but underwent a change in 1956. Under the 28th Resolution of the 36th session, the National Assembly of Bhutan formalized the present design on 8 June 1972. When the Kingdom's Constitution was adopted in 2008, it described the national flag as follows:

"The upper yellow half that touches the base symbolizes the secular tradition. It personifies His Majesty the King, whose noble actions enhance the Kingdom. Hence, it symbolizes that His Majesty is the upholder of the spiritual and secular foundations of the Kingdom. The lower orange half that extends to the top symbolizes the spiritual tradition. It also symbolizes the flourishing of the Buddhist teachings in general and that of the Kagyu and Nyingma traditions in particular. The dragon that fully presses down the fimbriation symbolizes the name of the Kingdom, which is endowed with the spiritual and secular traditions.

The white dragon symbolizes the undefiled thoughts of the people that express their loyalty, patriotism and great sense of belonging to the Kingdom although they have different ethnic and linguistic origins."

National Dress

Bhutanese men wear the *Gho*, a knee-length kimono type robe tied at the waist by a *Kera*, a woven woolen belt about 2 inches wide. Women wear the ankle-length *Kira*, which is wrapped around and clipped at the shoulders by two silver/bronze brooches called *Koma* and tied at the waist with a *Kera*. Two other pieces of clothing called *Toego* and *Wonju*

Top: National Flag of Bhutan.
Bottom: Young Bhutanese girls in full traditional attire called *'Kira'* during a festival in Ura, Bumthang, Central Bhutan.
Right: A pile of traditional hand-woven textiles.

accompany the *Kira*. In addition, during official occasions and when entering Dzongs (fortresses) and Lhakhangs (monasteries), a kind of long scarf is worn known as *Kabney* for men and *Rachu* for women. It is mandatory to wear national dress during office hours and when entering Dzongs and government establishments.

National Bird

Bhutan's national bird is the Common Raven *(Corvus corax)*. Slightly larger than the common crow, it can be found in Bhutan at altitudes of around 4,200 meters above sea level (m.a.s.l.) and above.

National Animal

The Takin *(Budorcas taxicolor whitei)* is the country's national animal. It lives in the upper reaches of Gasa but migrates down to warmer areas during winter.

National Butterfly

Endemic to Tobrang in eastern Bhutan, Ludlow's Bhutan Swallowtail *(Bhutanitis ludlowi)* was adopted as the national butterfly on 16 February 2012.

National Tree

The Himalayan Cypress *(Cupressus torolusa)* is Bhutan's national tree. It is most often found close to religious structures such as Lhakhangs and Dzongs.

National Sport

Archery is Bhutan's national sport. Other traditional sports are *Khuru* (Darts), *Doegor* and *Soksum*.

Physiography, climate, and environment

Bhutan is characterized by mostly high mountains and plunging gorges which are traversed

Top: Common Raven *(Corvus corax)* - National Bird of Bhutan.

Middle: Takin *(Budorcas taxicolor whitei)* - National Animal of Bhutan.

Bottom: Ludlow's Bhutan Swallowtail *(Bhutanitis ludlowi)* - Bhutan's National Butterfly.

Right: A game of archery in progress using traditional bamboo bows and arrows. These traditional bows and arrows are increasingly being replaced by fiberglass bows and aluminum arrows with plastic fletches.

Left Top: Mt. Gungchen Taag with traditional cantilever bridge in the foreground. The world famous Snowman Trek route passes through this region.

Middle: A glacial river flowing from the base of Mt. Gungchen Singye.

Bottom: A small brook that flows southward to become part of the Punatsangchhu.

by swift flowing rivers that drain into the plains of India in the south. It is a country of extreme altitudinal variations—ranging from 97 m.a.s.l. at its lowest point to 7,570 m.a.s.l. at its highest point, the snow-clad summit of Mt. Gangkhar Puensum, the world's highest unclimbed peak. The topographical and altitudinal variations induce immense variability in climatic conditions and associated vegetation over short distances. This variability is captured by the six agro-ecological zones of Bhutan.

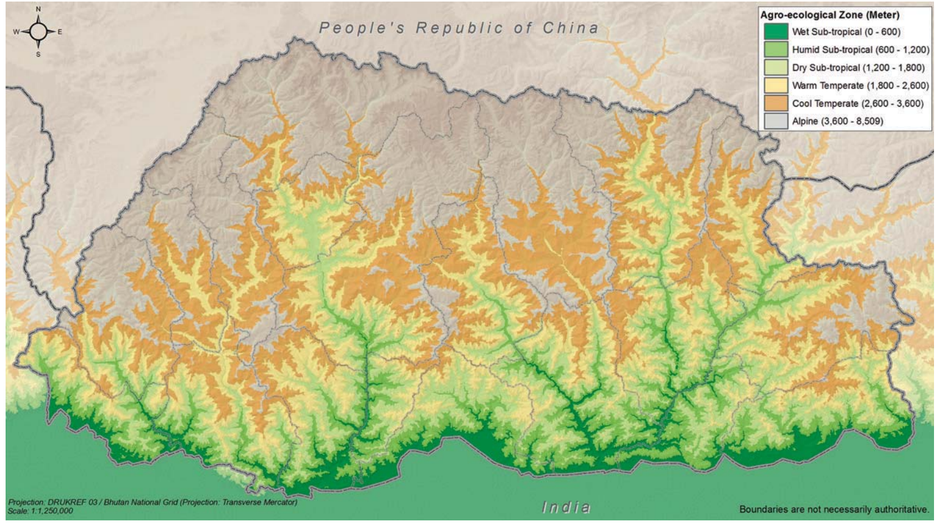
The country has four seasons, namely spring, summer, autumn, and winter, experienced in varying degrees across its territory.

The combined geographical and climatic variations contribute to Bhutan's exceptional biodiversity and ecosystems. Positioned in one of the 10 global biodiversity "hotspots", Bhutan is ranked among the most biodiverse countries of the world. Over 72% of the country is covered in natural forests, which provide refuge to some 700 species of birds and over 5,400 vascular plants, some of which are among the world's most rare and endangered species. Some of the rare animals include the Golden Langur, Royal Bengal Tiger, Clouded Leopard, Hispid Hare, Sloth Bear, and the Red Panda. The upper reaches of the alpine region in the north are home to the Snow Leopard, Musk Deer, Blue Sheep, and the Takin, Bhutan's national animal. The pristine riverine and wetland ecosystems provide natural habitats for the endangered Black-necked Cranes and the critically endangered White-bellied Herons.

Conservation

Conservation is at the core of Bhutan's development planning. The Constitution

Agro-ecological zones of Bhutan



Left: The critically endangered White-bellied Heron *(Ardea insignis)*. The global population of this bird is estimated anywhere from 50 to 200 individuals. Within its known range, Bhutan has recorded the highest number at 28 birds.

