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**PERFORMANCE AUDIT REPORT ON
CLIMATE CHANGE ADAPTATION ACTIONS
IN WATER RESOURCES MANAGEMENT**

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ས་གཤིས་འགྱུར་བཟོད་དང་འབྲེལ་
མཐུན་བཟོ་ནིའི་དང་ལེན་ཚུ་གི་ལས་
འབྲེལ་ཚུས་ཞིབ་སྟན་ལྟུ།



October 2025

DISCLAIMER NOTE

The audit was conducted in accordance with the International Standards of Supreme Audit Institutions (ISSAIs). The audit was conducted based on the audit objectives and criteria determined in the audit plan and programme prepared by the Royal Audit Authority and the findings are based on the information and data made available by the Department of Environment and Climate Change, Department of Water, Department of Infrastructure Development, National Center for Hydrology and Meteorology, Department of Local Governance and Disaster Management and ten sampled Dzongkhags.

This is also to certify that the auditors during the audit had neither yielded to pressure nor dispensed any favour nor resorted to any unethical means that would violate the Royal Audit Authority's Oath of Good Conduct, Ethics, and Secrecy.



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ROYAL AUDIT AUTHORITY

Bhutan Integrity House

Reporting on Economy, Efficiency & Effectiveness in the use of Public Resources



RAA/DPCA/PAD (PA-CCAA in WRM)/2025-26/640

Date: 10 October 2025

Secretary
Ministry of Energy and Natural Resources
Ministry of Infrastructure and Transport
Thimphu, Bhutan

Subject: Performance Audit Report on Climate Change Adaptation Actions in Water Resources Management

Dear Sir,

Enclosed herewith please find the **Performance Audit Report on the Effectiveness of Climate Change Adaptation Actions in Water Resources Management**, *focusing on drinking & irrigation water, and GLOF Early Warning Systems*, covering the period 1 July 2018 to 30 June 2023. The Royal Audit Authority (RAA) conducted the audit in line with the mandate enshrined in the Constitution of the Kingdom of Bhutan and the Audit Act of Bhutan 2018. The audit is conducted in accordance with the International Standards of Supreme Audit Institutions on Performance Auditing (ISSAI 3000). The audit is also conducted in the context of Performance Auditing following the RAA's Performance Audit Guidelines.

The audit objectives were as follows:

- ☑ To examine Bhutan's capacity to effectively adapt to Climate Change impacts in Water Resources Management, mainly:
 - ➡ To assess the adequacy of the governance framework to improve oversight and coordination for climate change adaptation in Bhutan's Water Resources Management.
 - ➡ To assess whether the actions have been designed and implemented to effectively address climate change risk.

The report has been prepared based on the review of available documents, observation from field visits, analysis of data, and discussion with relevant officials of the Department of Environment and Climate Change (DECC), Department of Water (DoW), National Center for Hydrology and Meteorology (NCHM), Department of Local Governance and Disaster Management (DLGDM), Department of Infrastructure Development (DoID) and ten selected Dzongkhags.

The report contains shortcomings and gaps as well as recommendations aimed at improving capacities to adapt to climate change impacts. The draft report was shared on 25 August 2025 for factual confirmation, comments, and feedback, especially on the relevance and applicability of the recommendations. The responses received have been incorporated into the report along with the necessary revisions of the recommendations.

In line with the Audit Act of Bhutan (2018) and the Audit Rules and Regulations (2020), the agencies are required to submit Management Action Plan (MAP) specifying the actions for implementing the recommendations with a definite timeframe. The RAA will follow up on the implementation of the corrective actions and recommendations based on this MAP.

Therefore, the RAA would like to request the agencies concerned to submit a MAP for the implementation of recommendations with a definite timeframe **on or before 03 November 2025** along with the signed AS (format attached under Appendix-III). In the event of non-submission, the RAA shall invariably fix the overall supervisory accountability on the head of the audited agencies in line with Section 55(17) of the Audit Act of Bhutan 2018.

We take this opportunity to acknowledge the officials of the audited entities for rendering the necessary cooperation and support, which facilitated the timely completion of the audit.

Yours sincerely,



(Tashi)
Auditor General

Copy to:

1. Hon'ble Lyonchhen, Royal Government of Bhutan
2. Hon'ble Gyalpoi Zimpon, Office of Gyalpoi Zimpon
3. Hon'ble Speaker, National Assembly of Bhutan
4. Hon'ble Chairperson, National Council of Bhutan
5. Hon'ble Opposition Leader, National Assembly of Bhutan
6. Hon'ble Chairperson, Public Accounts Committee, National Assembly of Bhutan
7. Director General, Department of Infrastructure Development, Ministry of Infrastructure and Transport,
8. Director General, National Center for Hydrology and Meteorology
9. Director, Department of Environment and Climate Change, Ministry of Energy and Natural Resources
10. Director, Department of Water, Ministry of Energy and Natural Resources
11. Director, Department of Local Governance and Disaster Management
12. Assistant Auditor General, Policy and Planning Division, RAA
13. Office copy

*"Every individual must strive to be principled. And individuals in positions of responsibility must even strive harder."
- His Majesty the King Jigme Khesar Namgyel Wangchuck*

TITLE SHEET

1. Title of the Report	:	Performance Audit Report on the Effectiveness of Climate Change Adaptation Actions in Water Resources Management (focusing on drinking & irrigation water, and GLOF Early Warning Systems)
2. AIN	:	PAD-2024-408
3. Audited Entity	:	DECC, DoW, NCHM, DLGDM, and DoID
4. Audit Period	:	1 July 2018 to 30 June 2023
5. Audit Schedule	:	March 2024 to December 2024
6. Audit Team	:	1. Namgay Choden, Sr. Audit Officer 2. Ugyen Tshering, Asst. Audit Officer 3. Tenzin Wangmo, Asst. Audit Officer
7. Supervisor	:	Sonam Delma, Asst. Auditor General
8. Overall Supervisor	:	Dorji Wangchuk, Joint Auditor General

ACRONYMS AND ABBREVIATIONS

ACREWAS	:	Advancing Climate Resilience of Water Sector
ADB	:	Asian Development Bank
BTFEC	:	Bhutan Trust Fund for Environmental Conservation
BTR	:	Biennial Transparency Reports
BUR	:	Biennial Update Report
BWSI	:	Bhutan Water Security Index
C4	:	Climate Change Coordination Committee
CCD	:	Climate Change Division
CoP	:	Conference of Parties
CSOs	:	Civil Society Organisations
DECC	:	Department of Environment and Climate Change
DFO	:	Divisional Forest Office
DHS	:	Department of Human Settlement
DI pipes	:	Ductile Iron Pipes
DLGDM	:	Department of Local Governance and Disaster Management
DMDF	:	Department of Macro-Fiscal and Development Finance
DoA	:	Department of Agriculture
DoFPS	:	Department of Forest and Park Services
DoID	:	Department of Infrastructure Development
DoW	:	Department of Water
EWS	:	Early Warning Systems
FCR	:	Ferro Cement Reservoir
FYDP	:	Five-Year Development Plan
FYP	:	Five-Year Plan
GCF	:	Green Climate Fund
GDP	:	Gross Domestic Product
GEF	:	Global Environment Facility
GI Pipes	:	Galvanised Iron Pipes
GLOF	:	Glacial Lake Outburst Floods
GNHC	:	Gross National Happiness Commission
GoI	:	Government of India
HDPE	:	High-density polyethylene
ICIMOD	:	International Centre for Integrated Mountain Development
IDI	:	INTOSAI Development Initiative
INDC	:	Intended Nationally Determined Contribution
INTOSAI	:	International Organisation of Supreme Audit Institutions
IoT	:	Internet of Things
IPCC	:	Intergovernmental Panel on Climate Change
ISDR	:	International Strategy for Disaster Reduction
ISO	:	International Organisation for Standardisation
IWRM	:	Integrated Water Resources Management

KPI	:	Key Performance Indicators
LDC	:	Least Developed Country
LG	:	Local Government
M&E	:	Monitoring and Evaluation
MoAF	:	Ministry of Agriculture and Forest
MoAL	:	Ministry of Agriculture and Livestock
MoENR	:	Ministry of Energy and Natural Resources
MoF	:	Ministry of Finance
MoIT	:	Ministry of Infrastructure and Transport
MoWHS	:	Ministry of Work and Human Settlement
MRG	:	Mainstreaming Reference Group
NAP	:	National Adaptation Plan
NAPA	:	National Adaptation Programme of Actions
NC	:	National Communication
NCCC	:	National Climate Change Committee
NCHM	:	National Center for Hydrology and Meteorology
NDC	:	Nationally Determined Contribution
NEC	:	National Environment Commission
NECS	:	National Environment Commission Secretariat
NIWRMP	:	National Integrated Water Resource Management Plan
NKRA	:	National Key Result Area
NSB	:	National Statistics Bureau
O&M	:	Operation and Maintenance
PES	:	Payment for Ecosystem Services
PMU	:	Project Management Unit
PPCR	:	Pilot Programme for Climate Resilience
R&D	:	Research and Development
RAA	:	Royal Audit Authority
RCC	:	Reinforced Cement Concrete
RCSC	:	Royal Civil Service Commission
RGoB	:	Royal Government of Bhutan
RSPN	:	Royal Society for Protection of Nature
RWSS	:	Rural Water Supply and Sanitation
UNDP	:	United Nations Development Programme
UNFCCC	:	United Nations Framework Convention on Climate Change
WASH	:	Water, Sanitation, and Hygiene
WASIS	:	Water and Sanitation Information System
WEGA	:	Working Group on Environmental Audit
WFP	:	Water Flagship Programme
WHO	:	World Health Organisation
WMD	:	Watershed Management Division
WRCD	:	Water Resources Coordination Division
WRM	:	Water Resources Management
WSD	:	Water and Sanitation Division
WUA	:	Water Users' Association

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EXECUTIVE SUMMARY

Bhutan is among the world's most vulnerable countries to climate change, posing significant threats to its abundant water resources. The country also faces increasing threats from climate hazards and extreme events such as flash floods, Glacial Lake Outburst Floods (GLOF), and landslides. Given Bhutan's significant international commitments to combat climate change, government investments in adaptation efforts, and the essential role of water in Bhutan's economy, it is crucial to evaluate the government's actions to prevent, respond to, and adapt to climate-induced impacts on water availability.

To address national and global climate challenges, Bhutan developed the Climate Change Policy (CCP) in 2020. Accordingly, the National Adaptation Plan (NAP) was developed in response to the threat of climate change, aiming to reduce vulnerability to climate change impacts and to facilitate the integration of climate change adaptation into relevant policies, programmes, and activities.

The RAA conducted this performance audit on the Effectiveness of Climate Change Adaptation Actions in Water Resources Management, focusing on drinking & irrigation water, and GLOF Early Warning Systems, as mandated by the Constitution of the Kingdom of Bhutan and the Audit Act of Bhutan 2018. The audit was conducted following the Performance Audit Guidelines, which are in line with the International Standards for Supreme Audit Institutions (ISSAIs). The audit was conducted with the following audit objectives:

- ☑ To examine Bhutan's capacity to effectively adapt to Climate Change impacts in Water Resources Management.
- ➡ To assess the adequacy of the governance framework to improve oversight and coordination for climate change adaptation in Bhutan's Water Resources Management.
- ➡ To assess whether the actions have been designed and implemented to effectively address climate change risk.

RAA conducted the performance audit in the Department of Environment and Climate Change (DECC), Department of Water (DoW), Department of Infrastructure Development (DoID), National Center for Hydrology and Meteorology (NCHM), and Department of Local Governance and Disaster Management (DLGDM) as the main agencies and ten selected Dzongkhags covering the period 1 July 2018 to 30 June 2023.

The RAA observed gaps and shortcomings, of which significant findings are briefly highlighted below:

- Although the CCP Action Plan is yet to be developed, the NAP was completed in November 2023. However, there was no monitoring and evaluation framework developed to monitor the progress of the CCP or the action plan. Additionally, the Climate Change Coordination Committee (C4), entrusted to monitor and provide guidance on the overall implementation of the policy, remains non-functional, with no monitoring or reporting of climate actions to the National Climate Change Committee (NCCC).
- The RAA noted coordination gaps within water sector agencies, which have impeded the integrated approach to the implementation of climate change actions in the water sector.

- There is a gap in integrating climate change considerations into the plans and programmes of the implementing agencies, posing a risk of greenwashing, although it is a priority in relevant authorities of Acts, rules, policies, and plans. There are no mechanisms in place to ensure the integration or mainstreaming of climate resilience strategies into developmental plans and programs, except for the reports submitted as part of the progress of the FYP.
- There is a lack of resource mobilisation strategy and limited engagement of relevant stakeholders to enhance climate funding, posing a risk to the successful implementation of the climate priorities outlined in the NAP.
- Technical capacity gaps persist across key agencies with shortages of trained personnel in hydrology, water engineering, and climate-resilient design, affecting implementation and innovation in drinking water and irrigation schemes.
- Current adaptation actions in drinking water and irrigation remain reactive, with outdated infrastructure, limited use of climate-resilient technologies, and frequent reliance on vulnerable water sources without proper assessments.
- Risk management, and monitoring & evaluation have not been initiated for the NAP.
- The GLOF EWS faces challenges, including outdated hazard maps, ineffective communication systems, and a lack of community awareness and training.

To improve the country's capacity to effectively adapt to climate change impacts in water resources management, the RAA provided 14 recommendations as follows:

- The DECC should coordinate and support NCCC to strengthen the implementation of the Climate Change Policy (CCP).
- The DoW and DoID should strengthen institutional linkages with water-related agencies to improve coordination in planning and implementation of drinking and irrigation activities.
- The DECC should ensure coordinated actions for adapting to the impacts of climate change.
- The DECC should establish mechanisms to ensure that the intent and priorities of policies and legislations on climate adaptations are mainstreamed into national and sectoral policies and plans.
- Agencies should strengthen institutional capacity for effective implementation of climate actions.
- The DECC, in collaboration with DMDF, should collaborate to explore and implement innovative financing options that enhance funding for climate initiatives.
- The DECC, in collaboration with RUB, should review and operationalise the Roadmap and Strategy for Strengthening Climate Change Research in Bhutan.
- The DoID, in collaboration with the Dzongkhag Engineering Sector, should ensure the prioritisation and effective implementation of adaptation actions for drinking water and irrigation at the local level.

- The DoW and DoID should strengthen the O&M of drinking water and irrigation systems.
- The DECC should implement a comprehensive risk management and Monitoring & Evaluation process for the National Adaptation Plan of Bhutan.
- The NCHM and DLGDM should strengthen the GLOF EWS.
- The NCHM and DoW should collaborate in generating local-level climate data based on areas of critical importance.
- The DECC should maintain a central repository for climate adaptation actions.
- The DLGDM, in collaboration with the DECC, should develop a Loss and Damage Data Repository.

CHAPTER 1: ABOUT THE AUDIT

1.1 Mandate

The RAA conducted the Performance Audit on ‘Effectiveness of Climate Change Adaptation Actions in Water Resources Management’ as mandated by Article 25 of the Constitution of the Kingdom of Bhutan to audit and report on the economy, efficiency, and effectiveness in the use of public resources.

Further, Chapter 5, Section 69 of the Audit Act of Bhutan 2018 stipulates, “The Authority shall carry out performance, financial, compliance, special audits and any other form of audits that the Auditor General may consider appropriate.”

1.2 Audit standards

The RAA conducted the Performance Audit on ‘Effectiveness of Climate Change Adaptation Actions in Water Resources Management’ in accordance with the International Standards of Supreme Audit Institutions on Performance Auditing (ISSAI 3000). The RAA followed audit procedures as prescribed under the RAA’s Performance Audit Guidelines 2019 to maintain uniformity and consistency of approaches in auditing.

1.3 Audit objectives

The RAA conducted the Performance Audit on ‘Effectiveness of Climate Change Adaptation Actions in Water Resources Management’ with the following audit objectives:

- ☑ To examine Bhutan’s capacity to effectively adapt to Climate Change impacts in Water Resources Management.
 - ➡ To assess the adequacy of the governance framework to improve oversight and coordination for climate change adaptation in Bhutan’s Water Resources Management.
 - ➡ To assess whether the actions have been designed and implemented to effectively address climate change risk.

1.4 Audit scope

The Performance Audit on ‘Effectiveness of Climate Change Adaptation Actions in Water Resources Management’ (*What?*) was conducted in the Department of Environment and Climate Change (DECC), Department of Water (DoW), National Center for Hydrology and Meteorology (NCHM), Department of Local Governance and Disaster Management (DLGDM), Department of Infrastructure Development (DoID) and ten selected Dzongkhags (*Who?*). The following list details the audit scope:

- i. The audit covered the period from 1 July 2018 to 30 June 2023 in line with the 12th FYP of Bhutan (*When?*).
- ii. The audit focused on adaptation actions implemented in the drinking and irrigation water systems in rural areas, as well as GLOF risk management.

- iii. For the selection of projects implemented, three criteria, vis-à-vis, drying up of sources, issues covered in the media, and the number of adaptation actions, were considered. Using these criteria, ten Dzongkhags were selected.

The Dzongkhags were Dagana, Paro, Pemagatshel, Punakha, Samdrup Jongkhar, Samtse, Sarpang, Thimphu, Tsirang, and Wangdue Phodrang (*Where?*)

The audit focused on and covered areas such as legal framework, institutional collaboration, institutional capacity, financial mechanism, identification of adaptation actions, planning and designing of adaptation actions, implementation of adaptation actions, and monitoring & evaluation of adaptation actions.

1.5 Audit approach

The audit applied the system-oriented approach to assess the governance framework and enabling environment for planning and implementing the climate actions in Water Resources Management (WRM). The audit focused on the legal framework, institutional arrangements, institutional capacity, and financing mechanisms. The system-oriented audit approach was applied using the mind map in the four thrust areas identified in the audit scope, as portrayed.

The audit also used a result-oriented approach to assess the activities, ways, and means to implement the climate actions in WRM. The audit focused on whether the climate actions are effective in addressing the climate risks in WRM.

1.6 Audit methodology

The RAA applied the following methodologies to gather information, analyse data, and derive conclusions:

i. Document review

- a. The RAA reviewed relevant legislation related to climate change, environment, and water resources – Bhutan Water Vision and Water Policy of Bhutan 2007, Water Act of Bhutan 2011, Water Regulation 2014, National Environment Protection Act 2007, Environment Assessment Act 2000, Climate Change Policy of Bhutan 2020, and Environmental Standard 2020.
- b. Reviewed plan documents, policies, and strategies – National Integrated Water Resources Management Plan (NIWRMP) 2016, National Adaptation Plan (NAP) of the Kingdom of Bhutan 2023, National Adaptation Programme of Actions (NAPA I-III), National Irrigation Policy, National Irrigation Master Plan 2016, and 12th Five-Year Plan (FYP) Vol I, II and III.
- c. Reviewed other documents and publications – National Communication (NC) and Nationally Determined Contributions (NDCs) report, Climate Projection reports of Bhutan, Water Roadmap, Analysis of Historical Climate and Climate Change, Climate Change vulnerability assessment for NAP, Climate risk assessment on water resources for NAP, Skills assessment for NAP, Stocktaking for NAP formulation, Roadmap and Strategy for Strengthening Climate Research in Bhutan 2021-2025, Adaptation Research Alliance Evidence Review 2-Good Practice for Adaptation Action Research, Conference of the Parties (COP) 28 resolutions, SoP for Glacial Lake Outburst Floods

Early Warning Systems (GLOF EWS) Punakha-Wangdue Valley, Disaster Management and Contingency Plan-Punakha and Wangdue Dzongkhag, Competency-Based Framework for Hydrology and Meteorology Officers, Water Flagship Programme (WFP) blueprint, proposal, and assessment documents, Spring revival reports, Manual for O&M of Rural Water Supply and Sanitation (RWSS), and Annual reports of the agencies.

- d. Reviewed past audit reports pertaining to water and its infrastructure - PA report on the provision of drinking water in Thimphu Thromde, PA report on Irrigation Systems, PA report on food self-sufficiency and security, financial and compliance audit reports with regards to irrigation and RWSS projects.

ii. Consultation and Discussions

- a. During the conduct of the performance audit, the RAA consulted the following agencies on their mandates and activities:
 - 1. Department of Environment and Climate Change;
 - 2. Department of Water;
 - 3. National Center for Hydrology and Meteorology;
 - 4. Department of Infrastructure Development;
 - 5. Department of Local Governance and Disaster Management;
 - 6. Department of Macro-Fiscal and Development Finance (DMDF);
 - 7. Royal University of Bhutan (RUB).
- b. Interviewed relevant officials of the DoW, DECC, DoID, ten Dzongkhags, DMDF and RUB to draw an understanding of the process involved in WRM. Those interviewed included engineers, technicians, foresters, environment officials, LG leaders-Gups, Mangmis, Tshogpas, DT Secretary, and local communities during site visits.
- c. Interviewed environment officers of Paro, Thimphu, Samtse, Pemagatshel, Samdrup Jongkhar, Dagana, Punakha, and Wangdue.
- d. Interviewed foresters of Paro, Samtse, Pemagatshel, and Sarpang.

iii. Field Visit

- a. The RAA conducted site visits to 10 Dzongkhags (as per the defined scope) to assess the adequacy of WRM, including the efficiency and effectiveness of the water-related projects and its infrastructures. The Dzongkhags are Dagana, Paro, Pemagatshel, Punakha, Samdrup Jongkhar, Samtse, Sarpang, Thimphu, Tsirang, and Wangdue Phodrang.
- b. Conducted site visits to 50 drinking and irrigation water schemes in the ten Dzongkhags.

iv. Survey

The RAA administered structured survey questionnaires to the relevant officials through Google Docs to understand the institutional capacity of the agencies.

CHAPTER 2: INTRODUCTION

2.1. The rationale for this audit

Water, a vital resource in Bhutan, is fundamental to its economy and societal well-being, supporting crucial sectors such as agriculture, hydropower generation, and drinking water. However, the impact of climate change, along with other factors, poses a significant threat to the availability and sustainability of water resources in the country.

Given the multifaceted impacts of climate change on water resources in Bhutan, it is crucial to undertake a comprehensive performance audit to assess and enhance the country's resilience towards climate risks. This audit focused on evaluating the government's climate change adaptation efforts, ensuring that strategies are appropriately planned to avoid maladaptation, which could lead to long-term unfavourable development outcomes. Additionally, the audit evaluated the governance framework and other factors comprising the enabling environment for implementing adaptation actions in WRM.

This performance audit on climate change adaptation actions in WRM has never been conducted in Bhutan, making this endeavour a pioneering effort. Furthermore, this is also a part of the global initiative on climate change adaptation actions facilitated by the INTOSAI Development Initiative (IDI) and the Working Group on Environmental Audit (WGEA). Therefore, this audit holds global significance, providing insights into critical issues related to adaptation actions in WRM and enhancing Bhutan's capacity to effectively respond to the impacts of climate change on water resources.

The following points further emphasise the necessity of conducting this performance audit:

i. Bhutan's Commitment to Climate Change

Bhutan has made significant commitments to addressing climate change. In 2009, at COP15 of the UN Framework Convention on Climate Change (UNFCCC), the Royal Government of Bhutan (RGoB) pledged to remain carbon neutral. This commitment was reaffirmed in Bhutan's Intended Nationally Determined Contribution (INDC) to the Paris Agreement in 2015. Under these agreements, Bhutan aims to ensure that its greenhouse gas emissions do not exceed the sink capacity of its forests.

Furthermore, Bhutan's commitment to addressing climate change extends beyond the Paris Agreement, as evidenced by its participation as a signatory to ten other international conventions related to climate change and environmental conservation. Given Bhutan's significant commitments to international conventions, there arises a critical need to ensure effective implementation and assess the nation's progress towards meeting its climate targets.

ii. Vulnerability to climate change

In 2021, Bhutan was ranked 38th in terms of vulnerability to climate change and 62nd in readiness to respond, as per the Global Climate Change Adaptation Index. Changes in temperature and precipitation are directly affecting the country, contributing to hazards such as floods and landslides. Flooding, exacerbated by heavy monsoon rains and glacial lake outburst floods (GLOF), has emerged as the most pressing climate-related risk. These challenges highlight the need for a performance audit to assess the government's efforts to prevent, respond to, and adapt to such climate-induced impacts.

iii. Importance of water in Bhutan's economy: Hydropower generation and Agriculture

Bhutan's economy heavily relies on climate-sensitive sectors such as agriculture and hydropower. According to Bhutan's Labor Force Survey Report 2022, agriculture employs 43.5% of the workforce. Hydropower plays a key role in Bhutan's economy, contributing 13.4% to the Gross Domestic Product (GDP) in 2022 (National Statistics Bureau (NSB), 2023).

The country's economic growth is closely tied to its river systems and ecosystems, which are highly vulnerable to climate change. Given that these sectors are key drivers of economic growth, maintaining the health of water resources is essential to mitigating climate change risks and sustaining economic growth.

iv. Localised water scarcity: access to clean water for drinking and irrigation

Localised water scarcity is a growing concern in many parts of Bhutan, particularly in terms of access to clean drinking water and irrigation. This issue manifests in various ways, including drying up water sources, damage to water infrastructure, and shortages of irrigation water. In some regions, the challenge is compounded by the long distances residents must travel to access water sources.

Population growth further exacerbates the problem, creating a gap between water supply and demand. Delays in the implementation of water projects add to the problem, making it even more difficult for communities to address water scarcity.

v. Government investments in adaptation actions

Bhutan has undertaken numerous adaptation actions to address climate change, with support from government agencies and Civil Society Organisations (CSOs), as well as international funding sources such as the Asian Development Bank (ADB), Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund and Government of India (GoI). Given the substantial financial resources allocated to these efforts, it is imperative to assess whether the adaptation actions are designed and implemented to effectively address Bhutan's climate risks and vulnerabilities.

In conclusion, the performance audit of climate change adaptation actions in WRM is crucial for safeguarding Bhutan's water resources and ensuring resilience to climate impacts.

2.2. The impacts of climate change on WRM

Bhutan is considered one of the most vulnerable countries to climate change in the world. It is featured as the 46th most vulnerable country and the 64th of 182 countries in terms of readiness. Bhutan's vulnerability is affected by glacial retreat, changes in precipitation and temperature patterns, extreme weather events, and disturbance to ecosystem services. Bhutan is undergoing warming at an unprecedented rate, with evidence suggesting higher warming trends during winter months and also at higher altitudes (>4000 m.a.s.l).

Bhutan's first inventory of glaciers and glacial lakes, conducted by International Centre for Integrated Mountain Development (ICIMOD) and the Department of Geology and Mines in 2001, identified 25 potentially dangerous glacial lakes. An updated inventory carried out by the NCHM in 2018-2019 identified 17 such lakes, of which the maximum numbers are located in the Pho Chhu sub-basin. Studies show glaciers of Bhutan are melting, and rapidly melting glaciers are magnifying the risk of GLOFs and disrupting the annual flow of water to communities. Increasingly unpredictable and variable precipitation is causing landslides and flash floods in some areas of the country and drying up water sources and causing dry spells in others. A total of 29 incidents of floods and flash floods have been observed since 2017-2021 in Bhutan. Of the 7,399 water sources utilised in the country, 0.9% (69) have dried up, and 25.1% (1,856) are in the process of drying up. Climate change, forest degradation and forest fire are further accelerating the drying up of water sources.

2.3. Integrating climate action

Bhutan's commitment to climate action has been integrated into development planning by identifying 'carbon-neutral and climate-resilient development' as one of the National Key Result Areas (NKRA) in the 11th Five-Year Plan (FYP) 2013-2018. Bhutan's 12th FYP also prioritises climate change, with an NKRA on 'Carbon neutral/green and climate-resilient development'. Continuing this commitment, the 13th FYP reinforces climate resilience and sustainability through the Ecological Diversity and Resilience Programme, highlighting Bhutan's dedication to climate-resilient development.

Furthermore, to enhance green growth and employment, fiscal and tax measures for increasing energy efficiency and pollution control in industries, transport, and other sectors have been provided in the Economic Development Policy 2016. Low Emission Development Strategies (LEDS) for the priority sectors of Industries, Transport, Human Settlements, and Energy Efficiency were also developed to guide sectors in prioritising sectoral actions and programmes. The National Climate Change Policy for Bhutan was adopted in 2020.

Nonetheless, climate change adaptation is not explicitly integrated into policies such as the Water Policy, Water Act, National Environment Protection Act (2007), and the Economic Development Policy (2017).

2.4. Legal framework

i. Constitution of Bhutan (2008)

Article 5(3) enshrines the protection of the environment for present and future generations.

ii. Bhutan Water Vision and Bhutan Water Policy 2009

The policy provides a comprehensive framework for the sustainable management of the country's water resources. It emphasises an integrated approach to water resource management, focusing on the development of a national adaptation strategy for climate change, coordinated water resource development, and institutional mechanisms for sustainable WRM.

iii. Climate Change Policy of Bhutan 2020

This policy does not explicitly mention WRM, but it emphasises integrating adaptation actions into development planning at all levels, which can include WRM strategies to ensure the sustainability of water resources in the face of climate-related challenges.

iv. Water Act of Bhutan 2011

The Water Act acknowledges water as a vital state resource and aims to ensure its protection, conservation, and management in an economically efficient, socially equitable, and environmentally sustainable manner. The Act also establishes institutions responsible for water resource management.

v. Water Regulation of Bhutan 2014

It is developed to implement the Water Act. The Regulation sets out the roles and responsibilities of designated authorities and other relevant organisations in managing and enforcing water resource management efforts.

vi. Hydromet Policy of Kingdom of Bhutan (2023)

The policy provides the strategic direction for the development, enhancement, and provision of services on meteorology, hydrology, and cryosphere in the Kingdom of Bhutan. The policy is to ensure reliable and quality hydromet services for socio-economic development, disaster risk reduction, and protection of lives and properties.

CHAPTER 3: AUDIT FINDINGS

This chapter discusses the audit findings, which are based on the review of documents, discussions, and field visits to selected locations. The audit findings are presented below under ten different areas, including institutional framework, implementation of adaptation actions, and early warning systems for GLOF.

3.1 Institutional Framework

The increasing risks due to climate-related and natural disasters highlight the need for a robust institutional framework to support and implement climate change adaptation actions. This framework is vital for guiding government and stakeholders in strengthening resilience and adaptive capacity. An effective institutional framework involves a whole-of-government approach, fostering coordination across sectors and stakeholders, and ensuring coherent policies and plans related to climate change. They are also crucial for mainstreaming climate change adaptation planning into national and local plans, thereby contributing to the reduction of climate-induced risks.

Recognising the importance of a robust institutional framework in implementing effective climate-change adaptation actions, the RAA reviewed institutional arrangements, coordination, oversight, and information sharing between the stakeholders, and noted the following:

3.1.1. Climate change policy

Bhutan is extremely susceptible to climate change due to its landlocked and mountainous geographical condition, coupled with its reliance on agriculture and hydropower. The country also faces increasing threats from climate hazards such as flash floods, glacial lake outbursts, windstorms, forest fires, landslides, and erratic rainfalls. To remain carbon neutral while pursuing sustainable development, Bhutan must reduce growing emissions from all sectors. In order to address these challenges, the Climate Change Policy (CCP) was developed in 2020.

One of the goals of the policy is to provide strategic guidance to ensure that the country remains carbon neutral and protects the well-being of the people by adapting to climate change in an efficient and effective manner. The policy also stresses the importance of climate change adaptation actions by requiring the government to take measures or actions in protecting the health, lives, and livelihoods of the people from adverse impacts of climate change and to integrate adaptation actions into development planning at all levels.

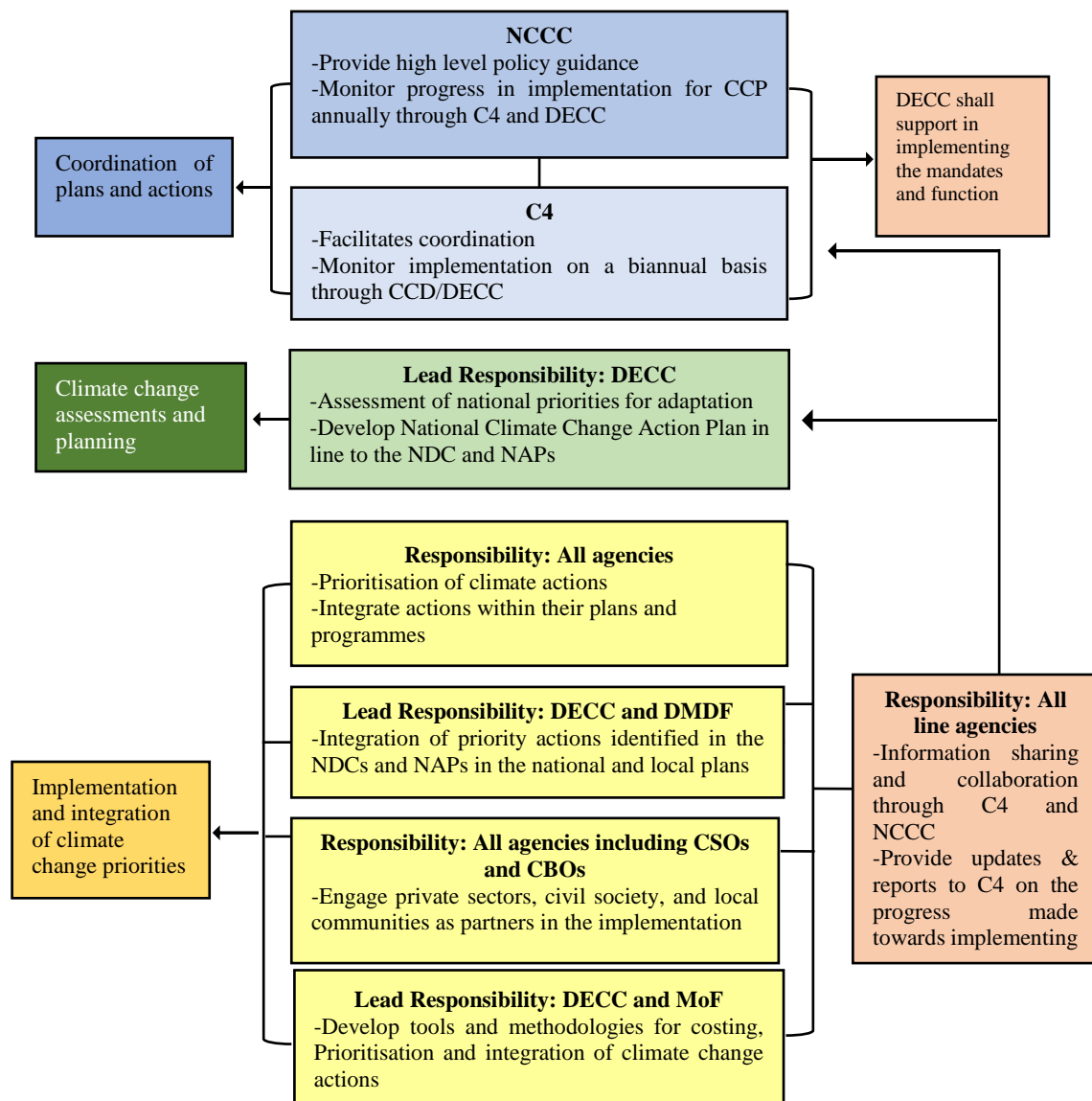
In order to implement climate change adaptation actions in a coordinated and effective way, the CCP instituted the following institutional arrangement:

- a) *Overall Coordination and Oversight:* The National Climate Change Committee (NCCC) is Bhutan's high-level, multi-sector coordinating decision-making body for climate change, and the Climate Change Coordination Committee (C4) is a technical body that supports the committee in coordinating matters related to climate change in the country. The C4 is required to ensure an effective and coordinated implementation of actions on climate change. The preparation of national strategies and plans (NDCs, NAPs) is led by the DECC. The erstwhile Gross National Happiness Commission (GNHC) was to extend support in the integration of climate change into policies, programs, and plans.