Right Top: Golden Langur *(Trachypithecus geei)*. This rare primate is found only in Bhutan and small parts of upper Assam, India.

Right Bottom: The Crested Serpent Eagle *(Spilornis cheela)* is found in most parts of Bhutan. It is among the most beautiful raptors of Bhutan.

mandates the maintenance of 60% of the country's land under forest cover at all times. Bhutan's conservation initiatives have seen the creation of a number of protected areas and biological corridors that cover over 50% of the country. During the recent UNFCCC COP21, the EU recognized Bhutan's leadership role in addressing climate change and the "extraordinary ambition" of its efforts.

System of governance

In 2008, Bhutan transitioned from an absolute monarchy to a constitutional monarchy with a parliamentary form of government. The country's reigning monarch, His Majesty King Jigme Khesar Namgyel Wangchuck, is the head of state, and the elected Prime Minister is the head of government.

Bhutan's political system consists of the National Council and the National Assembly. The National Council, or the Upper House, is the house of review and has 25 members, 20 of which are directly elected by the people and 5 nominated by the King. The National Assembly, or the Lower House, consists of 47 members elected by the people. Executive power is vested in the Council of Ministers headed by the Prime Minister. Legislative power is vested in the National Assembly and the government. Judicial power is vested in the courts of Bhutan with the Chief Justice as the head of the judiciary.

Bhutan's first general election was held on March 24, 2008. The Druk Phuensum Tshogpa formed the first democratically elected government. The People's Democratic Party won the second general elections in 2013.

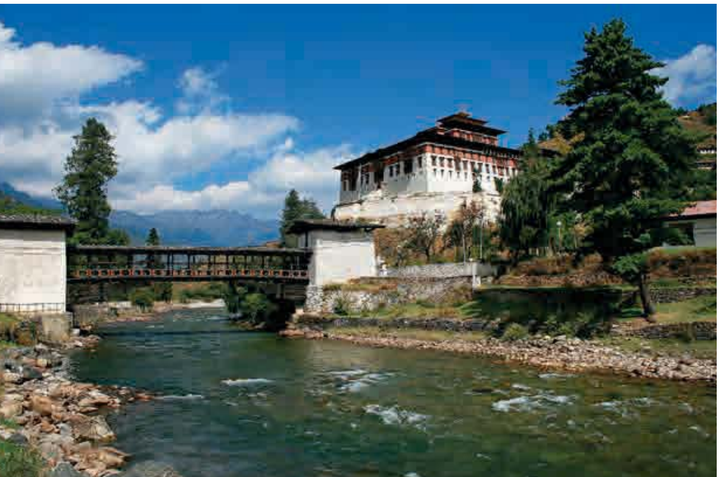
Administration

For ease of administration, Bhutan is divided into twenty districts (Dzongkhags) and large municipalities (Thromdes). Each Dzongkhag is composed of local administrative

Top: The Assembly Hall of the Parliament of Bhutan.

Bottom: Some Members of Bhutan's Cabinet. They represent the executive branch of the government, which includes two other branches—the legislative and the judiciary.

Right: His Excellency Lyonpo Yeshey Dorji, Minister for Agriculture and Forests and Vice Chairman of the National Environment Commission, being received at an official function.



Left Top: Lingzhi Dzong, Bhutan's most remote Dzong with the famous Mt. Jichu Drake in the background.

Left Bottom: Paro Rinpung Dzong with the Pachhu in the foreground.

Top: Trongsa Dzong. Located in the central part of the country, the Wangchuck Dynasty has its roots here.

Bottom: Pungthang Dechen Phodrang Dzong. Located in the western part of the country, it was once the capital of Bhutan.

blocks called Gewogs. The Dzongkhag Tshogdu, or district council, is the district level legislative wing. The legislative wing at the Gewog level is the Gewog Tshogde. The Gewog Tshogde, comprised of Mangmi and Tshogpa (local representatives), is chaired by an elected Gewog head called the Gup. The Dzongkhag Tshogdu is comprised of the Gup and Mangmi and is headed by a Chairperson elected from among the Gups. The Dzongkhag Administration, headed by Dzongdags (district governors) and their Gewog administrations, is the executive wing of the districts. To facilitate the delivery of development programs, some districts are further divided into subdistricts called Dungkhags. Large municipalities are administered by the Thromde Tshogdes. The Thromdes are headed by elected Thrompons (mayors).

There are 20 Dzongkhags comprised of 205 Gewogs and four large Thromdes (municipalities). The Dzongkhags are Bumthang, Chhukha, Dagana, Gasa, Haa, Lhuntse, Monggar, Paro, Pema Gatshel, Punakha, Samdrup Jongkhar, Samtse, Sarpang, Thimphu, Trashigang, Trashi Yangtse, Trongsa, Tsirang, Wangdue Phodrang, and Zhemgang. The four major Thromdes are Thimphu, Phuentsholing, Gelephu, and Samdrup Jongkhar.

Society and culture

Bhutan has a small population of 745,153 inhabitants (2014: Statistical Yearbook of Bhutan, NSB) made up of various ethnic groups, each with a distinct dialect, tradition, and way of life. There are four dominant ethnic groups, namely the Sharchops in the east, the Khengpas in the center, the Ngalops in the west, and Lhotshampas in the south. Their culture, language, and dress are different from each other.

Sharchops

The Sharchops, literally meaning "easterners", are comprised of a number of separate ethnic groups such as the Kurteops, Khengpas, Lhuentsips, Sharchops,

Left: *Choe-kor* – as part of the celebration of their annual festival, the people of Merak in eastern Bhutan carry holy Buddhist scriptures on their backs and circle the village.

Right Top: A Bhutanese lady seen at the Paro Tsechu (festival) wearing her festive clothing and necklace of coral and cat's-eyes.

Right Bottom: An old man in Merak carrying his grandson on his back. In Bhutan, it is customary for grandparents to baby sit.

Left: A young girl from the highlands of Laya.

Top: A Lhotshampa woman. The Lhotshampas originally migrated from Nepal but now live in the south of the country.

Bottom: A Bhutanese man belonging to the Khengpa ethnic group who live in the south central part of the country.

and Brokpas. They mostly live in the eastern parts of the country.

Khengpas

The Khengpas are from central Bhutan, and are the single largest ethnic group in the country. They speak a language called Khengkha. Two other groups occupying the central region are the Bumtaps and the Mangdeps.

Ngalops

The origin of the Ngalops of western Bhutan can be traced to Tibetans from the Tibet Atonomous Region who migrated to Bhutan in the early 9th century. They form the dominant political, cultural and economic group of Bhutan. They speak the Dzongkha language, which is also the official language of Bhutan.

Lhotshampas

The Lhotshampas, or "southerners", reside in southern Bhutan and are mostly of Nepalese origin. Of the Hindu faith, they migrated from eastern Nepal.

In addition to the above four ethnic groups, which account for the majority of the population in Bhutan, there also are other minority groups. They include small populations of indigenous people scattered around the country. These people are known by a variety of names: Brokpa, Dakpa, Monpa, and Doyap.

Religion

The state religion is Vajrayana Buddhism, which is practiced by two-thirds of the population. Buddhism was introduced to Bhutan during the 7th century. However, it was the exiled Indian King Sindhu Raja who propagated the religion in real earnest from his base in Bumthang, where he built a palace. Bhutan's most revered religious figures are Buddha, Guru Padmasambhava, and Zhabdrung Nawang Namgyel. A minority of the Bhutanese, mostly in the south, practice Hinduism.

Apart from mainstream Buddhism, animistic rituals, local beliefs, and worship of natural objects such as rocks, trees, and water bodies are still widespread in rural communities.

Economy

Agriculture is the primary occupation of the Bhutanese people with over 60% of the population engaged in subsistence farming and animal husbandry. Bhutan's economy is driven by hydroelectric power, tourism, and agriculture. The export of electricity to India and a regulated 'high value low impact' tourism sector are the primary sources of foreign currencies. Agricultural produce such as apples, oranges, potatoes, and cardamom are exported to India and Bangladesh. In recent times, the controlled harvesting and export of medicinal Cordyceps has supplemented the income of communities living in high altitudes.

The country has a small industrial sector comprised of industries such as dolomite and limestone mining, fruit processing, cement, alcoholic beverages, and ferroalloys. Small, medium and cottage industries such as dairy farming, fishery, poultry, textiles, and handcrafts also contribute to the economic activity of the country.

Gross National Product

Bhutan's Gross Domestic Product (GDP) is around US$1.943 billion. According to the National Accounts Statistics, the per capita GDP for 2014 is US$2,592.

Gross National Happiness

Bhutan is known around the world as the country that propagated Gross National Happiness (GNH), a concept conceived by His Majesty the Fourth King of Bhutan during the 1970s. GNH and its four pillars—sustainable and equitable socioeconomic

Top: The massive 51.5–meter–tall statue of Buddha Dordenma. This statue is still under construction at Kuensel Phodrang in Thimphu and is supposed to be the world's highest sitting Buddha statue.

Bottom: A monk in deep prayer at Talo Goenpa.

Right: The Druk Wangyel Lhakhang (temple) at Dochula. It was built in honor of His Majesty Jigme Singye Wangchuk, the Fourth King of Bhutan.

Left: From left to right - statues of Guru Rinpoche, Buddha and Zhabdrung Ngawang Namgyal.
Right Top: *Shana Cham*, or Black Hat Dance - one of many mask dances performed during annual festivals around the country.
Right Bottom: *Pa Cham*, or Dance of the Heroes.

development, preservation and promotion of cultural values, conservation and sustainable utilization and management of the natural environment, and promotion of good governance—guide Bhutan's 5-year planning process. All development policies undergo a GNH policy screening process and no policy is adopted unless it passes this process. Recognizing that happiness is central to human wellbeing, the General Assembly of the United Nations unanimously passed Resolution 65/309 in July 2011, which placed happiness on the global development agenda.

Education and health

The government provides free education to all children from primary to tertiary levels. Bhutan's literacy rate is 63% and life expectancy is 62.2 years, with females living longer (64.5 years) than males (61 years). For every 1,000 females, there are 1,070 males.

Health care is provided free by the state.

Top: Students of the Zorig Chusum Institute learn the traditional art of thangka painting.
Bottom: Weaving – Bhutanese women are excellent weavers and produce textiles that are sold for thousands of dollars.
Right: School children walking to school.

II WATER RESOURCES OF BHUTAN

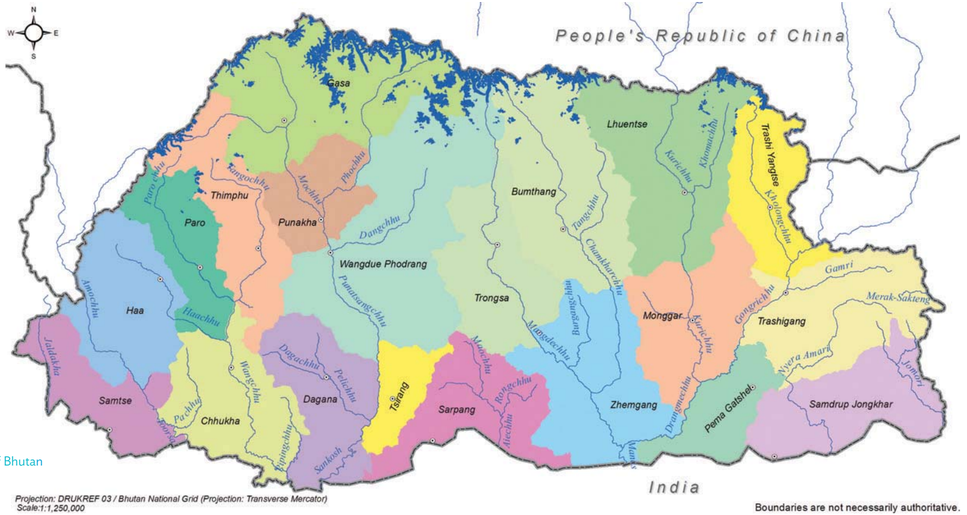
Water Resources of Bhutan

Left: Waterfall near Kuenga Rabten in Trongsa.

Bhutan is endowed with enormous water resources, of which glacial lakes and high altitude wetlands are the most important. Combined with snow, ice, freshwater lakes, running streams, rivers, and ground water, Bhutan has one of the highest per capita availability of water in the world. With an average flow of 2,238 m³/s, Bhutan generates 70,572 million cubic meters per annum, i.e. 94,500 m³ per person per year, the highest in the region.

All of Bhutan's major river systems, as well as several smaller southern waterways, drain into the plains of India.

Bhutan's water resources are best described in terms of i) glaciers, ii) glacial and high altitude wetlands, iii) rivers and river basins, and iv) groundwater and reservoirs.