- b) *Resource Mobilisation and Allocation:* The DMDF under the Ministry of Finance (MoF) is responsible for mobilising external resources for the implementation of climate change programmes and projects.
- c) *Climate Data and Information:* The NCHM is mandated to provide hydro-meteorological data and information, climate modelling and scenarios, and early warning services.
- d) *Sectoral Integration:* Sectors and line agencies are required to integrate climate change actions within their respective mandates, policies, and programmes. Further, they are required to take specific responsibilities of relevant agencies defined in the National Climate Change Action Plan.

The process for implementation of provisions and actions under CCP is detailed in Figure 1 below:

Figure 1: Process for Implementation of climate actions



Source: RAA's illustration based on the CCP

Upon the review of the institutional framework in regard to climate change and adaptation actions, the RAA observed the following:

- i. The National Environment Commission (NEC), which is an independent authority and the highest decision-making body on matters related to the environment, serves as the NCCC. After the civil service reforms, the NCCC was restructured by the Royal Civil Service Commission (RCSC) vide letter No. RCSC/LTD/1/COM/2023/1217 dated 8 November 2023, with the appointment of the Secretary of the Ministry of Energy and Natural Resources (MoENR) as the Chairperson, supported by six members, including a member secretary from DECC.

To translate the CCP into tangible actions that mitigate climate change impacts and enhance resilience, it is required to develop action plans for the implementation of the policy. The need for such an action plan with a timeline and specific targets was notified by the erstwhile NEC Secretariat (NECS) vide letter no. NEC/CCD/Climate Policy/2019/600 dated 4 April 2019 to 41 agencies, including a directive to conduct a consultation workshop to seek input on the CCP Action Plan.

Although the CCP Action Plan has not yet been developed, as part of the requirement of UNFCCC, the National Adaptation Plan (NAP) was developed in November 2023.

- ii. As highlighted in the CCP, the C4 plays an important role, serving as a technical forum to discuss and coordinate matters related to climate in the country and make recommendations for consideration by the NEC/NCCC.

Additionally, the C4 is entrusted to monitor and provide guidance on the overall implementation of the policy and ensure an effective, efficient, and coordinated national approach for implementing climate change actions by avoiding duplication of efforts and promoting synergies through active collaboration and guidance.

However, the RAA noted that there was no evidence suggesting operationalisation of C4 in the absence of documents relating to the constitution of committee members and records of meetings. Even for NCCC, there were no records indicating guidance provided in the implementation of CCP, except for the minutes of the meeting of NCCC held recently on 5 April 2024 at the time of the audit.

There was no monitoring and evaluation framework developed to monitor the progress of the CCP or the action plan. The RAA noted that the committee (C4) has not been able to carry out the monitoring of CCP since its adoption in 2020. This may potentially result in delayed and uncoordinated responses to climate change, adversely affecting water resources management and other critical areas.

The DECC acknowledged that documentation on the operationalisation of C4 was unavailable during the audit period ending 30 June 2023. However, a proposal to reconstitute and strengthen C4 was presented at the 2nd NEC meeting on 06 February 2025 and subsequently endorsed. Concrete actions have been taken to address the gaps and to ensure that C4 resumes its role in monitoring and reporting to the NCCC/NEC. At present, the NEC will continue to function as the High-level NCCC for the overall coordination and oversight of the CCP.

Regarding M&E, the NAP completed in September 2023 provides a framework to guide the M&E of climate action implementation.

During the exit meeting, the DoW further explained that the audit period coincided with the transition phase, during which some reports were misplaced. It stated that C4 still exists and C4 meetings were held once every six months, with minutes duly maintained. Major decisions and technical matters were deliberated at the C4 and subsequently reported to the NCCC, which is by default the NEC.

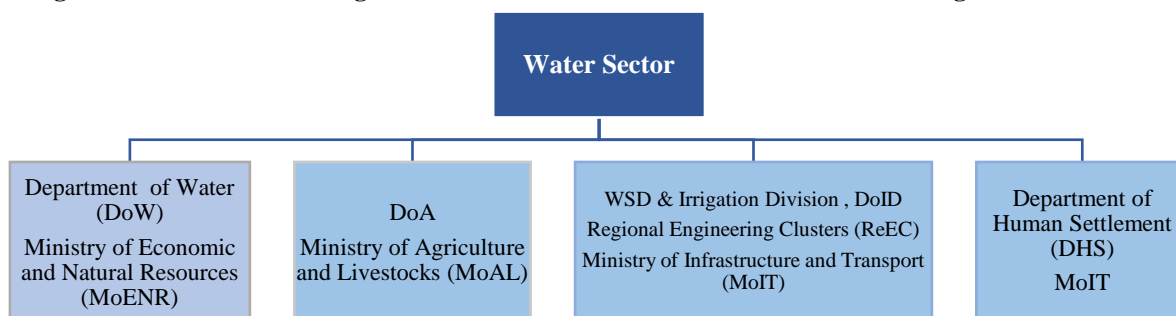
While noting the responses provided by the DECC and DoW, the RAA emphasises that the C4 plays a pivotal role in the implementation of the CCP and other climate-related matters. Therefore, non-constitution and operationalisation of C4 could impede a coordinated approach to implementing climate actions. Moreover, not having an M&E framework and timely oversight by the C4 may delay the realisation of the intended objectives of the CCP.

3.1.2. Coordination in planning and implementation of climate change adaptation in water resources (drinking and irrigation activities)

The CCP emphasises the importance of a coordinated approach among relevant agencies to avoid and reduce duplication of efforts in the formulation and implementation of climate change actions. Since such an enabling environment is essential for the effective implementation of climate change actions, the RAA reviewed the coordination between the water agencies and the DECC, based on their respective mandates, roles, and responsibilities.

After the civil service reform in 2022, the water-related agencies were restructured as depicted in Figure 2

Figure 2: Institutional arrangement for water-related activities after restructuring in 2022



Source: Analysis from interviews with water-related agencies and Restructuring of Civil Service by Executive Transformation Team (Agency structures & HR systems, Version 3 and Final Version 2022)

The mandates of these agencies are detailed in the following Table 1:

Table 1: Mandates of water related agencies

Sl. No.	Institutions/Agency	Mandates
1	DoW, MoENR	<ul style="list-style-type: none"> -Coordinate and facilitate effective WRM. -Coordinate and collaborate with ministries and agencies on the implementation of water-related activities. - Provide regulatory role on WRM and related activities. -Coordinate, develop, and promote environmentally sound technologies for sustainable water management. - Assess the risks, trends, and impacts of climate change and other anthropogenic activities on water resources.

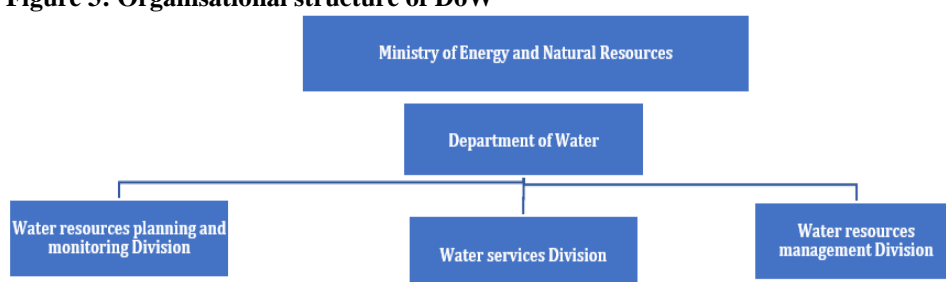
Sl. No.	Institutions/Agency	Mandates
		- Recommend the declaration of critical watersheds and significant wetlands of international importance to the Parliament.
2	DoA, MoAL	-Policy and Planning for irrigation water and drought management.
3	Irrigation Division, DoID, MOIT	- Lead engineering division for irrigation infrastructure. -Infrastructure development for irrigation
	Water & Sanitation Division, DoID, MOIT	-Lead engineering division for water infrastructure. -Infrastructure development for water-related activities (Rural and urban water supply-drinking excluding irrigation). -Planning, designing, and construction of water infrastructure.
	DHS, MOIT	-Water resources planning within the town /growth centers
4	ReEC	Support LGs in: -Design & Planning of water infrastructure -Promote innovative/cost-effective technology -Compile Water Infrastructure Inventory -Technical backstopping.
5	Local Government (LGs) (Thromde/Dzongkhag Administrations):	-Responsible for drinking water and irrigation within their jurisdiction with support from/collaboration with the concerned ministry/ReEC: -Planning and budgeting. -Procurement and award of works. -Operation & Maintenance (depending on threshold)
6	DECC, MoENR	-Acts as the secretariat to the NCCC in providing support to the NCCC in leading and coordinating the implementation of national climate change strategies. -Preparing national climate strategies such as the NDCs and NAPs. -Provide technical and administrative support to the C4, which monitors the implementation of climate change policies and actions. -Mobilise financial and technical resources for the implementation of climate adaptation and mitigation actions, in consultation with the MoF. -Monitoring the progress of climate change actions and reporting these to the NEC/NCCC and relevant national and international bodies, including international obligations under the UNFCCC and Paris Agreement. -To ensure effective and coordinated implementation of climate actions across sectors

Source: Analysis from interviews with water-related agencies and Restructuring of Civil Service by Executive Transformation Team (Agency structures & HR systems, Version 3 and Final Version 2022)

The 2022 restructuring sought to streamline and consolidate water-related agencies to improve efficiency and coordination. As part of this reform, the WRCD under the erstwhile NECS and Watershed Management Division (WMD) under DoFPS were merged into the DoW under the Ministry of Energy and Natural Resources (MoENR). Additionally, the Irrigation Section under the Department of Agriculture (DoA) in the erstwhile MoAF and the Water & Sanitation Division (WSD) under the Department of Engineering Services (DES) were merged into the DoID under the Ministry of Infrastructure and Transport (MoIT).

Figure 3 shows the organisational structure of DoW:

Figure 3: Organisational structure of DoW



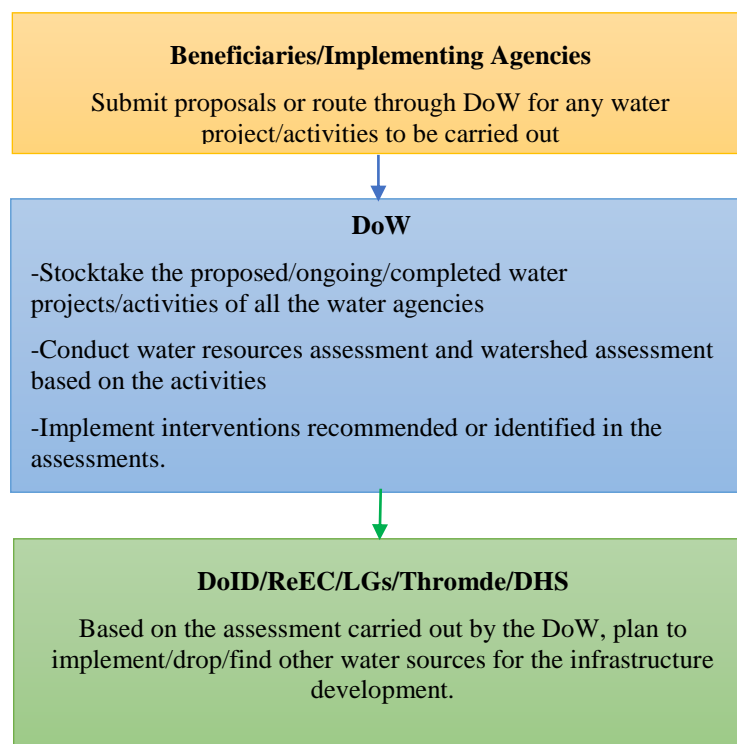
Source: DoW

Figure 4 depicts the coordination process among water-related agencies to ensure a collaborative approach in the management of water resources and their sustainable utilisation. This process is developed based on the responsibilities delineated after restructuring.

Despite the structural changes and policy emphasising the need for coordination, the RAA noted the following challenges in terms of the coordination of planning and implementation of climate adaptation actions between the water-related agencies:

- i. The DoW, which is mandated to assess risks, trends, and impacts of climate change and anthropogenic activities on water resources, has not been actively engaged in water source assessment for drinking and irrigation. Instead, these assessments are either carried out by Dzongkhag Engineers and technicians or DoID, without the involvement of the DoW.
- ii. Moreover, water project proposals from the LGs are not submitted through DoW, as intended by the coordination mechanism, and there is limited information sharing between these agencies. During field visits, the RAA learned that Dzongkhag Engineers, technicians, and Gewog officials were unaware that water source assessments were to be carried out by the DoW.
- iii. The RAA noted that assessments carried out by the DoID focus on water discharge at the intake point, whereas assessments of the DoW evaluate the long-term sustainability of the water source, which also includes climate change considerations and adaptation actions.
- iv. Furthermore, the DoW is facing resource constraints, including insufficient human and financial resources, to conduct comprehensive water source assessments for all Gewogs and Dzongkhags.
- v. Prior to the restructuring, the WMD under DoFPS had staff stationed across Dzongkhags, enabling effective planning, implementation, and maintenance of watershed management activities. Following the restructuring, the DoFPS no longer has a mandate and financial support to implement these activities.

Figure 4: Coordination process among water-related agencies



Source: RAA's illustration from the mandates of water

For example, during a field visit (18 July 2025) to the springshed management site at Lholing, Shaba Gewog, Paro, the RAA observed that interventions aimed at reviving dried-up springs for drinking water were not being carried out. Figure 5 shows the spring revival measures implemented in 2018 and the current site condition during the site visit.

The Spring Revival Report highlighted that trenches, drainage, and check-dams are vulnerable to disruption from the continuous run-offs and sediment deposits during heavy rainfall,

thereby requiring regular maintenance. However, as shown in Figure 5, certain roadside drainage and trenches were filled with sediment deposits, indicating a lack of regular maintenance.

Further, the RAA learned from the Divisional Forest Office (DFO), Paro, that following the transfer of the mandate to the DoW, no dedicated budget was allocated to the DFO to carry out maintenance activities, although the DoW needs to request DoFPS for implementation. However, there is concern over limited support due to competing priorities within DoFPS unless financial support is provided.

- vi. Although DECC is designated as the focal agency for climate change and is responsible for ensuring integration of adaptation strategies across sectors, the RAA learned that its involvement with agencies such as DoW, DoID, and LGs remains limited in terms of technical guidance, capacity support, or monitoring of adaptation efforts in water resource projects. Furthermore, the RAA did not find any evidence of support from the DECC to strengthen the capacity of these agencies by providing the tools and resources needed to address climate change challenges.

Figure 5: Spring revival measures in Lholing, Paro



Source: Spring Revival Report: A Pilot Study at Lholing, Paro (Left) and RAA (Right)

- vii. The NAP identifies six entry points for integrating adaptation into development plans: FYPs, National Economic Development Plans, Regional Plans for Rural and Urban Areas, National Standards and Guidelines, LG Planning, and Sectoral Policies and Strategies. The DECC has not established mechanisms to ensure that DoW, DoID, and LGs effectively integrate climate adaptation actions into their departmental and sectoral plans, despite the NAP identifying entry points for such integration.
- viii. Dzongkhag Environment Officers, who are expected to support the DECC's functions at the district level, remained focused on environmental aspects like waste management and environmental clearances, with little to no role in climate adaptation activities, further incapacitating DECC's reach.
- ix. There is no systematic monitoring or reporting of climate adaptation actions implemented by agencies to NCCC.
- x. The lack of a coordination mechanism was also evident during the 6th B-WASH (Water, Sanitation, and Hygiene) cluster meeting held from 7 to 8 September 2023, where agencies highlighted the uncoordinated efforts in addressing water source vulnerabilities. The meeting resolution to assign DECC and DoID as the lead agencies for climate-resilient WASH solutions further reflects the absence of proactive and structured coordination.
- xi. Additionally, DECC has not actively engaged in raising awareness or conducting outreach programs to promote climate adaptation strategies among stakeholders and the public.