Glaciers and rivers of Bhutan

Glaciers

About 1.6% of Bhutan's total land area in the elevation range of 4,050 to 7,230 m.a.s.l. is covered in glaciers, snow, and ice. The analysis of recent Landsat satellite images shows that Bhutan had 885 Clean Ice (CI) and 50 Debris Covered (DC) Glaciers in 2010 covering an area of 642 ± 16.1 km^2. The details are presented below:

BASIN	SUB-BASIN	NUMBER of GLACIERS		GLACIER AREA (km^2)			LARGEST GLACIER
		Clean Ice	Debris Covered	Clean Ice	Debris Covered	Total	km^2
Wangchhu	Thimphuchhu	19	0	5.2±0.1	0.0±0.0	5.2±0.1	1.5
	Parochhu	37	2	22.2±0.4	5.4±0.0	27.6±0.5	7.2
	Subtotal	**56**	**2**	**27.4±0.6**	**5.4±0.0**	**32.8±0.7**	**7.2**
Punatsangchhu	Mochhu	180	15	103.8±2.9	9.9±0.1	113.7±3.1	10.4
	Phochu	256	15	201.1±4.9	46.9±0.2	247.9±6.1	36.6
	Subtotal	**436**	**30**	**304.8±7.9**	**56.8±0.4**	**361.6±9.3**	**36.6**
Mangdechhu	Mangdechhu	150	5	91.9 ±2.5	15.8±0.1	107.8±3.05	20.3
	Chamkharchhu	125	7	62.1±1.5	9.8±0.1	71.9±1.8	15.6
Drangmechhu	Kurichhu	96	6	57.8±1.3	3.6±0.0	61.4±1.4	12.5
	Drangmechhu	22	0	6.7±0.1	0.0±0.0	6.7±0.0	2
	Subtotal	**393**	**18**	**218.5±5.4**	**29.2±0.3**	**247.7±6.2**	**20.3**
TOTAL		885	50	550.7±13.8	91.4±0.7	642.1±16.1	36.6

Number and size of glaciers in Bhutan in 2010 (Bajracharya et al, 2014)

Glacial and high altitude wetlands

Glacial and freshwater lakes are major natural reservoirs in Bhutan. Glaciers cover about 10% of the total surface area of the country and are important renewable sources of fresh water for Bhutan and downstream riparian states. When glaciers melt, the water

Right: Animo Tsho - Lake of the nun. A high altitude lake on the way to Dhur Tsachu (hot-spring).

Left: Thorthorme Tsho and Rapstreng Tso (lakes) in Lunana—two of the thousands of glacial lakes in Bhutan. Many years were spent lowering the level of Thorthorme lake because it had the potential of creating a GLOF.

Right Top: A high altitude lake on the way to Lunana.

Right Bottom: A glacial lake in Dhur, Bumthang.

Left: Tshophu lake with Mt. Jichu Drake in the background.
Top: The frozen lake at the base of Mt. Jichu Drake. This is the source of the Pa Chhu.
Bottom: Mt. Chundugang – the Haa Chhu starts at its base.

accumulates in depressions, forming glacial lakes over time. There are some 2,674 glacial lakes in Bhutan. Although they contribute substantially to the country's water resources, the fragility of the Himalayan landscape in which they are located makes glacial lake outburst floods (GLOF) a major threat to downstream communities.

Freshwater lakes on the other hand are natural water bodies formed and recharged through runoff from rain, melting snow, and glaciers.

Rivers and river basins

Rivers are Bhutan's primary water resource. Most of Bhutan's rivers originate in the frigid alpine regions of the north, including two in the Tibet Autonomous Region and one in India. They are fed by melting glaciers, snow, and rain.

Bhutan has five major and five minor river systems that drain through separate basins. A river basin in the context of Bhutan is the entire land area, comprised of mountains and valleys, into which all waters—ice melt, snow, lakes, rainwater and groundwater—flow into, and merge with, a specific river that exits the area at one point.

The major river systems and their basins are:

Amochhu

The smallest river system in the country, the 358 km long Amochhu river originates in Chumbi valley in Tibet Autonomous Region and flows swiftly through western Bhutan. It exits the country at Phuentsholing and then flows into India where it is known as the Torsa.

The Amochhu basin covers the districts of Haa, Samtse, and Chhukha. Its total catchment area is 2,298 km², which is about 6% of the country's total land area.

Wangchhu

The 370 km long Wangchhu runs southeasterly through the valleys of Haa, Paro, and Thimphu. Its principal tributaries are Haachhu, Parochhu, Tangochhu, Wangchhu, and Pipingchhu. It flows into the plains of Jalpaiguri district in India where it is known as the Raidak. It then finally joins the Brahmaputra and flows into Bangladesh where it is sometimes referred to as the Dudhkumar river.

Spread over 11% of the country's total land area, the Wangchhu basin has an area of 4,596 km^2, and covers Haa, Paro, Thimphu and Chukha districts.

Punatsangchhu

The Punatsangchhu is one of the largest rivers of Bhutan. Its two main tributaries—Mochhu and Phochhu—rise in the frigid regions of northwestern Bhutan. Fed by snow and ice melt from the Great Himalayan range, they flow southward toward Punakha where they merge to become the Punatsangchhu. Further downstream, the river is joined by several other tributaries such as Dangchhu, Basochhu, Kamechhu, Digchhu, Harachhu, Changchechhu, Burichhu, and Dagachhu. The 320 km long Punatsangchhu flows southward and enters West Bengal in India.

The largest in Bhutan, the Punatsangchhu basin covers 9,645 km^2, which represents 25% of the country's total land area. The districts of Gasa, Punakha, Wangduephodrang, Tsirang, Dagana, and Sarpang lie within the Punatsangchhu basin.

Mangdechhu

The river derives its name from the valley of Mangde through which it initially runs. The main tributaries are Nikachhu, Burgangchhu, and Chamkharchhu including its tributary Tangchhu.

The Mangdechhu basin covers the districts of Bumthang, Trongsa, Zhemgang, and

Top: The Chamkharchhu starts here at the base of Mt. Gangkhar Puensum.

Right: Mt. Tarigung – 7,300 m.a.s.l. One of Bhutan's highest peaks, the twin Tari Tsho is one of the many sources that go on to form the Punatsangchhu.

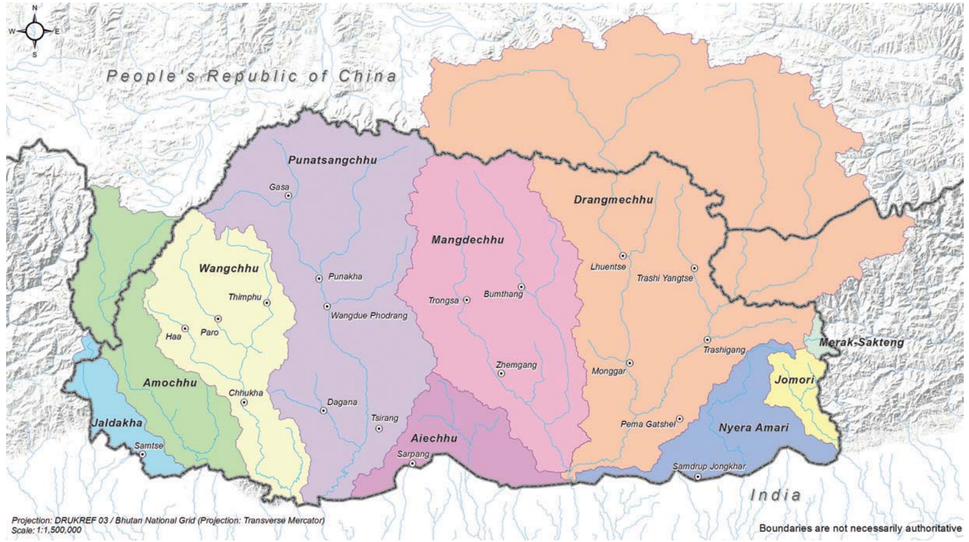
Sarpang. Its catchment area is 7,380 km², which is roughly 19% of the country's total land area.

Drangmechhu

The Drangmechhu is made up of several rivers including Kurichhu, Khomachhu, Kholongchhu, Sherichhu, Gongrichhu, Gamri, and Zhongarchhu. This river joins the Mangdechhu at the southern end of the country after which it flows into India where it is known as the Manas.

The Drangmechhu basin is the second largest river basin after Punatsangchhu. It covers 8,457 km², which represents 22% of Bhutan's total land area. All of the eastern districts of Lhuentse, Monggar, Tashi Yangtse, Trashigang, Pemagatshel, and Samdrup Jongkhar lie within this river basin.

River basins of Bhutan



Top: The Chamchkarchhu – with Mt. Gangkhar Puensum in the background.

Bottom: Pachhu runs under a traditional Bhutanese chain-link bridge. The iron chains are supposed to have been cast by the great bridge builder – Thangtong Gyalpo.

The smaller river systems and their basins comprise i) Jaldakha in Samtse, ii) Aiechhu in Sarpang, iii) Nyera Amari in Samdrup Jongkhar, iv) Jomori in Samdrup Jongkhar/ Trashigang, and v) Merak-Sakteng in Trashigang.

These river systems are harnessed primarily for agriculture and hydropower generation. Bhutan currently generates 1,616 MW of electricity. Ongoing and planned hydropower construction is expected to generate a total of 10,000 MW by the year 2020.

Groundwater and reservoirs

Groundwater and reservoirs contribute to the country's overall water resource. Although groundwater resources are believed to be limited in the rugged mountain areas of Bhutan, the wider and flatter valleys of Paro, Punakha, Thimphu, Wangdue, and areas bordering the plains of India may have significant groundwater reserves. Indeed groundwater is already being tapped at an individual level in some of these areas.

Bhutan has no large-scale reservoirs. The existing reservoirs found on some of the rivers or their tributaries are relatively small-scale diversion reservoirs for hydropower plants. Others are micro schemes built to buffer diurnal flow variations and trap sediments.

III USES OF WATER

Uses of Water

Left: Water-driven prayer wheels on the way to Tango Monastery. In Bhutan, one of the many uses of water is to drive prayer wheels. These types of structures dot the country and earn merit for the people who construct them.

Water is our lifeline, the very essence of life on earth. The Blue Planet—a name by which our Earth is also known, was derived from water. In Bhutan, water assumes a variety of roles—that of life giver, purifier, a source of strength as well as a source of destruction. In the hands of the military, it is a weapon of annihilation, while in the hands of a healer, it holds the power to cure and mend.

The Bhutanese describe water by a variety of names. Large rivers are called *Tsangchhu* (literally translated as clean water), while streams and rivulets are known as *Rongchhu*. Waterfalls are known as *Zarchhu* while *Umchhu* is the name given to small water pools and ponds. Lakes are called *Tso*. Seas and oceans are called *Gyamtsho*. And best among all waters is *Drupchhu*, a holy or blessed water that often emerges out of the cavities of rocks and cliffs.

Traditional uses of water

Religious

Water plays a central role in the everyday lives of the Bhutanese people, touching every aspect of their existence. Every mother of a newborn must be fed water to recondition her body from the ravages of childbirth. Every newborn must begin life on this earth by being cleansed with water—a ritual known as the *Lhabtsang Thruesey,* which involves pouring sanctified water from a ritual vase *(Bumpa)* over the head of the child.

Water is also used in the preparation of *Thruechhu*—consecrated water contained in a *Bumpa* which is served in small measures to people visiting *Lhakhangs*. Water is also used to turn the *Choekhormani*, the cylindrical sealed drums containing printed prayers.

The Buddhist practice of offering seven bowls of water *(Yoencha)* in front of an altar every morning is an exemplary way of maintaining consciousness about the importance of clean, fresh water. The offering is an act of worship undertaken before any house or

Left: An altar in a Bhutanese home. Small water bowls are placed in front of statues as offerings *(Yoencha)* – this act of worship is practiced every morning in Buddhist households and temples.

Right: A monk pouring sanctified water from a *Bumpa* – a ritual vase.

farm work. Although it is believed to help relieve ghosts from thirst, it represents the purity of mind in the practice of giving.

Health

Drungtso or *Sowa-Rigpa* practitioners (traditional medics), harvest and use rainwater to prepare medicinal pills because they believe that rain water is the second purest water after *Drupchhu*.

Tsachhu and *Menchhu* are sanctified waters credited with healing powers which cure a number of ailments. Annual bathing in these waters is an occasion for cleansing, healing and relaxation.

Drinking

Until recently, rivers were seldom used as a source of drinking water, either for human consumption or watering livestock. Water for household use came from ponds, streams and springs. In most cases, since villages are sited in water sparse locations, water had to be carried on human backs in cane baskets *(Tseow)* over long distances, using bamboo containers knows as *Kadung* and, more recently, plastic Jerry cans. Water was stored in large containers called *Chhuzang* and placed inside the kitchens or on the first floor landing of a home, called *Tengu*.

Irrigated farming

One of the most widespread uses of water is for farming. Most of the water for irrigation is drawn from small streams and spring water. Unlike other countries, ground water is not extracted for irrigation purposes in Bhutan.

Agro-processing

Water is also important for agro-processing. Rural households are dependent on indigenous techniques for processing grains such as corn, wheat, barley and buckwheat.

Top: People soaking in Dunmang *Tshachhu* – hot springs which are believed to be sanctified waters with powers to heal a number of ailments.

Bottom: Menchu – water with healing powers.

Right: Hot stone bath at Wangdue – people soaking in *Menchu* in a naturally formed stone bathtub.

Left Top: Paddy field in rural Wangdue.

Left Bottom: Traditional water canal in Berti village, Zhemgang.

Right: Paddy harvest in Dobshari village, Paro.

Running water is also used to turn the wheels of mills called *Chhuthag*, used for grinding a variety of food grains.

Social gatherings

The daily task of drawing water from the community well, the *Choekhormani,* also strengthens social bonds. Every morning and evening, people go there to wash and collect water, providing a perfect occasion to socialize and catch up with each others' news and views.

Burial purposes

The Bhutanese also use rivers for burial. Stillborn babies and babies under 5 years of age are not cremated but put inside wooden cages and submerged in deep parts of a *Tsangchhu* (river). Water is also the final resting place for the ashes of cremated bodies.