These coordination gaps within water sector agencies, exacerbated by staff attrition within the DECC and inadequate knowledge transfer, have significantly impeded the integrated implementation of climate-resilient measures in the water sector. Without proper coordination, Bhutan's efforts to build resilience in its water resources against climate risks may remain ineffective.

The DoID responded that DoW and DoID are two departments under different ministries, and priorities do not match. At the local government level, engineers report to MoIT rather than MoENR, creating a disconnect. To address this, MoENR and MoIT have agreed that water projects should not require routing between departments for approval. Instead, any projects undertaken by MoIT will be shared with DoW or included as part of the project.

The DoW stated that in line with the Civil Services Reform Act of Bhutan 2022, the mandates are clear. However, due to implementation challenges and non-transfer of mandates, an arrangement was made as per the 32nd session of the Committee of Four Coordinating Secretaries (C4CS) meeting held on 28 December 2023. Still, the decision defeats the principles of Integrated Water Resources Management (IWRM), resulting in fragmentation of mandates and creating confusion.

The DoW further mentioned that it has been engaged in springshed management at Lholing through the ICIMOD project since 2024.

The RAA acknowledges the challenges faced by the Departments. However, it reiterates that the lack of effective coordination mechanisms among agencies for water-related activities continues to inhibit the implementation of their respective mandates. Without proper coordination, achieving effective and sustainable water resource management remains difficult.

3.1.3 Mainstreaming of climate change adaptations in policies and plans

Mainstreaming climate actions is important to integrate adaptation actions into policies, budgeting, and planning processes at national and local levels. This approach ensures that climate risks are mitigated as part of planning, rather than treated as a standalone activity.

One of the goals of the CCP stipulates that the government shall take proactive measures to protect the health, lives, livelihoods, and happiness of its people from the adverse impacts of climate change by building resilience and adaptive capacity, and this includes integrating adaptation actions into the development planning process at all levels.

As per the Guide on Mainstreaming Climate Change in National Development Processes and UN Country Programming, mainstreaming climate change into national policies, plans, and development projects contributes to:

- a. *reducing vulnerability to climate impacts and variability,*
- b. *increasing the adaptive capacity of communities and national activities facing climate impacts, and*
- c. *ensuring sustainable development and avoiding decisions that will generate maladaptation.*

The RAA reviewed the following Acts, Policies, and plans related to irrigation and drinking water, as shown in Table 2, to assess whether climate change aspects have been integrated.

Table 2: Climate change consideration in water related legislations

Sl.no	Name of the Document	Climate Change aspects
1	National Environment Protection Act, 2007	✓ An Act to provide for the establishment of an effective system to conserve and protect the environment (Section 3)
2	Forest and Nature Conservation Act, 1995 (amended in 2023) and Forest and Nature Conservation Rules, 2006 (revised in 2017)	<ul style="list-style-type: none"> ✓ Watershed Management (chapter 35) ✓ Declaration of Degraded Watershed (chapter 37) ✓ Preparation of Critical or Degraded Watershed Management Plan (chapter 38)
3	Bhutan Water Vision and Bhutan Water Policy 2009	<ul style="list-style-type: none"> ✓ Recognition of Climate Change Impacts and Risks (Sections 1.7 & 6.5) ✓ Need for Adaptation strategies (Section 3.5) ✓ Sustainable Management and Conservation (Sections 4.1 and 6.4) ✓ Risk and Disaster Management (section 6.5)

Sl.no	Name of the Document	Climate Change aspects
4	The Water Act of Bhutan 2011	<ul style="list-style-type: none"> ✓ Recognition Threat (Preamble) ✓ Source Protection (Chapter 2, Section 4) ✓ IWRM (Chapter 2, section 6) ✓ Protection of water catchment (Chapter 2, section 8) ✓ Polluter Pays Principles (Chapter 2, Chapter 9) ✓ Community-based WRM (Chapter 2, section 7) ✓ NEC's Role (Chapter 12 &13) ✓ Harvesting water resources (Chapter 2, section 47)
5	Disaster Management Act of Bhutan, 2013	<ul style="list-style-type: none"> ✓ An integrated and coordinated disaster management focusing on community participation. (Section 6 (c))
6	National Irrigation Policy (NIP)	<ul style="list-style-type: none"> ✓ Statement 4.1: Catchment and water management principles shall be integrated with overall irrigation development ✓ Statement 4.4: Environmentally friendly measures in planning, construction, and management of irrigation schemes shall be followed ✓ Statement 1.3: Alternative water resources like water harvesting, groundwater, pumping water from major rivers, and linking up with future hydropower projects to use water stored in reservoirs for irrigation shall be explored and mainstreamed
7	National Irrigation Master Plan (NIMP), 2016	<ul style="list-style-type: none"> ✓ Assessment of climate change and its impact on agriculture (Chapter 6) ✓ Potential responses to climate change in planning irrigation development (Subsection 6.5)

Source: Compiled by RAA

Upon the review, the RAA noted that most of these documents acknowledge the impact of climate change and the need for adaptation strategies. *For example:*

- ✓ The Bhutan Water Vision and Bhutan Water Policy 2009 recognises the direct impacts of climate change on water resources and emphasises sustainable management and conservation as key strategies to address these challenges. It also specifies the need for a national adaptation strategy, including flood management, and highlights the requirement for disaster risk management measures to mitigate climate-related disasters.
- ✓ The Water Act of Bhutan 2011 includes provisions for integrated water resource management and community-based approaches to address climate risks.
- ✓ The National Irrigation Policy (NIP) and the NIMP also highlight climate change impacts on irrigated agriculture and incorporate an environmentally sustainable approach and emphasise coping strategies for climate-induced challenges in agriculture.

Despite recognising the impacts of climate change and the need for climate action, the RAA observed the following challenges in the practical integration and enforcement of climate change considerations:

- i. Most of the policies and legislation were developed more than a decade ago (also highlighted in Water Road Map 2023). As a result, they do not adequately reflect recent

developments in the climate change landscape and emerging needs to be addressed. Components such as a comprehensive water resources database, springshed revival, multi-purpose water use, integrated abstraction schemes, service digitisation, non-revenue water management, nature-based solutions, and a water curriculum are essential for enabling effective climate actions and must be included.

- ii. Further, the stocktaking report for NAP formulation revealed that many of the existing documents lack explicit provisions for climate change for compliance and regulations, which acts as a barrier to mainstreaming climate change actions into sectoral strategies and LG planning.
- iii. The RAA noted a lack of monitoring mechanisms for integrating climate change actions. There is no central agency to validate the integration of climate resilience strategies into developmental plans and programs, except for the reports submitted as part of the progress of the FYP.

During field visits to Dzongkhags, the RAA found that local officials, including Dzongkhag Engineers and Planning Officers, lacked information and records on climate and disaster resilience-related activities implemented under the 12th FYP NKRA. To cite a case in point, the terminal report of one Dzongkhag revealed that a key performance indicator related to river protection works (climate actions) was not achieved.

- iv. The RAA also noted that the central Mainstreaming Reference Group (MRG), which was formed to institutionalise the mainstreaming of environment, climate, and poverty (ECP) issues into planning, had been dissolved at both central and local levels.

This multi-sectoral group includes policymakers, planners, environmental specialists, finance experts, and Non-Governmental Organisations (NGOs), providing expertise on policy-making and advocating for cross-cutting issues at all planning and implementation levels. As of June 2016, 20 local MRGs have been established in all 20 districts to facilitate mainstreaming of cross-cutting issues in the LG development plans and programmes.

- v. Discussion with Environment Officers across the eight Dzongkhags visited by the RAA revealed that their roles are largely focused on issuing Environmental Clearances and managing waste. They are not involved in mainstreaming climate change into Dzongkhag and Gewog plans, indicating a lack of awareness on mainstreaming climate change in the preparation of plans and programmes of the LGs.
- vi. Furthermore, the DECC, which is the lead agency for coordinating on climate adaptation, had no reports or information regarding coordinating efforts, and the extent of mainstreaming of climate change action across agencies is not clear.

Although the importance of mainstreaming climate change is recognised in various Acts, rules, policies, and plans, there remain gaps in translating this priority into concrete plans and programmes by implementing agencies. This gap increases the risk of greenwashing, where climate-related commitments remain largely rhetorical. This is further exacerbated by the lack of clear reporting requirements on implementation status to the reporting authority.

3.1.4 Reporting and information sharing mechanisms of climate actions implementation by the national level agencies and LGs to C4

The CCP requires all government agencies, including national-level and local-level agencies, to take climate change actions in line with their respective mandates. Under the CCP, all responsible agencies are required to provide updates and reports to C4 on their progress in implementing climate actions.

The RAA noted gaps in reporting and information sharing that may hinder the effective implementation of climate change actions as discussed below:

- i. There is no system of submitting updates or reports to the C4 as required by CCP. For project-based initiatives, where the DECC serves as the Project Management Unit (PMU), reporting is carried out according to the specific project's requirements.

For instance, under NAPA II, the DECC served as the PMU, responsible for the coordination, management, and monitoring of the project's progress. DECC submitted quarterly reports with key project updates to the United Nations Development Programme (UNDP) Country Office, which was subsequently forwarded to the UNDP-GEF Regional Office. In such cases, implementing agencies, such as Phuentsholing Thromde, reported directly to DECC for project-specific progress updates. However, these reports were never submitted to C4.

- ii. The RAA found no evidence of follow-ups or reminders from C4 through DECC to ensure agencies submitted reports on climate change actions.
- iii. While the CCP emphasises the need for collaboration and information sharing among agencies through C4, there is no formal mechanism in place for exchanging data, receiving real-time updates, sharing best practices, discussing challenges, or finding solutions.
- iv. To increase knowledge sharing, synergies, information transparency, and improved coordination efforts between various agencies, the Bhutan Climate Platform (BCP, envisioned as a 'one-stop platform' for all climate efforts in Bhutan) was developed as a part of the NAP readiness and hosted by NECS (now DECC). However, this platform has not been able to serve its purpose due to a lack of updates and limited usage by stakeholders.

The gaps in reporting and information sharing could be due to a lack of monitoring to track the progress of climate adaptation activities implemented by agencies in their annual plans and programmes. This may potentially pose a risk to achieving the targets of NAP.

3.1.5 Market-based Instruments for Climate Change Actions in WRM

Market-based incentives and penalties play a crucial role in promoting climate adaptation actions by influencing behaviours toward resilient and sustainable practices. Effective incentives, such as subsidies, concessional financing, and tax breaks, can encourage individuals, businesses, and sectors to invest in climate-smart technologies and infrastructure. On the other hand, penalties, such as environmental taxes and fines for non-compliance with climate policies, serve to discourage harmful practices that exacerbate climate vulnerability.

These strategies are particularly vital in developing the private sector and ensuring that adaptation efforts are pursued efficiently, which is especially important in developing economies where the resources for addressing climate risks are limited.

The CCP 2020, Chapter 5, Section 1(b), highlights that the government is committed to encouraging climate action by the private sector, civil society, and communities through adequate support and incentives. Similarly, the Water Act of Bhutan 2011 and the Water Regulation of Bhutan 2014 emphasise the need for imposing penalties to deter actions that degrade water resources.

To assess the strategies on incentives and penalties to encourage adaptation actions in addressing climate risks in water resource management, the RAA reviewed the legal framework and noted the following:

- The Water Act of Bhutan 2011 and the Water Regulation of Bhutan 2014 outline provisions for penalties, fines, and sanctions against activities and behaviours that cause environmental harm to water resources. As shown in Table 3, the offenses and penalties include:

Table 3: Provisions of punitive Measures for non-compliances in water legislation

Source	Violations/Offences	Penalties
Water Act of Bhutan 2011 and Water Regulation of Bhutan 2014	<p>i. Offense of felony</p> <ul style="list-style-type: none"> - Person endangering a water source resulting in death or serious physical injury, and damage to the environment. - Abstract water resources and discharge effluents in the water bodies without obtaining Environmental Clearance, and activities leading to the degradation of watershed and catchment areas. <p>ii. Offense of misdemeanour</p> <ul style="list-style-type: none"> - Endangerment of public water sources, failure to comply with terms and conditions of EC, failure to comply with administrative sanctions, and vandalism and destruction of water supply infrastructure. <p>iii. Offense of petty misdemeanour</p> <ul style="list-style-type: none"> -Providing false information, failure to extend necessary cooperation to the authorised person, and failure to maintain records. 	<ul style="list-style-type: none"> - Orders for compliance and corrective measures -Fines up to twelve man-months of minimum wage -Reimbursement of authority costs -Compensation for environmental damage -Suspension or revocation of Environment Clearance -Fines for continued offenses -Shutdown for failure to comply with stop orders

Source: Compiled by RAA

- Regarding the incentives, the Environmental Assessment Act of Bhutan 2020, Section 78. a,b,c, the government offers tax incentives for eco-friendly services and products, reduced duties for importing green technologies, and provides grants for environmental projects by civil society or the public sector.

However, the RAA noted the following:

- Limited Private Sector Incentives:* While the Environmental Assessment Act provides incentives for civil society and public-sector projects, it lacks provisions to incentivise private individuals or sector engagement in climate adaptation actions.
- Emphasis on Compliance Over Support:* The Water Act and Regulations primarily focus on compliance and punitive measures without offering adequate support or incentives to encourage private sector or individual participation in climate adaptation efforts.

- iii. *Financial Burden on Users:* The Water Policy tends to emphasise financial contributions from water users rather than providing incentives to promote sustainable practices or adaptation measures.
- iv. *Lack of Technical Support:* The RAA noted that local communities and private individuals interested in initiating climate actions, such as water management projects, often lack technical support and positive reinforcement from the government.
- v. *Limited Private Sector Participation:* Most climate actions in WRM are undertaken by the government or a few civil society organisations.
- vi. Participations, with minimal contributions from the private sector due to the absence of incentives or support mechanisms.

The absence of market-based incentives discourages participation in private sector engagement and communities from going beyond compliance to investment in long-term adaptation measures. This limitation undermines efforts to strengthen water security and resilience to climate risks. Further, governments are left to bear the full burden of financing adaptation strategies, hindering effective response to climate challenges due to limited resources.

3.2 Institutional Capacity

Recognising the importance of institutional capacity in implementing climate actions, the CCP mandates the “*RGoB to ensure adequate means of implementation (through finance, technology, capacity building, research and awareness, integration) to support both mitigation and adaptation actions*”. Further, the Bhutan Water Vision and Bhutan Water Policy 2009 stipulate *sufficient human resources, skills, and knowledge for efficient management and development of water resources*.

The RAA reviewed the institutional capacities of agencies responsible for climate actions in water resource management and noted the following:

3.2.1 Human Resource Capacity

i. National Center for Hydrology and Meteorology

NCHM is the nodal agency responsible for the generation of climate change information and delivery of products and services on weather, climate, cryosphere, and water resources in Bhutan to implement appropriate mitigation and adaptation measures. The center is mandated to provide a national source of hydro-meteorological data, service, and advice to meet the needs of the general public, emergency services, and other specialised users. Additionally, the NAP requires NCHM to provide hydro-meteorological data and information, climate modelling scenarios, and other early warning services to have a scientific basis in risk identification and prioritisation of adaptation actions.

NCHM developed the Competency-Based Framework for Hydrology and Meteorology Officers, detailing the requirements of necessary skills, knowledge, and competencies for the provision of quality services. As per the CBF, comprehensive technical knowledge and skills are required in:

- a) *Hydro-met science and technologies;*
- b) *Hydro-met network system; and*
- c) *Engineering (communication and electronics, CT, Infrastructure, remote sensing, GIS, Satellite)*

NCHM has four divisions, viz. Meteorological Service Division, Hydrology and Water Resources Services Division, Cryosphere Services Division, and Technical Standard and Research Division, with a total of 198 staff. However, NCHM is currently facing challenges in retaining professionals and experienced people.

The skills assessment conducted for NAP also revealed the need for skills to interpret climate model outputs, analyse high-resolution satellite images, and develop long-term climate forecasts for climate-sensitive activities. The existing manpower has challenges in catering to these specific services and information. *For instance*, NCHM produced a Climate Projection of Bhutan (2024) with the assistance of experts (UNDP, ENSCAP¹), and all the modelling and downscaling were done outside Bhutan due to limited capacity within the Center.

These challenges can be largely attributed to the limited professionals with specialised backgrounds in meteorology, atmospheric science, hydrology, and cryosphere studies during recruitment, leading to continued reliance on external support and required technology. The continued dependency on external expertise will pose a barrier to building the national ability to plan and implement effective adaptation actions to address future climate risks.

ii. Department of Environment & Climate Change

The DECC, as the central coordinating body responsible for the integration, implementation, and management of climate policies across sectors and governance levels, plays a crucial role in ensuring the alignment of national goals with the international climate goals. Further, the NAP guidelines emphasise the critical role of the nodal agency in promoting and enhancing cross-sectoral coordination for effective adaptation planning and implementation. Therefore, it is imperative to ensure that the Department has adequate institutional capacity to effectively carry out its responsibilities.

Nevertheless, the Department is also facing challenges due to a shortage of experienced staff in the Climate Change Division (CCD). The Division has a total of six staff, including the division chief, having less than a year of experience, and the rest with under two years of experience.

As per the skills assessment for NAP, capacity building is necessary for the new staff to effectively serve as the national focal point. The assessment also highlights the need for the Department to strengthen skills in assessment and cost-benefit analysis, particularly for developing project proposals.

Further, the current staff also needs to strengthen their knowledge and skills necessary for NDC progress tracking, which is crucial to accurately monitor, report, and evaluate the country's

¹ ENSCAP: Economic and Social Commission for Asia and the Pacific

progress towards achieving its NDCs. This is also essential to ensure that reports, such as the Biennial Transparency Reports (BTRs), meet the standards set by the UNFCCC.

These issues are attributed to high staff attrition and inadequate knowledge transfer processes, resulting in a lack of succession planning. Consequently, this may lead to non-/under achievement of NAP and delays in adaptation efforts to address the impacts of climate change.

iii. Department of Water

The DoW, as the national focal point for water, envisions to *‘ensure safe, affordable, accessible and sustainable water resources through adaptive, integrated and enhanced management to achieve environmental, social and economic security for national wellbeing and natural ecosystem integrity.’* To achieve this vision, it is important to have sufficient human resources with adequate skills and knowledge.

The Department is constrained by human resources to effectively carry out its functions across the country. Out of the 36 approved staff positions, the DoW has 22 staff, leaving a shortage of 14 positions. Additionally, 4 staff are on EOL, reducing the active workforce to 18. The Department is also short of a Geologist, Civil and Water Engineers, Environmental Officers, and Forestry Officers.

In the absence of a Geologist, the Department could not carry out a detailed study of geological structures and properties required to understand the underlying aquifers and water storage systems for spring shed management.

Similarly, the DoW does not have knowledge/expertise for the planning and development of a reliable water storage and conveyance system due to the absence of Water and Civil Engineers.

The shortage of manpower is also mentioned in the Water Road Map, 2022, and it is further stated that a limited pool of expertise available is scattered across different line agencies. It also specified the need for staff skilled in water engineering and hydrological assessments.

Currently, the Department is primarily focused on the implementation of projects, such as watershed and spring shed management, Payment for Ecosystem Services (PES) schemes, and adaptation actions such as sensitisation and awareness of WUA, development of River Basins Management Plans, initiation of data repositories on springs, water conflict management, and approval of water permits. However, complete regulatory and facilitation functions related to WRM have not yet been adequately carried out.

These issues can be attributed to the absence of a human resource development plan and minimal collaboration between professionals from interdisciplinary agencies, private companies, public citizens, and the youth contributes to low knowledge transfer and manpower availability.²

The lack of adequate HR in terms of strength and skills hinders the development of sustainable water management practices, exacerbates the vulnerability of communities to water-related impacts of climate change, and undermines efforts to ensure water security and resilience in the face of increasing climate risks.

² Skill Assessment for NAP Formulation Process in Bhutan and Water Road Map, 2022

As of 12 September 2025, the DoW reported having 28 staff, with a shortage of 8 positions. Of the 28 staff, 2 are on Extended Official Leave (EOL), 1 on secondment, and 1 on long-term training (LTT), reducing the active workforce to 24. This includes the recent recruitment of a Geologist, expected to enhance the department's capacity for detailed studies of geological structures and properties related to spring shed management.

iv. Department of Infrastructure Development

The core business areas of the DoID include quality infrastructure development in drinking water, irrigation, and sanitation, and disaster-resilient construction technologies. The department envisages *'towards quality, cost-effective, green and sustainable infrastructure'*. The WSD and Irrigation Division are responsible for ensuring safe and reliable drinking water and irrigation.

a) Water & Sanitation Division

The division has a total of 21 employees with engineering backgrounds and experiences ranging from 5 to 34 years. However, the division has only 12 active workforces as some of the staff are either on deputation or EOL. Further, none of the engineers has done specialisation in water.

Although several training on management of climate-resilient water infrastructures, planning, designing, and implementation of climate-resilient drinking water infrastructure, use of EPA-net software for the design of water distribution network, and emerging innovative technologies and automation systems were provided to build the capacities of the engineer, there is still need of training such as use of design software-EPA-net, GIS, Water CAD, Water GEMS, and AutoCAD, structural design software such as Midas, project management tools such as Prima Vera/ Microsoft Project according to the division.

b) Irrigation Division

As per the HR gap analysis, the ID required 25 civil engineers for irrigation and 2 civil engineers for flood control. However, only 12 civil engineers were approved for irrigation, of which 11 are with the division. During discussions with the ID, the RAA noted that the division had 12 engineers, including 2 engineers holding a degree in Master of Science specialising in water resources and flood management, but the division is still short of staff.

Further, NIMP also highlights that while ID is involved in designing new irrigation systems and major rehabilitations of existing ones, its current capacity is limited because the engineering division lacks specialised professionals in irrigation.

In addition, there are limited skills to use technologies like IrriCAD software and know-how in pumps and pump accessories (Both solar and electrical) to provide climate-resilient irrigation facilities.

These HR capacity issues within the DoID are also attributed to staff attrition and the absence of a proper human resource development plan, and are further compounded by a lack of collaboration with other water agencies, such as DoW.

Inadequate HR capacity in infrastructure development will result in not having climate-resilient drinking water and irrigation infrastructures, which in turn will increase the risk of making communities highly vulnerable to severe impacts of climate change, such as water scarcity, flooding, and landslides.

v. Dzongkhag Engineering Sector

- a) In each Dzongkhag, there is an engineering sector, and one of the responsibilities of this sector is designing and implementing drinking water and irrigation infrastructure.
- b) However, the NIMP stated that the engineering sectors in Dzongkhags mainly handle the maintenance and repair of irrigation systems and headworks, while the planning and development of new systems or major rehabilitations are managed by the central Engineering Division (now Irrigation Division under DoID). This has limited the local capacity for maintenance works and not for planning new irrigation works.
- c) During the field visit, the RAA noted that there is limited capacity for planning and designing irrigation infrastructure, which is why the Dzongkhags rely on DoID for complex infrastructure projects. But most of the time, the works get delayed due to the Department's competing priorities.
- d) Design issues were also noted that had led to inadequate headwork (*structures at the start of a water supply or irrigation system designed to collect, divert, and control water from its source*), especially when there are water source drying-up issues. The infrastructure is either washed away, filled with debris, or there is water seepage. These situations are forcing the communities to resort to extensions or find alternate water sources to address water scarcity.

For instance, Namseling village in Thimphu is facing water scarcity, particularly in the winter season, due to a reduction of water availability by 50%. The RAA observed that the village relies on the Wolona water source (Figure 6) for both drinking and irrigation. During the site visit, it was noted that water from Wolona flows through a natural earthen channel for approximately 100 meters before entering a concrete open canal. However, there is no proper water control structure (like a weir) to enhance water collection. Additionally, about 100 meters downstream, the quantity of irrigation water has decreased due to water seepage resulting from the absence of adequate infrastructure.

Figure 6: Wolona, Thimphu water



Source: RAA

- e) As a case in point, due to inadequate planning and design, the Gaden Irrigation Channel in Sarpang Dzongkhag, originally an earthen structure, was washed away by floods in 2016. In 2022, it was reconstructed using Reinforced Cement Concrete (RCC) by the Dzongkhag under the WFP (Figure 7). During construction, the intake and 300m drainage were damaged by floods, but were later restored. However, after completion, another 150m of drainage was damaged by flood and has not been restored to date. The engineers are yet to provide a concrete flood-resistant solution to the recurrent flood issues.

Figure 7: Gaden Irrigation Channel in Umling Gewog, Sarpang



- f) The DoID has the mandate of ‘*capacity development on innovative planning, designing and construction technology*’. However, the RAA noted that technicians responsible for RWSS, including the development of drinking water infrastructures, are still relying on outdated design methods that fail to address modern challenges such as climate change. They have been using the Design Manual for Rural Water Supply in Bhutan since 1999, which has not been updated to reflect current conditions and innovations in water management. Many have not been familiarised with modern design principles, climate-resilient strategies, or new technologies such as advanced hydraulic modelling and efficient water distribution systems. Moreover, they have not received adequate training in these areas.

Table 4 presents the summarised training details of the Dzongkhag engineers and technicians.

Table 4: Training details of Dzongkhag Engineers and Technicians

Sl. No.	Dzongkhag	No. of engineers/ technicians	Years of experience	Avg no. of training received	Training
1	Pemagatshel	16	10-35 years	1 to 2	RWSS design and construction of FCR tanks
2	Sarpang	18	10-32 years	1 to 2	RWSS and irrigation design
3	Dagana	2	3-11 years	2 to 4	Climate-resilient water infrastructure and climate-resilient irrigation design
4	Wangdue Phodrang & Punakha	20	1-21 years	3 to 5	Design of a climate-resilient irrigation system

Source: Respective Engineering Sector, Dzongkhag

The RAA noted that the amount of formal training these professionals have received has been limited, with most of them gaining their expertise primarily through practical, hands-on experience.

The HR capacity challenges within the Dzongkhags can be attributed to the absence of a well-structured human resource development plan and inadequate collaboration with DoID. These issues, if left unaddressed, will ultimately lead to increased vulnerability to climate impacts, frequent infrastructure damage resulting in cost escalation, and inefficient water distribution, further exacerbating the unreliable water supply.

3.2.2 Technology capacity

i. Technology adoption in climate information

NCHM is facing limitations in scientific and technical infrastructure. The Center requires essential tools such as weather RADAR and LiDAR, advanced drones for hazard and glacier mapping, AI and Machine learning capabilities, and supercomputing facilities for data computation and modelling.

These technologies are essential to provide reliable baseline data for climate and hydrology modelling and projections. Additionally, the rapid changes in technologies present a significant challenge, wherein the Center has not been able to upgrade the systems and tools to keep pace with these technologies due to financial constraints.

Lack of adequate technology may lead to inadequate hydrometeorological data and information and unreliable climate projections, increasing vulnerability to climate-related risks. This, in turn, undermines the formulation and implementation of long-term mitigation and adaptation plans for climate-resilient development and disaster risk reduction.

ii. Technology adoption in drinking and irrigation schemes

The DoW is tasked with coordinating, developing, and promoting environmentally sound technologies for sustainable water management, while the DoID has the mandate to promote innovative, cost-effective, sustainable infrastructure/technologies for drinking and irrigation.

The DoW is challenged in exploring and implementing key technologies such as built and natural water storage systems, as well as the adoption of the Internet of Things (IoT), like smart water meters, sensors, and automated systems for detecting leakages, and ICT-based solutions for improved water management. On the other hand, while DoID is mandated to promote innovative and sustainable infrastructure/technologies, limited initiatives were observed at the LG level.

During field visits to sampled drinking and irrigation water sites, the infrastructure observed was largely conventional (*observation 3.6 and 3.7 (iii)*), with no evidence of automation, real-time monitoring tools, or advanced climate-resilient innovations. This reflects a gap between policy-level intent and the actual application of modern technologies in practice. However, certain donor-funded schemes did incorporate advanced or emerging technologies, indicating their potential when supported through targeted investments.

These limitations are largely attributed to dissected mandate among the agencies and the absence of a clear technology adoption strategy, insufficient technical expertise, and financial constraints that restrict investment in modern systems. As a result, drinking and irrigation schemes remain vulnerable to climate variability.

The DoW stated that it already has a Water Roadmap, which includes technological aspects, and therefore does not see the need for an additional roadmap specifically for technology adoption. Instead, it suggested updating and enhancing the existing draft roadmap.

The DoW further added that capacity-building initiatives should be led by the respective agency within its mandate, while cross-cutting areas should require a designated lead agency. For example, in technology-related matters, DoID and DoW should collaborate, whereas DECC should lead on NAP-related issues.

The DoID also shared that it has been undertaking activities within its capacity, including developing a guideline for climate-resilient infrastructure, which has already been implemented in some areas. However, for mainstreaming, climate change remains crucial, with DECC as the lead agency. The Department also mentioned that interventions have been constrained by factors beyond their capacity.

Regarding technology, the DoID shared that it has been implementing SCADA for larger schemes to support project implementation and O&M, in collaboration with IT experts from Druk Holding and Investments (DHI). However, these efforts have not been sustainable, and they have faced challenges in ensuring continuity. The Department noted that operators need proper training and capacity building to effectively operate the technology; however, limited funding has hindered such activities.

The NCHM highlighted the need for economy-wide capacity building and emphasised the importance of integrating training and educational institutions in developing institutional capacity.

All agencies mentioned that capacity building is primarily constrained by a lack of dedicated funding. They emphasised that while there is limited expertise within each

agency, sharing expertise across agencies, based on need, would enhance institutional capacity and benefit all relevant agencies.

While the efforts and initiatives undertaken by the respective agencies are acknowledged, the RAA notes that the absence of a unified and coordinated approach continues to limit the effective mainstreaming of climate change and technology adoption in the water sector. The lack of sustained capacity-building initiatives, sufficient funding, and clear leadership in cross-cutting areas such as technology and climate adaptation has hindered institutional readiness and long-term sustainability. The RAA emphasises the need for a harmonised and adequately resourced approach that clearly defines institutional responsibilities, promotes inter-agency collaboration, and ensures long-term capacity development to achieve effective and sustainable climate-resilient water management.

3.3 Climate Financing

Funding for adaptation is vital for developing countries to plan and implement adaptation plans and projects. There is a critical need for sustained financing to support adaptation efforts. Without sustained funding, adaptation may not be effectively addressed and could be restricted to reactive measures. This approach would not support sustainable development and could ultimately become very expensive.³

The CCP, Section 3.1. Statement for finance support states the following on climate finance:

3.1.1 Ensure a coherent and coordinated nationally driven approach to accessing climate finance for prioritised climate actions, from international climate funds, development partners, and donors to supplement support for sustainable development activities, including as a part of or in support of a national resource mobilisation strategy.

3.1.2 Ensure sufficient budget allocation for prioritised climate change activities from various sources, including national budgets, funds, and other domestic contributions for climate change action.

3.1.3 Support and promote private sector investment in climate change action in line with applicable national laws and support from international mechanisms available for private sector action on climate change, including Public Private Partnership (PPP Policy) and climate change funds.

3.1.4 Monitor and report the flow of financial support from domestic and international sources for climate action through the government budgetary system to ensure transparency of support needed and received.

The RAA noted the following with regard to climate funding:

- i. The UNFCCC's Technical Assessment of Climate Finance in the LDCs in Asia, led by the NEC of Bhutan, was developed to inform and thereby facilitate the development of a climate finance mobilisation and access strategy for the LDCs in

³ Impacts, Vulnerabilities and Adaptation in Developing Countries, UNFCCC

Asia. It has identified the key sources of climate finance for the region as of mid-2021. For Bhutan, these sources include:

- ✓ National Climate Trust Fund: Bhutan Trust Fund for Environmental Conservation (BT FEC)
- ✓ International Public Finance: GCF, GEF, Adaptation Fund (now Loss and Damage Fund)
- ✓ Other Climate Funds: Climate Investment Funds - Pilot Programme for Climate Resilience
- ✓ Multilateral Financial Institutions: Asian Development Bank (ADB) and World Bank (International Bank for Reconstruction and Development)

Mobilising private-sector finance for climate-related initiatives is crucial for enhancing additional resources and improving access to climate finance. However, it is evident that Bhutan lacks private-sector funding for climate initiatives.

- ii. Further, the technical assessment revealed that between 2013 and 2018, Bhutan received USD 268 million in international climate finance (including adaptation). However, as highlighted in the assessment, comprehensive data on climate-related finance flows from domestic or local sources in LDCs-Asia, including Bhutan, remains largely unavailable at aggregate levels, which is crucial to ensure transparency of support needed and received.
- iii. In addition, the Public Expenditure and Financial Accountability (PEFA) Assessment of Climate Responsive Public Financial Management, 2023 and Public Financial Management, 2023, and Reform Strategy and Action Plan 2023-2028 mentioned that the RGoB do not have methodology/mechanism in place that defines what constitutes “climate change expenditure and climate-related expenditure” and is not identified using specific budget expenditure line items and programme codes. This issue has been noted since the Public Environmental Expenditure Review for the 10th FYP in 2011.
- iv. NAP states that Bhutan's domestic financial resources are limited, and international development assistance is still a major source of financing climate actions. The funding needed for climate change adaptation over the next five years may exceed the available resources.
- v. The NAP has identified seven key adaptation priorities and five enabling activities, with an estimated total funding requirement of USD 13.9 billion. Of this amount, USD 204.9 million is allocated for the water sector, which is planned to be implemented over 15 years.

In addition to financial sources outlined in the assessment report, NAP mentions the Bhutan Climate Fund (BCF), the RMA’s green financing options as part of its 10-year strategic plan, the Sustainable Development Fee (SDF), and the private sector as potential financing sources for the implementation of NAP activities.

However, access to international financing sources requires that adaptation priorities be integrated into national and sectoral plans. Additionally, it is dependent on donor requirements and subject to their approval.

- vi. While reviewing the trend of financial support received, the BUR reveals that between 2015 and 2020, the country received only USD 82.5 million in climate finance support from the GCF, GEF, and UN Environment Programme (UNEP). This amount is significantly lower than the USD 911.6 million required for the Third National Communication. The report also underscores the insufficiency of financial resources as a major barrier to implementing climate initiatives.

This trend of financial support indicates that there could be a financial gap in the implementation of NAP activities where the estimated costs of meeting a given adaptation target in the NAP are more than the amount of finance available for the whole adaptation plan.