Military

One of the most lethal weapons in the hands of the military was once water. In times of war, water sources were poisoned to silently kill invading enemy forces. Cutting off water supplies was one means of forcing enemies to relinquish their fortified strongholds. Fortresses such as Drugyel Dzong and Jakar Dzong had secret fortified passages to water sources to ensure that their water supplies were not disrupted during times of war and conflict.

Modern uses of water

Hydroelectricity generation

Overall, Bhutan's main and most profitable use of water is for the generation of electricity. Bhutan has a potential to generate 30,000 MW of hydroelectricity, of which only 1,616 MW is currently being generated.

Top: Diversion tunnel for the Punatsangchhu Hydropower Project-I, Wangduephodrang.
Bottom: High-voltage power cable transmitting power to India.
Right: Kurichhu Hydropower Project in eastern Bhutan.

Left: Kayaking in Punatsangchhu – a modern use of water.

Right: Brown Trout *(Salmo trutta)*. Although not endemic, most rivers in the northern part of the country are stocked with Brown Trout which were introduced from Kashmir, India in the early 1900s.

Left: *Chhuthag* or *Chura* – water mill. In rural Bhutan water is used to turn wooden wheels to grind grain and corn.

Top & Bottom: Different types of grinding stones that are turned by water wheels.

Industrial use of water

In modern times, the use of water for industrial purposes, which was unheard of a few decades ago, has been growing fast. The construction industry consumes a large amount of water. Other modern uses of water include: sprinkler systems for gardens and lawns, mechanized car wash systems, swimming pools, and cooling towers in air-conditioning systems.

Domestic use of water

A large volume of water is consumed for drinking and washing in both urban and rural areas. The scarcity of safe drinking water in and around populated areas has caused the government to invest considerable sums of money to draw water from distant locations to supply storage and distribution networks in urban and rural areas. The delivery and storage of water varies from place to place. Not all of the systems are efficient and sometimes large amounts of water go to waste through poor management and maintenance. Traditional water user groups look after the maintenance of water supply systems in rural communities. In general, the shortage of drinking water is not life threatening and mortality caused by unsafe drinking water is relatively low in Bhutan.

IV WATER ISSUES AND CHALLENGES

Water Issues and Challenges

Although water resources are abundant (70,576 million cubic meters per year), accessing them for drinking and irrigation purposes is not easy due to the country's difficult terrain. The bulk of Bhutan's water resources flow through small streams and rivers located at the bottom of gorges and ravines while human settlements and farmland occupy the upper slopes and hilltops. The paradoxical situation of water paucity in the face of plenty is thus not new to Bhutan. Unfortunately, the situation is likely to deteriorate furthwer as the country seeks to modernize and develop. Rapid human population growth in both urban and rural areas is amplifying the pressure on available water resources due to increases in agricultural farming, animal husbandry, industrial and domestic uses. However, climate change brought on by global warming will most likely be the biggest threat in coming decades.

Bhutan and climate change

Because of its rugged mountainous terrain and wide altitudinal variations, Bhutan is unique in terms of the diversity of its climatic conditions. Bhutan is located in the Himalayas where the warming rate is much greater than the global average. This means that Bhutan is particularly susceptible to climate change threats.

Temperature and precipitation are two key climatic variables that are greatly influenced by climate change. This phenomenon is predicted to cause marked changes in seasonal water availability, which could have serious impacts on irrigated agriculture, and consequently on Bhutan's overall economy.

Predicted impacts of climate change

Studies recently conducted throughout the country suggest a change in climatic variables with an overall increase in temperatures, resulting in more rainfall, but with large spatial and temporal variations. This increase is projected to occur during the monsoon, whereas

Left: The Thimchhu in spate

during the remainder of the year rainfall will not increase and may even decrease. The increase in rainfall is likely to be more pronounced in the south of the country than in the north. The projected increase in rainfall is attributed mainly to a greater intensity of precipitation rather than an increase in the number of rainy days.

As far as temperature is concerned, there is a consistent finding across climate projection models of a warming pattern, with greater temperature changes during the winter months.

The predicted climate change is likely to induce the following changes in climatic and hydrological variables:

- Precipitation will increase
- Precipitation will take the form of rainfall rather than snowfall
- Rainfall will be more erratic and intense
- Snowmelt will start earlier
- Winter seasons will be shorter
- Wet season flood flows and transportation of sediment and debris will increase
- Dry season flows, in contrast, are expected to decrease

Climate change is likely to impact agricultural production. Rising temperatures will affect the areas under cultivation and the timing of crops to be grown as well as the impact of pests and diseases.

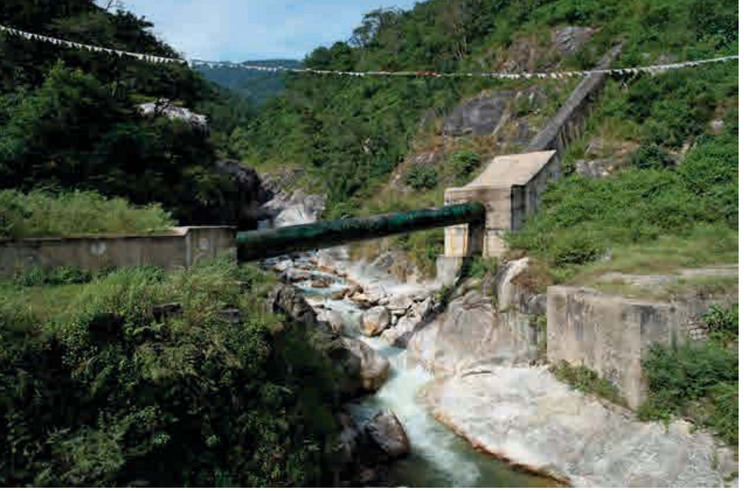
More intense rainfall may result in more runoff and less water retention in the soil. Forest fires, deforestation, landslides and road construction may further aggravate this phenomenon.

Since most of the agricultural land in Bhutan is located on slopes, farms are likely to be

Right: Landslides are becoming more frequent.

Left Top & Bottom: Water leakage that contributes to increasing water insufficiency.

Right: Example of pollution in water systems.



Left Top & Bottom: Examples of modern day and traditional water delivery systems.

Right: HDPE water pipes being carried on the backs of villagers. Rural communities now have access to clean and safe drinking water under the government's rural water supply scheme.

Left Top & Bottom: Modern irrigation structures at the Taklai Irrigation Project.

Top: Example of a modern day water storage system – concrete tank for municipalities.

Bottom: Overhead plastic water tank. Storage of water for domestic use.

affected by increasing landsides due to more intense and erratic rainfall.

While the availability of water in Bhutan is the highest in the region, access to water resources still remains an issue because of the highly dispersed nature of settlements and their low population densities. The per capita cost of delivering water services is very high. Very little farmland is located near rivers where irrigation water is plentiful. At present, rivers are mainly used in Bhutan to produce hydroelectricity and alternative uses are practically nonexistent.