- vii. The Development Coordination and Debt Management Division, DMDF, MoF, has the responsibility to facilitate the mobilisation of financial resources, grants, loans, and technical assistance from bilateral and multilateral development partners to support national development priorities, including implementation of climate actions. For the NAP implementation, in line with the CCP, MoF is tasked with resource mobilisation and allocation. In carrying out their functions, the RAA noted the following:

- ✓ Bhutan's graduation from LDC status eliminates special financial considerations and funding access typically granted to LDCs. The DMDF informed the RAA that since the country's graduation in December 2023, no new specific donors have been sought. The focus has remained on traditional partners, including the GCF, the GEF, and the Adaptation Fund.
- ✓ The DMDF further reported challenges in securing funding for hard infrastructure projects, such as flood protection or renewable energy facilities. Many donors favour funding soft components, which encompass capacity building, policy development, and technical assistance. Hard infrastructure projects typically entail significant financial investment and long-term commitments, making it difficult to attract donors willing to support them.
- ✓ Regarding diversifying funding sources, enhancing domestic resource mobilisation for climate finance, and fostering partnerships with international donors, DMDF expressed that enhancing domestic resource mobilisation and allocation are key priorities in Public Financial Management for the MoF and have been emphasised in the 13th FYP.
- ✓ The Department is planning to develop a resource mobilisation strategy aiming to attract additional climate finance beyond traditional donors and development partners. The need for such a resource mobilisation strategy has been recognised in several earlier documents, specifically in the CCP, the stocktaking for the NAP formulation process, and the technical assessment, which were published before

2022. However, despite the launch of the 13th FYP, the strategy is still under development, with no definite timeline for implementation.

The absence of a resource mobilisation strategy and limited engagement of relevant stakeholders to enhance climate funding could pose a significant risk to the successful implementation of the climate priorities outlined in the NAP. This, in turn, could pose a risk of increasing the vulnerabilities to climate change impacts.

The DoW shared that while DECC and DMDF serve as the overarching bodies for climate finance, each sector remains responsible for proposing climate finance initiatives within their respective area.

Further, DoW informed that the department has developed the Bhutan Climate Adaptation Investment Plan (CAIP) (draft) for the Water Sector to advance prioritised climate adaptation investments. The Climate Adaptation Investment Plan builds on the adaptation priorities identified in NAP and aims to support the mobilisation of finance to implement these investments.

The RAA appreciates the initiative of the DoW to come up with the CAIP, as it provides a sector-specific, structured approach for translating adaptation priorities into implementable projects. Nevertheless, the RAA notes that the draft CAIP has yet to be finalised and operationalised. In the absence of a clear implementation strategy, financing plan, there remains a risk of not achieving the climate actions identified in the NAP.

3.4 Adaptive Capacity for Climate Change Adaptation Actions

To take effective climate change actions, it is essential to strengthen the capacity of countries, particularly those highly vulnerable to the adverse effects of climate change. The implementation of climate actions requires adequate finance, technology transfer, and capacity-building initiatives. These efforts include relevant aspects of education, training, and public awareness, which will further enhance the capacity of countries to adapt to climate change impacts (Paris Agreement).

The Organisation for Economic Co-operation and Development (OECD) also states that developing countries' efforts to combat climate change are hindered by capacity gaps, making it difficult to design, implement, and monitor climate actions. Capacity development is essential to address these challenges, enabling countries to take ownership, build resilience, and promote sustainable solutions.

3.4.1 Research and Development

Research plays a crucial role in successful climate change adaptation by guiding actions to incorporate anticipated climate shifts, reducing the risk of maladaptation, and deepening understanding of climate risks and their interactions with other societal risks.⁴

Bhutan faces significant climate-related challenges, including melting glaciers, changing monsoon patterns, and an increasing frequency of climate-related disasters, which threaten key

⁴ ARA Evidence Review 2: Good Practices for Adaptation Action Research, 2022

sectors such as water and agriculture. Thus, it has become utmost important for the country to develop well-researched actions that address the climate risks.

Recognising the importance of R&D for climate actions, the CCP of Bhutan 2020 states, “*Research and Development is required for the implementation of climate actions*”. Accordingly, a Roadmap and Strategy for Strengthening Climate Change Research in Bhutan 2021-2025 was developed in November 2020 to address the fragmented and sporadic nature of climate research in the country, wherein each sector, depending on funds available, has been conducting one-off climate change-related research projects, with no particular long-term goals and continuity plans.

Thus, it aims to institute a more coordinated and systematic approach to climate change research to improve institutional capacity, promote collaboration, and provide actionable data to guide evidence-based climate action.

The roadmap charts a way forward to strengthen climate change research in Bhutan by seeking delivery on five strategic (Figure 8) imperatives:

Figure 8: Five strategic imperatives



Source: RAA's representation based on the Roadmap

To ensure that key objectives are met and that milestones are achieved, both RUB and the DECC are required to provide leadership and assume catalytic roles.

The RAA, during the assessment of the implementation of the activities in the roadmap related to water, found the following:

- i. On inquiry with DECC and RUB, the activities and milestones laid down based on five strategic imperatives in the roadmap were not operationalised. Therefore, the following activities were not carried out:
 - Strengthen and capacitate national institutions for conducting climate research to tackle pressing climate issues.
 - Prioritise and carry out key research areas of water.
 - Operationalise CRISP.

- Research institutions form mutually beneficial MoUs with regional and international partners.
 - Conduct leadership seminars and high-level workshops annually.
 - Convene annual forums for climate research dissemination annually.
 - Establish the Bhutan Science Foundation.
- ii. The RUB informed RAA that while they have conducted research in collaboration with certain government agencies, these efforts were not part of the roadmap initiatives.
 - iii. The RUB also informed RAA that the University provide grant support for climate change and environmental research proposals through its Annual University Grant and Research Endowment Fund, and RUB colleges have agreements with various external universities and agencies to collaborate on climate change initiatives. However, these efforts were not part of the roadmap initiatives.
 - iv. In the Skills Assessment for NAP Formulation Process in Bhutan, it has been highlighted that the capacities of NCHM, Universities, and research agencies are not fully utilised to help translate climate information and interventions.
 - v. Further, the Water Roadmap, 2022, notes that RUB colleges have research centres with mandates related to water sector needs. Government agencies also have specific mandates for applied research, and these agencies could be linked with RUB colleges to support long-term R&D growth. The road map for research also requires RUB Colleges to initiate discussions on MoUs with relevant government agencies to conduct research collaboratively. Though the need for collaboration is clear, it has been continually delayed, and no actions have been taken.
 - vi. On the other hand, the DoID informed RAA that a dedicated section for R&D on climate-resilient infrastructure development is needed, but it is currently lacking. This indicates a lack of collaboration with RUB and other institutes as well.
 - vii. As mentioned in observation 3.1.2, the Bhutan Climate Platform, developed as part of the NAP readiness and hosted by DECC, was designed as a ‘one-stop platform’ for knowledge exchange, coordination, and sharing of climate data, research, and guidance. However, the RAA found that DECC lacks ownership of the platform, which remains underutilised and outdated.

The DECC, as the focal agency for climate and an integral part of the roadmap, is yet to operationalise the roadmap. While responsibilities are assigned, there are no concrete steps, procedures, or systems to carry out the required actions. Without these mechanisms, the research roadmap remains unimplemented, which could lead to fragmented or duplicated efforts and not being able to derive synergies from the collaborations.

This also causes research to be sporadic and lacking consistency, much like it was before the roadmap was created. Ultimately, the absence of coordinated research or, in some cases, the absence of research altogether continues to pose challenges for evidence-based climate action, including water.

The DECC stated that *the Roadmap and Strategy for Strengthening Climate Change Research in Bhutan 2021-2025* is relevant, noting that it was developed as part of the NAP activities and will be further reviewed. DoID and NCHM also agreed that research and development (R&D) is an integral part of every organisation and emphasised the need for targeted interventions to strengthen it.

3.4.2 Awareness of climate change

Climate change awareness is a crucial first step in adaptation, prompting proactive and coordinated responses against its impacts. Climate change awareness refers to familiarity with key concepts of climate change.

As per Article 6 (UNFCCC, 1992), the parties to the convention are required to encourage education, training, and public awareness programmes within their own capacities and assets.

Similarly, section 3.4.2 of the CCP requires an increase in public awareness and understanding of climate change among different groups of people at all levels through education and outreach programs by using print, broadcast, and online media.

CCP further specifies that national-level agencies should support LGs, civil society, and the private sector by providing capacity building, awareness, financial assistance, and technical expertise. Local-level agencies are expected to act as partners in advocating and raising awareness among different groups within the general public and their respective communities.

Even the NAP 2023 highlights the need for greater awareness and capacity building for climate change and integration with development at the local level.

While reviewing the initiatives in terms of awareness, the RAA noted the following:

- i. The DECC, as the nodal agency for climate change, has the responsibility to raise awareness of climate change across the country. Nonetheless, the current awareness efforts are sporadic and they also lack comprehensive records or data tracking for their awareness activities, both before and after the reorganisation.
- ii. The Watershed Management Division, when under DoFPS before merging with DoW, conducted several awareness programmes between 2018 and 2022, all focused on watershed management. These programmes primarily addressed environmental aspects and did not focus on the impacts of climate change.
- iii. In semi-structured interviews conducted across 10 Dzongkhags, the RAA found that engineers and technicians had no prior knowledge of the CCP. Additionally, they were also not familiar with essential concepts like vulnerability and risk assessments, which they need to include during pre-feasibility and feasibility studies as outlined in NIMP. This indicates a lack of awareness among the engineers and technicians.
- iv. During discussions with Gewog officials and Gups, the RAA noted that the climate change topic has been discussed during Gewog and Dzongkhag Tshogdu (GT and DT) meetings, but it was not provided as a structured awareness.

- v. Additionally, community members interviewed during site visits to drinking water and irrigation infrastructure projects had little to no information on climate change awareness received.

Limited awareness of climate change can be attributed to not having a clear strategy for the conduct of awareness programs. Additionally, there is also a lack of collaboration with DoW, DoID, and LGs. This absence of a structured approach created uncertainty about how such initiatives would be rolled out and sustained over time.

This gap in awareness and sensitisation efforts will lead to a low understanding of climate change and its impacts by the public, as well as by implementing agencies. As a consequence, the effectiveness of adaptation measures may be undermined, and local engagement in climate resilience initiatives could be hindered. Without adequate awareness, communities may remain unprepared for climate-related risks, exacerbating their vulnerability to extreme weather events, such as floods, droughts, and other climate-induced challenges.

3.5 Prioritisation of Adaptation Actions for Drinking Water and Irrigation

Climate risks and impacts cannot be completely eliminated. Governments must develop strategies to ensure individuals and communities swiftly recover without facing devastating long-term consequences (World Bank).

Prioritisation of adaptation actions for drinking water and irrigation involves a systematic approach of understanding areas, systems, or communities that face the greatest risks from climate change and need the most support. This is done through two key assessments: climate risk assessment and vulnerability assessment.

A climate risk assessment identifies potential climate-related hazards, such as floods, droughts, or landslides, evaluating their likelihood and severity. A vulnerability assessment examines how exposed and sensitive people, water systems, or communities are to these hazards and their abilities to adapt. These assessments are critical for prioritising adaptation actions, ensuring resources are directed to the most at-risk areas.

For instance, in Tsirang, where alternative water sources are scarce, a prioritised adaptation action involves afforestation and watershed management to address the issue of drying water sources.

The process of prioritising adaptation actions involves the following steps:

- i. Identify Risks & Vulnerabilities: Assess climate hazards and the most exposed systems or communities.
- ii. List Adaptation Options: Outline possible measures to reduce risks.
- iii. Evaluate Feasibility & Effectiveness: Compare costs, benefits, and practicality of options.
- iv. Prioritise Actions: Rank measures by urgency, cost-effectiveness, and beneficiaries.

The RAA reviewed the Assessment of Climate Risks on Water Resources 2022 and Climate Change Vulnerability Analyses and Mapping 2022 for the NAP Formulation Process in Bhutan and noted the following:

- ✓ Drinking water and irrigation systems face increasing threats from dry spells, floods, landslides, and glacial floods. These risks are exacerbated by unpredictable precipitation, rising temperatures, and prolonged dry spells, posing challenges to water availability.
- ✓ Many communities rely on a single water source, such as springs or small canals, making them particularly vulnerable if these sources dry up or are damaged. Poor water infrastructure further exacerbates the situation.
- ✓ The resilience and reliability of water sources and supply systems for drinking and irrigation must be strengthened to support economic growth, enhance living standards, and effectively address the challenges of climate change.
- ✓ Further, adaptation measures must go beyond routine development plans, focusing on hazard-specific, practical, inclusive, and gender-sensitive solutions to reduce vulnerabilities and build resilience across vulnerable regions.

The RAA further reviewed the efforts in prioritising adaptation actions for drinking water and irrigation at the Dzongkhag level and noted that adaptation actions are not systematically prioritised through climate risk and vulnerability assessments. Typically, projects for drinking water and irrigation are first selected based on development priorities within respective dzongkhags, and adaptation aspects are considered later during water source assessments or infrastructure planning and development, rather than as dedicated adaptation actions.

This lack of prioritisation can be attributed to limited historical climate data for drinking water and irrigation, poor record-keeping of past hazards, and the absence of reliable hydrological models, all of which hinder evidence-based planning and systematic ranking of measures at the local level. Furthermore, stakeholders at both local and regional levels have limited awareness and understanding of climate risks and vulnerabilities, further constraining effective prioritisation.

The lack of prioritising adaptation actions through the systematic process of climate risk and vulnerability assessments will increase the vulnerability of communities to hazards, misallocate resources, and overlook high-risk areas. This will ultimately result in increasing the risk of water shortages, economic loss, social inequalities, and missed opportunities for long-term resilience, hindering national climate goals.

3.6 Implementation of Adaptation Actions for Climate-Resilient Drinking and Irrigation Infrastructures

Bhutan has abundant water resources, with one of the world's highest per capita water availabilities at 94,500 m³. However, water is unevenly distributed across regions and seasons, causing shortages in some areas. Most rivers flow through the valleys, while people live on the slopes and rely on smaller water sources like springs, streams, and ponds. Many of these smaller sources are reportedly drying up, making it difficult for local communities to get enough water for drinking and irrigation. Of the 7399 water sources (utilised), 0.9 % (69) have dried up over the years, while 25.1% (1856) are in the drying stage. The impact of climate

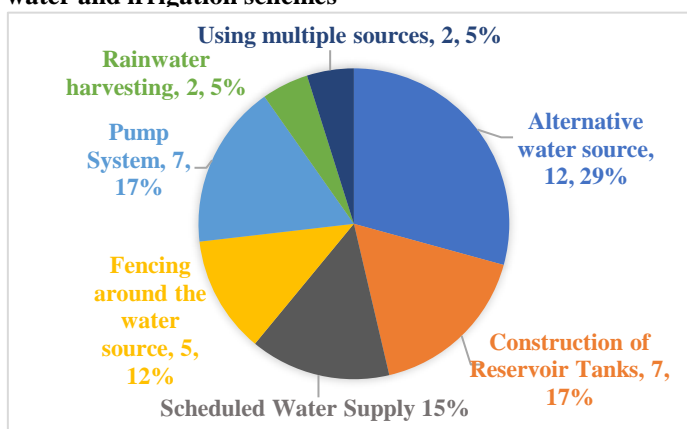
change (36.5%) is one of the major factors contributing to the drying up of water sources in the country.⁵

Looking ahead, climate projections for Bhutan indicate an overall increase in precipitation through 2100, particularly in the northern, western, and southwestern regions. However, this increase in rainfall is unlikely to resolve water scarcity issues. Instead, variability in rainfall patterns and extreme weather events such as floods and landslides pose significant threats to water infrastructure and storage systems. Uneven geographic distribution of rainfall exacerbates the issue, making climate-resilient drinking and irrigation systems a critical necessity. To assess the adaptation actions for climate-resilient drinking water and irrigation infrastructures, field assessments were conducted on 50 schemes (detailed in *Appendix-I*) across 10 Dzongkhags. The assessment covered 24 drinking water schemes, 16 irrigation schemes, and 10 integrated schemes. Notably, the Gelephu Landmark Water Project was visited to observe best practices and infrastructure standards.

The selection of schemes was based on criteria such as the drying up of water sources, climate-induced infrastructure damage, and the extent of adaptation measures implemented. The RAA noted the following during its field visits:

- i. *Reactive climate adaptation actions:* The adaptation actions implemented are largely reactive and scheme-specific. These actions are driven by developmental needs, such as repairing or replacing damaged structures and meeting urgent water supply requirements, without specifically addressing the climate risks. The common adaptation actions implemented across the selected schemes are presented in Figure 9.

Figure 9: Adaptation actions implemented in the drinking water and irrigation schemes



- ii. *Alternative water resource as the primary action:* The RAA noted that the most common solution for addressing drying water sources across the schemes was using alternative water sources such as springs and streams, implemented in 12 out of 27 schemes. In most cases, the community identifies potential new water sources and informs the Gewog and Dzongkhag authorities, who then assess their feasibility and reliability to use for drinking and irrigation. In four cases of water sources drying up, no alternative sources were available, and no other adaptation actions were taken, leaving the communities vulnerable to water shortages.