Most of the existing hydropower plants in the country are run-off-the-river types, which means that electricity production fluctuates with seasonal variations in river discharge. Bhutan consequently finds itself exporting electricity cheaply during summer months and importing expensive electricity during the winter.

V SECURING THE FUTURE

Securing the Future

Water is the primary resource upon which Bhutan's future is hinged.

Critical areas of water management

The manner in which its water resources are managed have a bearing on five critical areas of development, namely 1) rural drinking water and sanitation, 2) urban water management, 3) economic use of water, 4) ecosystem services for water supply, and 5) water related risks and disasters. This is further explained below.

Rural drinking water and sanitation

Access to safe drinking water and sanitation in Bhutan is a necessity in both urban and rural areas. In rural areas, communities are dependent on small streams and spring waters along the slopes. The impacts of climate change are beginning to be seen in decreasing quantities of water and the drying up of water sources. Traditional sources are disappearing, and communities must rely on distant water sources.

Urban water management

In urban areas, water issues pertain primarily to water for drinking and sanitation. With migration from rural areas, municipalities are facing increasing challenges in meeting growing demand for water, both in terms of quantity and quality. Middle class and low income urban residents are faced with a limited supply of treated water, resulting in poor sanitation and reliance on alternative, untreated sources. Inadequate and poor water distribution systems are rendering it difficult for municipalities to provide a reliable and uninterrupted supply of water. Urban areas are also beginning to experience flooding, due to an expansion of nonpermeable surfaces and poorly planned drainage systems, and pollution from inadequate sewerage and waste management systems.

Economic use of water

Water is the backbone of Bhutan's economy. It is essential for agriculture, the means of

Left: A young boy having fun being drenched by water from a leaky pipe.

subsistence for over 60% of the population. It is also the primary driver of hydropower, which is the largest contributor to national income through exports of electricity to India.

Agriculture

Although food self-sufficiency has always been a priority for the Royal Government, the small and fragmented landholdings in the narrow valleys and slopes of Bhutan impose labor intensive subsistence farming with a limited capacity for economies of scale. Despite government efforts to promote agriculture through extension services and subsidies for irrigation and mechanization, the younger generation is less and less interested in working in this sector. Rural-urban migration has left the older generation to take care of the land, and scope for mechanization is limited. The Royal Government is constantly exploring ways to tackle these constraints on agricultural development. The budgetary outlay for agricultural development in the 11th FYP has significantly increased over past allocations. A National Irrigation Master Plan (NIMP) has now been elaborated which sets out a strategy for increasing agricultural production for food self-sufficiency.

With continued seasonal variations in rainfall under a changing climate, innovative and cost efficient technologies, infrastructure and management interventions are key to increasing access to the abundant water resources available primarily in valley bottoms and deep gorges.

Hydropower generation

Given Bhutan's potential to produce 30,000 MW of hydroelectricity, the Bhutanese often refer to their water resources as 'white gold'. The current generation of 1,616 MW not only provides electricity to over 94% of households in the country but also continues to be the largest contributor to national revenue through the export of electricity to India.

Right: Thimchhu – main river of Wangchhu basin. The river runs through the capital city of Thimphu.

The Royal Government is wary of the economic as well as environmental implications of hydropower owing to the seasonal variations of river flows. At present, hydropower plants are concentrated in the middle to lower parts of the basins and are primarily 'run-off-the-river' schemes. As these are nonreservoir and nonconsumptive in nature, power generation fluctuates according to the seasonal variation of discharge in rivers. In terms of the environment, the stretch of river between the intake and outlet of the water diversion tunnel is affected, especially during the winter when river water is inadequate for the optimal utilization of the plants.

Under the projected scenario of excess water when not needed and too little water during times of need, enhancing storage capacity to harness excess monsoon water seems to be the only option to optimize the existing capacity of hydropower plants while allowing for advances in agricultural production. Future hydropower plans incorporating storage reservoirs (such as Bunakha, Sankosh, and Amochhu) may help stabilize and optimize electricity production.

Ecosystem services for water supply

Bhutan's water resources are regulated and sustained through its rich forest cover that protects the fragile slopes while facilitating ground water recharge. Maintaining the quality of watersheds to provide a steady supply of water is fundamental for water security. The constitutional requirement to maintain 60% of the land under forest cover at all times, and the creation of protected areas and biological corridors covering over 50% of the country, are sound foundations for sustained water resources. The Royal Government has adopted an innovative policy of providing at least 1% of annual hydroelectricity royalties to the Ministry of Agriculture and Forests for sustainable agriculture and upstream catchment protection.

Water related risks and disasters

Bhutan's location in the fragile and rugged Himalayas makes it vulnerable to flooding

Left: An example of shortage in the face of plenty. Most of Bhutan's rivers are located at the bottom of valleys while human settlements and farmland are sited on hill tops—resulting in paucity of water for drinking as well as farming.

Top: A waterfall in Trongsa—there are many waterfalls in Bhutan.

from intense monsoon rains that destabilize slopes, cause soil erosion, and damage life, infrastructure, and property. Settlements along rivers and tributaries are particularly exposed to the risks of flash floods and glacial lake outburst floods. Watershed protection, ecosystem conservation, drainage infrastructure, the installation of early warning systems and efficient disaster response mechanisms are key to building resilience to disasters.

Way forward

With the emerging threats and uncertainties surrounding climate change, combined with increasing demand resulting from population growth and lifestyle changes, Bhutan is mindful of the importance of managing water resources for a secure future. It has chosen to adopt the *Integrated Water Resources Management (IWRM)* approach to achieve this.

Bhutan has progressively expanded its focus from single-purpose engineering works in the 1960s (hydropower plants, irrigation schemes) to include environmental concerns in the 1970s and 1980s. Multiple stakeholders became involved in the planning and management of watershed conservation programs. The drive during the 1990s for more sustainable development paved the way to adopt a comprehensive system of water resources management, one that emphasized the coordinated development and management of water, land and ecological resources. With that, IWRM became the new paradigm. Over the past decade, the management scope of water resources has further expanded to include concerns about the impact of climate change. The emergence of IWRM in Bhutan may be traced back to the work of the Bhutan Water Partnership (BhWP) in the early 2000s. At that time, the Partnership began to advocate, alongside the Royal Government, the establishment of the necessary mechanisms to safeguard Bhutan's water resources. This was adequately considered in the Bhutan Water Vision and Policy document of 2008, which envisions that:

Water is the most important natural, economic, life sustaining resource and we must ensure

Right: Flooding in Thimphu. Water can cause severe damage to life and property.

Left: Weather station – efforts are under way to expand and modernize equipment for recording rainfall, temperature and other climactic data.

Top & Bottom: Various ways in which water is tapped and transported – both in rural as well as urban areas.

that it is available in abundance to meet the increasing demands. Present and future generations will have assured access to adequate, safe and affordable water to enhance and maintain the quality of their lives and the integrity of natural ecosystems.

(Bhutan Water Vision, 2008)

The Bhutan Water Act of 2011 captures the essence of this water vision and policy. The Act identifies IWRM as the approach needed to ensure that water resources are protected, conserved and/or managed in an economically efficient, socially equitable, and environmentally sustainable manner. It also stipulates that the NEC is the apex body for all matters related to water resources, and that:

- the NEC Secretariat (NECS) in consultation with competent authorities has to '*prepare and periodically update a National Integrated Water Resources Management Plan for the conservation, development and management of water resources*'.

- the NEC and competent authorities have to take into account the approved plan in all water related decisions and the plan must be mainstreamed into national policies, plans and programs.

To support the Royal Government's drive for comprehensive water resource management, the NECS launched water regulations in 2014 and initiated the preparation of plans to strengthen the institutional capacity needed to implement IWRM. The Asian Development Bank (ADB) funded Technical Assistance project, 'Adapting to climate change through IWRM', was implemented to prepare the National IWRM Plan, the River Basin Management Plan for a priority basin, the National Irrigation Master Plan (NIMP), and to strengthen water resources governance. A Technical Advisory Committee (TAC) comprised of representatives of competent authorities and stakeholders was set up to provide technical advice on outputs of the technical assistance team. The necessary

instruments and tools required for implementation of IWRM are now in place, as presented below:

National IWRM Plan

The National IWRM Plan is the overall framework document for the coordinated management of water resources in the country. The plan is based on a comprehensive assessment of current and future water resources through climate and hydrological modeling exercises. The following elements define the framework within which the ultimate goal of water security is to be pursued:

Delineation of management basins

In accordance with the provisions of the Water Act, the plan promulgates the river basin as the unit of management. Although Bhutan has five major and five minor *hydrological* basins, it delineates five *management* basins by integrating the minor basins into the larger ones, this for cost-efficiency and ease of administration of the river basins.

MANAGEMENT BASIN		HYDROLOGICAL BASIN		AREA (km²)	ANNUAL FLOW (million cubic meters)
1	Amochhu	1	Amochhu	2,310	9,375
		2	Jaldakha	942	
2	Wangchhu	3	Wangchhu	4,596	5,209
3	Punatsangchhu	4	Punatsangchhu	9,645	19,129
		5	Aiechhu	1,937	6,989
4	Mangdechhu	6	Mangdechhu	7,380	11,797
5	Drangmechhu	7	Drangmechhu	8,457	13,569
		8	Nyera amari	2,348	4,506
		9	Jomori/ Dhansiri	642	
		10	Merak-Sakteng	137	
			TOTAL	**38,394**	**70,576**
			FLOW (m³/s)		**2,238**

Delineation of management basins

Right: Mt. Gangkhar Phuensum (7,570 m.a.s.l.), Bhutan's highest peak and the world's highest unclimbed mountain.

Left Top: Cloud formation in the Lunana area. These clouds create rain that contributes to the water resource of Bhutan.

Left Bottom: Formation of ice on cliff tops. Low temperatures of the northern highlands help retain water in the form of ice. Melting ice contribute to the flow in rivers.

Right: Waterfall in Basochhu, Wangduephodrang. Such waterfalls add to the scenic beauty and provide water for hydropower.

Left: Mt. Jumolhari – one of Bhutan's highest mountains at 7,315 m.a.s.l.

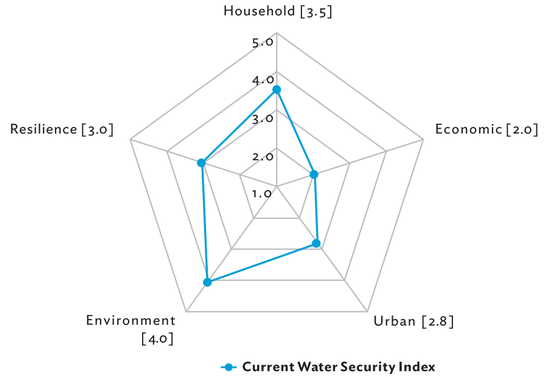
Bhutan Water Security Index (BWSI)

BWSI has been adapted from the Asian Water Development Outlook of ADB. It comprises five key dimensions, each with a set of indicators against which progress can be monitored. The dimensions are:

- KD1 - Rural drinking water supply and sanitation
- KD2 - Economic Water Security
- KD3 - Urban Water Security
- KD4 - Environmental Water Security
- KD5 - Disaster and Climate Change Resilience

BWSI has in total 57 indicators, each identified against a specific key dimension and responsible agency in the government. With the baseline developed for 2015, a computerized user authenticated online data entry system allows yearly progress to be gauged by both indicators and dimensions. The dimension scores and graphical presentation of the information facilitates planning and decision making.

BHUTAN WATER SECURITY INDEX : 2015



Institutional coordination and capacity development

The Royal Government is wary of the bureaucratic and cost implications of an expanded government machinery to facilitate the implementation of IWRM. It has therefore taken the approach of building on existing institutions by:

- strengthening the coordination role of the Water Resource Coordination Division of NECS;
- orienting the role of each of the stakeholders and competent authorities to contribute to water security and building their capacity; and
- integrating IWRM plans in sectoral priorities through the government's planning, budgeting, implementing, and monitoring processes.

In facilitating basin level management, the framework and terms of reference for River Basin Committees (RBCs) have been put in place. The recent establishment of the Wangchhu Basin Committee is a major step in implementing IWRM. Other basins have yet to establish their RBCs.

IWRM requires coordination and cooperation between responsible agencies. Efforts are being made to harmonize various Acts related to water management. Recommendations for updating the Acts and regulations are being generated. Guidelines and procedures also have been developed for the registration and operation of the water user groups (WUAs) which look after water distribution at local levels.

Wangchhu Basin Management Plan

A river basin management plan is a detailed plan for a basin prepared on the basis of the National IWRM Plan. The Wangchhu Basin Management Plan is Bhutan's first basin level management plan. It is expected that the experiences and lessons learned from implementing the plan will contribute to realistic management plans for other basins.

Right: Merak village in eastern Bhutan. People from this village and the village of Sakteng are called Dakpas. Ethnically they are distinct from other races of Bhutan.

Left: Lake at the base of Mt. Gangkhar Puensum. The Chamkharchhu originates from this lake.

Bhutan IWRM information system

Various types of information have been generated about Bhutan's water resources, including on hydrological and management basins. The information is available online in the form of interactive WebGIS, water balance information and calculator, and various maps. In addition, the BWSI system enables the authenticated input of data and public viewing of automated information on water security.

National Irrigation Master Plan

The national irrigation master plan has been formulated to support the Ministry of Agriculture and Forests in achieving food self-sufficiency. The plan includes the development of new irrigation schemes, the reconstruction of existing ones, technological interventions and institutional arrangements. The Department of Agriculture's Irrigation Engineering Manual has also been updated.

ISBN 978-99936-865-3-8