⁵ Assessment and Mapping of Water Sources in Bhutan, December, 2021

- iii. *Lack of seasonal assessment of water yield:* Dzongkhags such as Paro, Samtse, Samdrup Jongkhar, and Pemagatshel emphasised the need for year-round water yield assessment regardless of seasons to ensure long-term water sustainability and infrastructure resilience. Currently, water sources are identified during the peak summer flow, overlooking seasonal variations that affect long-term sustainability.
- iv. *Other adaptation actions:* With water sources drying up and water shortages, other adaptation actions include the construction of reservoir tanks, scheduled water supply, fencing around water sources, using pump systems, rainwater harvesting, and using multiple water sources (Figure 10). Adaptation actions in other categories include restoring damaged structures, replacing pipes with earthen canals, and resorting to borewells and groundwater, in a few instances.

While these actions are being implemented, they remain sporadic and often lack consistency across different areas, and actions are not always sustained or widespread. These efforts have

primarily been initiated and implemented within their respective capacities at the community and Dzongkhag levels.

- v. *Challenges with pump systems:* Regarding the use of pump systems, the RAA observed challenges arising from their frequent damage, which leads to high repair costs and prolonged downtime due to a lack of spare parts. Additionally, communities are reluctant to operate pump systems due to high electricity costs. *For instance*, in Samtse, the pump system for the Chunpatang irrigation scheme has had multiple repairs but remains non-functional. Similarly, in Pemagatshel, the Khonmaree pump system remains underutilised due to high electricity charges.
- vi. *Limited springshed management:* Further, as noted in Figure 9, communities heavily rely on alternative water sources, such as other springs and streams, to adapt to the water drying up issues, which are also vulnerable to drying up. Despite this vulnerability, no springshed management initiatives are in place to ensure the long-term sustainability. While the Tagulum RWSS in Punakha focuses on the protection

Figure 10: Adaptation Actions



Source: RAA's compilation from the field assessment conducted

of individual groundwater sources, and the Garamala RWSS in Dagana includes the construction of check dams supported by DoFPS and the World Health Organisation (WHO), neither of these initiatives constitutes a holistic springshed management approach. Springshed management is a holistic approach to rejuvenate spring resources, aiding in landscape restoration and enhancing climate resilience.⁶

Springshed management was initiated in 2018 to address the issue of drying water sources and ensure that water sources are secured. Currently, DoW is implementing springshed management interventions in different pilot sites. However, springshed management is not yet widely adopted at the community level.

- vii. *Absence of Payment for Ecosystem Services (PES)*: The RAA noted that none of the selected schemes include PES mechanisms, which could support water source protection and springshed management by incentivising upstream communities to conserve ecosystems vital for water quality and flow, ensuring a sustainable water supply, and reducing flood risks for downstream communities.
- viii. *Inadequate climate-resilient infrastructure*: During the field visits, the RAA also observed that most existing drinking water and irrigation infrastructure address only basic developmental needs, with no climate-resilient structures. For eleven schemes, water connection pipes and irrigation channels were either damaged or washed away due to landslides and floods. Some of the damaged structures are discussed below:
 - a) Pemathang Gewog in Samdrup Jongkhar: The main pipelines from the water source (figure 11) were washed away by erosion in 2023, with another landslide in June 2024.

Figure 11: Pipes washed away by landslides



Source: RAA

- b) Thedtsho Gewog in Wangdue: An irrigation channel and pipelines (figure 12) are frequently damaged by landslides, at least three times a year.

⁶ S. Chaudhary & N. Lamichhane, ICIMOD

Figure 12: Irrigation channel and pipelines damaged by landslides



Source: RAA

c) Samdrup Jongkhar, Pemagatshel, and Dagana Dzongkhags also reported challenges in procuring durable water pipes from nationally designated local manufacturers. High prices, unavailability of necessary fittings, and frequent pipe bursts due to improper fittings were highlighted.

- ix. *Outdated design standards:* As per NIMP, most irrigation systems in Bhutan, built using local skills and materials, are poorly equipped to withstand climate change. Increased floods and landslides will likely cause rapid deterioration.

For RWSS, the Design Manual for Rural Water Supply in Bhutan (1998) is used as the primary guide for building drinking water supply infrastructure, but it does not account for climate change impacts.

For example, reservoir sizing and pipeline capacities are based on current and near-term water needs, without considering shifting seasonal or long-term trends in water availability. While the manual focuses on durability to prevent leaks and breakages, it overlooks risks from climate-driven extreme events like floods and landslides. It also emphasises cost-effective materials, such as HDPE and GI pipes, without evaluating their performance under extreme temperature fluctuations.

- x. On the other hand, drinking water and irrigation schemes implemented through project funding like GCF incorporate climate-resilient infrastructure developed with high-quality materials, a well-defined scope of work, detailed planning and design with input from consultants, and a strong focus on climate considerations, supported by adequate funding.

As a case in point, the RAA compared the schemes funded by RGoB (executed by Dzongkhag) with those funded through projects in terms of budget allocated and time taken for construction.

Table 5: Comparison of Irrigation schemes funded throughs Projects and RGoB

Project Name:	DBOT of Phangyul Irrigation Scheme	Construction of Tharaykhola Irrigation Scheme
Contract Amount:	Nu. 550,991,357.76	Nu. 2,553,600
Start date:	September 2022	March 2024
Completion date:	September 2024	July 2024
Funded by:	GCF	RGoB

Source: Compiled by RAA

- xi. As shown in Table 5, the GCF-funded projects have a higher budget as compared to those implemented through RGoB funding. This financial backing ensured the use of high-quality materials, expert consultation, and the development of a climate-resilient irrigation system. Moreover, the time taken to complete the construction is also comparatively longer for GCF-funded projects than for RGoB-funded projects.

The Phangyul Irrigation scheme (Figure 13) was constructed under the UNDP's GCF-funded project to support *climate resilience and transformational change in the agriculture sector in Bhutan*. The irrigation scheme has used the DBOT (Design-Build-Operate-Transfer) contract model, which has effectively facilitated climate-resilient infrastructure. The model ensured that the project not only met the immediate water management needs of the community but also incorporated long-term sustainability and climate adaptability into its structure.

Figure 13: Phangyul Irrigation scheme



Source: RAA

The lack of adequate implementation of climate adaptation actions across drinking water and irrigation at the local level can be attributed to the absence of prioritisation strategies for adaptation actions and, subsequently, a lack of implementation strategies. Without climate-resilient measures, water sources and infrastructure remain highly vulnerable to climate-induced hazards, which not only exacerbate water scarcity for drinking but also decrease agricultural production.

DoID responded that PES is not suitable for rural water supply, as the beneficiary community cannot afford to pay for the upstream community. However, for urban areas, this approach is suitable as there is a tariff system. Similarly, the DoW stated that the PES mechanism is applied for watershed conservation. However, not all water supply schemes qualify for PES, as decisions are made on a case-by-case basis.

Regarding collaboration, the DoID explained that it has been actively engaging in joint efforts. To enhance infrastructure resilience, the Department has implemented measures such as using ductile iron (DI) pipes in the southern regions to prevent damage from elephants, insulated pipes in cold areas to prevent freezing, and thrust blocks to mitigate landslide risks. Conduits are designed to be climate-resilient, and effective intake structures have been designed to prevent blockages. However, such measures are largely constrained by budget limitations. Another challenge lies in the fact that most water-related activities are carried out by LGs, which have decision-making authority over prioritisation, budgeting, and implementation. The DoID is only involved if LGs seek

support in design. If LGs have the necessary capacity, they implement projects independently, leaving little opportunity for collaboration.

The DoID further shared that the department currently lacks sufficient knowledge on climate-resilient actions and may require a set of basic parameters to monitor the implementation of such actions by the LGs.

Although the RAA appreciates the introduction of several climate-resilient measures, such as using ductile iron pipes, insulated pipelines, and thrust blocks by the Department, these efforts remain fragmented and largely driven by budget availability and case-by-case basis rather than systematic prioritisation. Moreover, the absence of a structured monitoring mechanism and defined parameters to assess climate actions increases the risk of greenwashing, where initiatives are labelled as climate-resilient without verifiable evidence of impact.

3.7 O&M of Drinking Water and Irrigation Management

O&M is a crucial element for sustainability and a frequent cause of water supply failure. Maintenance includes preventive /routine maintenance and also breakdown maintenance.⁷ The major objective of the O&M of the water supply system is to provide sustainable, equitable, consistent, economic, safe, and adequate water. This is particularly vital for building resilience to the impacts of climate change, especially in the context of increasingly scarce and drying water sources.

The RAA, on review of the O&M for drinking water and irrigation in the LG, noted the following:

i. Institutional Coordination and Policy Support

- ✓ The Water Act, 2011, section 50 states that *‘any group of beneficiaries using a particular water source for their water supply needs may form a water users’ association (WUA) to maintain the water source and to manage water supply services.’* Section 51 states that *‘Competent Authorities within six months from the date of its formation.’* Further, section 52 stipulates that *‘To maintain a water source and protect it against a) vandalism and other damages. To coordinate and oversee the activities and b) management of water supply service by its members so as: i. to foster a sense of ownership among the users; ii. and to ensure the sustainability of such service.’*
- ✓ For both RWSS and irrigation schemes, the O&M responsibilities are handed over to the respective WUAs. These associations are critical for community ownership and the sustainable management of infrastructure. Once project implementation is completed, WUAs are expected to independently manage and maintain the facilities.
- ✓ However, according to DoW, the WUAs remain either informal or non-functional. To address this issue, the DoW conducted sensitisation programs across all 20 Dzongkhags to gather feedback and incorporate changes into the draft WUA guideline.

⁷ O&M Manual for Rural Water Supplies, Ministry of Drinking Water and Sanitation, GoI

Additionally, the WFP assessment highlighted that WUAs often face systematic functionality issues, leading to poor O&M and insufficient representation of women.

- ✓ Further, WFP noted that after the construction of RWSS, transferring scheme ownership to the beneficiaries and maintenance have been a major challenge. Many beneficiaries still perceive ownership and responsibility for the major maintenance and rehabilitation as the responsibility of the Dzongkhag or RGoB rather than their own. Many implementation procedures have contributed to a lack of beneficiary commitment to the self-management and maintenance of their schemes.
- ✓ The RAA observed that the GoI has developed the Manual O&M of Rural Water Supply Schemes developed since 2013, and provides a structured framework emphasising preventive maintenance, routine inspections, and clear operating procedures to avoid breakdowns and extend the lifespan of infrastructure. The manual highlights the importance of community involvement, financial planning, and capacity building for personnel to ensure sustainability. However, Bhutan lacks a similar structured O&M manual, creating a gap in implementing standardised O&M practices.
- ✓ For irrigation, the Phangyul Irrigation Scheme has an O&M Manual with specific guidelines on maintaining intake structures, pipelines, and sedimentation tanks. The manual also provides detailed checklists and emergency response plans, which are essential for addressing unforeseen challenges efficiently.

However, such comprehensive O&M manuals are not replicated across all irrigation schemes.

ii. Infrastructure Maintenance

- ✓ Most of Bhutan's existing irrigation systems were developed by communities using local skills and materials, making them vulnerable to climate impacts. Similarly, most of the drinking water infrastructure is outdated and requires upgrades to ensure resilience and reliability.
- ✓ During field visits, the RAA observed that, out of 50 drinking and irrigation water schemes, 17 had maintenance-related issues (*Appendix-II*), of which 13 had received no maintenance at all. Common issues observed were:
 - Frequent pipe blockages caused by debris, ice accumulation in winter, or sediment build-up.
 - Damage to pipes due to construction activities, such as farm road developments.
 - Lack of proper filtration systems, leading to contamination risks.
 - Water seepage and leakages at sources and along transit pipelines.
 - Frequent breakdowns in the pump systems, impacting the water supply.
- ✓ As per the RWSS O&M manual developed and used in other countries, operation activities include daily monitoring of pumps, pipelines, and storage tanks, as well as weekly water quality tests and record keeping.

Maintenance includes routine checks for leaks, monthly inspections, and preventive tasks like de-silting tanks and applying anti-corrosion treatments. Annual activities involve deep cleaning, reconditioning equipment, and replacing worn components to ensure system reliability and sustainability.

However, the RAA observed that in Bhutan, the approach to O&M of RWSS and irrigation schemes is not preventive, but rather need-based and reactive. Maintenance activities are often carried out only when issues arise, such as leaks or breakdowns, instead of following a structured schedule for preventive and routine tasks.

Figure 14 illustrates the insufficient or inadequate O&M practices in some of the drinking and irrigation schemes. These pictures highlight areas where proper monitoring, regular maintenance, and timely interventions are lacking.

Figure 14: Lack of adequate O&M activities



Source: RAA

iii. Technology Integration

- ✓ At the local level, technologies such as leak detection devices, data loggers, and SCADA systems for real-time monitoring of water networks are not yet widely implemented.

Nonetheless, in some projects, such as Semjong Drinking Water and dryland irrigation in Tsirang, executed by Dessung National Service, Internet of Things (IoT) technologies have been piloted. These IoT-based systems track water levels, quality, and flow, allowing real-time remote monitoring adjustments via smartphones. Such a system optimises water usage and reduces waste, thus improving efficiency in both irrigation and drinking water supply. Despite these innovations, IoT systems are

currently non-functional, and neither the operators nor dzongkhag engineers have the technical expertise to repair and maintain them.

iv. Capacity Building and Training

- ✓ According to WFP, there is a shortage of skilled manpower for O&M of water supply systems. The engineering sector plays a key role in supporting technically demanding facilities. For newly developed irrigation systems, engineers are essential for ensuring efficient O&M by WUAs. To sustain these systems, periodical training and technical backstopping should be provided to the WUAs.
- ✓ For RWSS, after the transfer of responsibility of the RWSS program to MoIT in 2018, an MoU was signed between MoH and MoIT, assigning MoIT the responsibility for providing education and awareness to water users. However, no such trainings were provided as of the date of the audit.
- ✓ Previously, when the RWSS programme was under the MoH, each dzongkhag had an RWSS focal person responsible for conducting training for water caretakers, developing rural water safety plans, and conducting RWSS construction training. Currently, there is no dedicated RWSS focal person.
- ✓ For irrigation, the RAA was informed that there is no dedicated budget for WUA training for O&M. Previously, under the Department of Agriculture (DoA), a portion of the construction budget was allocated for training the WUAs after the completion of the project, but no further capacity-building initiatives have been undertaken beyond this initial training for the WUA.
- ✓ After restructuring in 2022, the DoW is responsible for providing user training related to the O&M of water systems to the WUAs. However, no such training has been provided yet.

The lack of proper O&M is primarily due to limited awareness and training from DoW in coordination with DoID. Additionally, there is no mechanism to ensure ownership and community engagement, as well as a lack of manuals for O&M for systematic guidance.

Failure to conduct timely inspections can lead to severe consequences such as excessive sedimentation, clogged pipelines, and eventual system failure.⁸ A lack of consistent, proactive preventive O&M will result in inefficiencies, system breakdowns, and higher long-term repair costs. Additionally, it will result in water wastage and heightened vulnerability to climate impacts, thereby threatening the sustainability and resilience of the water system.

The DoW explained that the WUA guideline first needed to be endorsed before initiating related activities and shared that WUAs are voluntary in nature. Following the endorsement, awareness programmes have been carried out in five Dzongkhags during FY 2024–25: Dagana, Gasa, Punakha, Paro, and Tsirang. Training on O&M will be conducted in subsequent phases as implementation progresses.

⁸ Irrigation Division, DoID

With regard to the maintenance of infrastructure by WUAs, the DoID shared that the major maintenance is supported by the RGoB. The DoID stated that O&M is not given priority, and there is no dedicated funding allocated for it.

The RAA reiterates that a lack of systematic O&M will have a major impact on the sustainability of water infrastructure. Without proper prioritisation, training, and dedicated resources for routine maintenance, the risk of infrastructure deterioration and reduced effectiveness of water management initiatives is likely to increase.

3.8 National Adaptation Plan

The formulation of the NAP (National Adaptation Plan) of Bhutan started in 2019 and was completed in 2023 to safeguard the health, livelihoods, and well-being of Bhutan's people from climate change impacts by building adaptive capacity, enhancing resilience, reducing vulnerability, and integrating adaptation into development planning at all levels.

As part of the NAP Readiness Project, several activities were undertaken to facilitate the establishment of the NAP process and preparation of the NAP. The following technical reports, strategies, and guidelines were prepared to support the NAP process.

1. Guidelines for NAP Formulation Process in Bhutan, NAP Readiness Project, Thimphu 2020
2. Protocol for NAP formulation process in Bhutan, NAP Readiness Project, Thimphu 2020
3. Bhutan Climate Platform, Thimphu. NAP Readiness Project, Thimphu 2022
4. Skills Assessment for NAP Formulation Process in Bhutan, Thimphu, Bhutan, NAP Readiness Project, Thimphu 2020
5. Stakeholder Engagement Plan for NAP, NAP Readiness Project, Thimphu 2020
6. Stocktaking for Climate Change Vulnerability Analyses and NAP mapping for NAP Formulation Process in Bhutan, NAP Readiness Project, Thimphu 2020
7. Skills Assessment for Climate Change Vulnerability Analyses and NAP Mapping for NAP Formulation Process in Bhutan, NAP Readiness Project, Thimphu 2020
8. SDG Structured Dialogue, NAP Readiness Project, Thimphu 2020
9. A Roadmap and Strategy for Strengthening Climate Change Research in Bhutan 2021-2025, NAP Readiness Project, Thimphu 2020
10. Climate Change Vulnerability Analyses and Mapping for NAP Formulation Process in Bhutan, NAP Readiness Project, Thimphu 2022

The NAP contains five chapters covering (i) national circumstances and objectives for adaptation, (ii) an overview of climate projections, impacts, and vulnerabilities, (iii) a comprehensive list of adaptation needs and priorities for the country, (iv) an implementation strategy, and (v) a framework for monitoring and evaluation.

The total estimated budget for the NAP is USD 13.96 billion, which includes both detailed adaptation priorities (USD 13.94 billion) and enabling activities (USD 14.85 million). The

timeline for the implementation of the NAP is set over the short term (up to 5 years) and medium term (5-15 years), with ongoing reviews and iterations of the NAP planned throughout this period.

To support effective, accountable, and adaptive implementation of the NAP, the RAA assessed the existence and operationalisation of its risk management and monitoring & evaluation aspects.

3.8.1 Absence of risk management for NAP implementation

As per ISO 31000 (International Organisation for Standardisation), risk management is an important aspect as it fosters a shared understanding of risks, their nature, and effective ways to manage them. Rather than being purely reactive, it enables organisations to anticipate and address risks head-on, turning potential challenges into strategic advantages.

The ISO risk management framework includes the following processes:

- i. *Establishing the context:* Define the scope and objectives of risk management.
- ii. *Identifying risks:* Consider operational, financial, institutional, and external risks that could impact implementation.
- iii. *Analysing risks:* Assess the likelihood and impact of these risks using a standardised risk matrix.
- iv. *Treating risks:* Develop and implement mitigation strategies to address high-priority risks.
- v. *Monitoring and review:* Continuously evaluate the effectiveness of risk treatments and update the risk register as needed.

This framework emphasises structured, iterative processes and stakeholder involvement, making them effective for assessing risks in large-scale projects like NAP implementation.

Discussions between the RAA and the DECC confirmed that no established risk management framework is currently in place for NAP implementation. Furthermore, no risk management initiatives have been undertaken to anticipate or address potential risks.

The absence of risk management in the NAP implementation could lead to unforeseen challenges, delays, and inefficiencies that could impact the progress of NAP implementation. This could result in inadequate or wasted resource allocation, poor decision-making, and missed opportunities. Additionally, the failure to implement prioritised adaptation actions due to a lack of risk management may prevent the country from effectively addressing climate vulnerabilities, leaving critical sectors and communities exposed to increasing climate risks.

The DoW stated that while the NAP initially prioritised seven sectors, resource mobilisation efforts focused on three: water, energy, and irrigation. Subsequently, the focus was narrowed further, with water being the sole priority under the NAP.

3.8.2 Monitoring and Evaluation of NAP

To ensure effective implementation and accountability, the monitoring and evaluation (M&E) component of the NAP and its process was designed to meet both national and international

reporting requirements on adaptation, aligning with the Climate Change Policy of Bhutan 2020 and the Paris Agreement.

The M&E system for the NAP process in Bhutan covers three levels of processes:

- *Monitoring and evaluation of the NAP document:* This level involves tracking progress in implementing the adaptation priorities and enabling activities identified in the NAP.
- *M&E for National Reporting under Climate Change Policy:* It focuses on tracking and reporting adaptation actions at the national level in line with the national climate change policy.
- *M&E to support international reporting under the Paris Agreement:* This level focuses on enabling Bhutan to meet its obligations under the Paris Agreement by submitting Biennial Transparency Reports as part of the Enhanced Transparency Framework.

The RAA reviewed the institution of the M&E framework of the NAP document, considering the extensive efforts in its formulation, including technical reports, guidelines, and stakeholder engagement, to ensure progress in implementing adaptation priorities and enhancing resilience to climate change impacts.

For the M&E of the NAP document, the following modalities are to be used:

- i. Stock taking against priorities in the NAP Document
- ii. Consultation meetings or surveys guided by a framework for stock take
- iii. Annual reports to C4/NCCC and cabinet
- iv. Reports to funding agencies as required and appropriate

The timing of the M&E is as follows:

- i. Annual survey of progress or a stock take meeting to report on activities
- ii. A mid-term review in year 2.5 and completed by year 3 at the latest will inform the next phase of NAP
- iii. By year 4, preparations for the formulation of the next iteration of the NAP should begin based on the evaluation of reports from (i) & (ii)
- iv. By the end of year 5, the subsequent NAP must be ready (with short-term priority to 5 years and rolling priorities till year 10)
- v. At the end of year 5, evaluation of NAP
- vi. Align the stock-takes and reviews together with the preparation of BTR to reduce duplication of efforts
- vii. Post-project/post-NAP period review/evaluation after 2-3 years of the previous NAP for sustainability and impact

The DECC is responsible for initiating the M&E of NAP, with progress to be reported through the C4 to the NEC/NCCC. However, despite having a structured M&E framework developed, the RAA did not find any evidence showing the initiation of M&E activities.

Based on the established modalities and timelines of the M&E framework, an annual survey of progress or a stock-taking meeting to assess progress and report on activities should have been conducted. However, since the NAP formulation was completed in September 2023, no such review has been conducted. Additionally, while annual reports are required to be submitted to the C4, as noted in observation no. 3.1.1, the C4 is currently inactive. Although a mid-term review is planned, this has yet to be initiated despite over a year having passed since the NAP's completion.

The failure to initiate the M&E activities as planned may potentially undermine the effectiveness of the NAP. Without timely M&E, there is a risk of non-inclusion of vulnerable groups, private sector actors, and civil society, as well as neglecting gender considerations. Moreover, delays in the identification of gaps and issues in the adaptation process can further hinder the implementation of prioritised activities.

Such delays may ultimately compromise Bhutan's ability to systematically track progress, assess the impact of adaptation measures, and make necessary adjustments to strategies, thereby weakening the country's resilience to climate change.

The DECC shared that the department has initiated an adaptation stocktake in FY 2024-2025, collecting information for the implementation of adaptation projects from various ministries and agencies. Building on this initial effort, the Department is now working to formalise adaptation M&E through the support of the NAP Global Network and adapting the Japan Adaptation Monitoring and Evaluation System (JAMES) to our national context, with joint technical assistance from the Ministry of Environment, Japan, and the Institute for Global Environmental Strategies (IGES).

While the efforts of the Department demonstrate commitment to strengthening institutional capacity and integrating global best practices, the M&E system remains at an early stage and requires formalisation with clearly defined roles, responsibilities, and reporting mechanisms. Institution and operationalisation of the framework will be critical to ensure systematic tracking of adaptation outcomes, informed decision-making, and sustained progress toward enhancing Bhutan's climate resilience.

3.9 Early Warning Systems of GLOF

Glacial lakes are common features in mountainous areas formed as a result of glacial activities. The impact of climate change has triggered the rapid melting of glaciers worldwide, leading to a dramatic increase in GLOFs. Bhutan, due to its mountainous geography and with 17 Potentially Dangerous Glacial Lakes (PDGL) identified, is particularly vulnerable to these floods.⁹ The melting of Bhutanese mountain glaciers and the formation of glacial lakes as early as the 1940s were first reported in 2002¹⁰. GLOFs are among the most devastating catastrophes

⁹ Reassessment of Potentially Dangerous Glacial Lakes in Bhutan, 2019

¹⁰ Detailed Assessment Report on GLOF Hazard from Thorthormi Glacial Lake and Associated Glaciers, 2020

resulting from excessive glacier melt, causing damage to the lives and properties of people living in the downstream area.

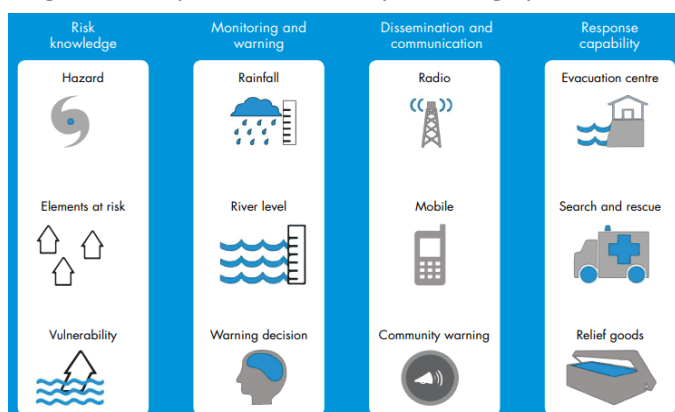
As per the Bhutan Glacial Lake Inventory (BGLI) 2021, Bhutan had experienced a total of 21 GLOFs in the past, and only 6 cases were reported in literature, while the remaining 15 were detected using field survey data. Bhutan experienced a massive GLOF in 1994, causing chaos downstream, taking the life of 20 people and damaging millions worth of infrastructure and properties, and is a testimony of the country’s vulnerability to such climate hazards.

To reduce the increasing impacts of disasters, including GLOF, the Platform for the Promotion of Early Warning (PPEW), an initiative under the International Strategy for Disaster Reduction (ISDR) framework, focuses on enhancing the effectiveness of Early Warning Systems (EWS).

PPEW states that ‘early warning and preparedness play a critical role in preventing hazardous events from turning into disasters. Clear warnings, received in time, coupled with the knowledge of how to react, can mean the difference between life and death, or between economic survival and ruin, for individuals and communities.’

To assist governments and communities in establishing people-centred early warning systems,

Figure 15: Key elements of Early Warning Systems



Source: NCHM

the Third International Conference on Early Warning (EWC III) under ISDR developed a checklist for Early Warning Systems. The checklist is structured around four key elements of effective early warning systems (Figure 15).

GLOF EWS is a service extended to the public by NCHM, as a part of civil contingencies, to help prepare, respond, and recover from GLOF events. The RAA reviewed the

GLOF EWS based on the four key elements of effective early warning systems and noted the following:

3.9.1 Risk knowledge

Risks arise from the combination of hazards and vulnerabilities at a particular location. Assessments of risk require the establishment of a systematic, standardised process to collect, assess, and share data, maps, and trends on hazards and vulnerabilities. The RAA noted the following:

- i. As per the checklist, the coordination of hazard identification, vulnerability, and risk assessment should ideally be managed by a single national organisation. In the context of Bhutan, as per section 67(b) of the Disaster Management Act of Bhutan, 2013, ‘an agency notified by the National Disaster Management Authority (NDMA) shall develop hazard zonation and vulnerability map’. Further, the Secretariat of

the National Disaster Management Authority is mandated to facilitate the formulation of hazard zonation and vulnerability maps by relevant agencies.

- ii. For GLOF, NCHM is responsible for the assessment and mapping of GLOF hazards. During discussions with NCHM, the RAA was informed that NCHM develops the hazard zonation map. However, currently, there is no agency to carry out the development of vulnerability maps for GLOF, which is a critical gap in the risk assessment process.
- iii. Section 31 of the Disaster Management Act requires that the Dzongkhag Disaster Management Committee “*prepare, review, update, and implement the Dzongkhag Disaster Management and Contingency Plan*” and “*ensure compliance with the approved hazard zonation and vulnerability map,*” indicating that these maps are essential reference tools for strategic planning and risk management efforts at the Dzongkhag level.
- iv. For the installation of the GLOF EWS in the Punakha Wangdue Valley for the Punatsangchu basin, initial activities such as site surveys, assessments, and land acquisitions were completed in 2009 as part of the hazard mapping process. However, the NCHM currently lacks an updated hazard zonation map to reflect the latest data and evolving risks. Despite the critical need for updated information to enable accurate and timely warnings for effective disaster management, efforts to revise and enhance the hazard zonation map have not yet been undertaken. Moreover, the initial document for hazard mapping is also not available, making it difficult to reference past assessments for decision-making.
- v. Punakha Dzongkhag staff during the awareness programme held by NCHM stated that the hazard map could be used as a supporting document for the rule against the construction along the river bank.

The lack of adequate risk knowledge stems from the absence of a well-defined strategy or plan for regularly revising and updating hazard data, as well as insufficient collaboration between NCHM and DLGDM in conducting vulnerability mapping. As a result, communities remain vulnerable by constructing infrastructure in the red zone area, response efforts are less effective, and both economic and social costs escalate, ultimately leading to preventable loss of life and property.

3.9.2 Dissemination and communication

Effective communication and dissemination systems must be developed and maintained to ensure that clear, simple, and useful warnings reach people and communities at risk of impending natural hazard events. These systems should enable proper responses that safeguard lives and livelihoods, and should also facilitate coordination and information exchange at the national and regional levels.

As per ISDR, it is essential that warning messages or alerts are recognised and understood by people and communities. To ensure this, the following checklist needs to be met.

- ✓ Warning alerts and messages tailored to the specific needs of those at risk (for example, for diverse cultural, social, gender, linguistic, and educational backgrounds).
- ✓ Warning alerts and messages are geographically specific to ensure warnings are targeted to those at risk only.
- ✓ Messages must reflect the values and concerns of those taking action (e.g., instructions for safeguarding livestock and pets).
- ✓ Warning alerts are recognisable and consistent over time and include follow-up actions when required. A study into how people access and interpret early warning messages was undertaken, and lessons learned were incorporated into message formats and dissemination processes.

The RAA, upon the review of the existing communication and dissemination systems for GLOF EWS, noted the following:

- i. The dissemination and communication of GLOF alerts includes two methods:
 - *The flow of information as per SoP:* The SoP for GLOF EWS installed in the Punakha Wangdue Valley outlines the flow of information when the siren is activated. As per the SoP, the Control Room staff are responsible for disseminating critical information to relevant stakeholders, including the GLOF focal person, DLGDM, and the Dzongkhag disaster focal person. These stakeholders further disseminate the information to the media, Gewogs, and vulnerable communities to ensure timely warnings.
 - *Siren activation:* When the siren activates, it serves as an urgent signal for immediate action by the communities at risk. Residents must respond swiftly to reach designated safe zones or evacuation areas.
- ii. It was noted that, as per the SoP, 18 sirens are installed along the river valley downstream to warn vulnerable communities. However, it does not provide clear guidelines to ensure that warning messages or alerts are easily recognised and understood by affected people and communities. There is no specific provision to address the needs of vulnerable individuals with special requirements, such as the elderly, children, and people with disabilities, who may require alternative means of receiving and responding to warnings.

For instance, while the SoP mentions sirens as the primary warning mechanism, it lacks details on the distinctiveness of the siren sound, making it difficult for communities to differentiate it from other emergency alerts, such as those from fire trucks or ambulances. Additionally, the SoP does not provide clear guidelines on how communities should interpret and respond to different types of warnings, which could lead to confusion and delays in taking appropriate action during an emergency.
- iii. This concern was confirmed during the RAA's interviews (para 3.7.4) with individuals and communities residing in the red zone of the Punatsangchu basin, where 113 out of 123 individuals were unaware of the siren sound, and many were unable to differentiate the siren from other common emergency sounds.

- iv. Similarly, while the SoP developed for GLOF in the Dzongkhag Disaster Management & Contingency Plan for Wangdue (2024) and Punakha (2019) contains the information flow and communication modes, mock drills are limited in testing their effectiveness, even though the plan also warrants regular mock drills.

Such issues can be linked to a lack of awareness and prevent the community's preparedness and timely action during an emergency, increasing the risk to life and property.

3.9.3 Monitoring and warning services

Warning services lie at the core of the system. There must be a sound scientific and technological basis for predicting and forecasting hazards and a reliable forecasting and warning system that operates 24 hours a day. Continuous monitoring of hazard parameters and precursors is essential to generate accurate warnings in a timely fashion.

The RAA, during the assessment, observed the following:

- i. A SoP for GLOF EWS Punakha-Wangdue Valley, 2021 was developed to ensure proper organisation, operation, and maintenance of the system, ensuring a well-standardised process and a proper institutional mechanism for all responsible staff to follow in delivering effective monitoring, detection, and issuance of a warning.
- ii. Section 5.2 (b) of the SoP specifies that *a duty schedule/roster shall be prepared for shift operations, with each shift lasting 8 hours per day. However, the In-Charge Control Room may prepare a duty roster based on manpower availability and other considerations.*

During the field visit to Wangdue, the RAA found that the control room operates with five staff, working 12-hour shifts to provide 24/7 monitoring of GLOF risks. The staff on duty shared that the schedule was especially challenging when covering shifts for those on leave.

- iii. Further, for effective monitoring and timely warnings, the system must be equipped with tools that are suited to local conditions. The Center also needs the analytical tools to process data and predict risks accurately. However, during the discussion with the officials from NCHM revealed several critical limitations:

a) *Control room*

- ✓ The DCS Toolkit and Tempest Hydro-Met Analysis System are operating at full capacity, with no updates or upgrades available.
- ✓ ICT facilities are deteriorating, affecting system efficiency and reliability.
- ✓ The DCS Toolkit lacks SMS alerting, offering only email alerting facilities.

b) *Filed Monitoring stations*

Most components, including sensors, power systems, and data loggers, are approaching the end of their operational life and require replacement. Additionally, frequent breakdowns at the monitoring station require regular maintenance.

c) *Operational*

In the development of effective EWS, reliability is essential. However, limited funding for operations and maintenance (O&M) forces trade-offs between maintaining system reliability and ensuring its long-term sustainability. The system, which is now over 10 years old, urgently requires updates and upgrades. Additionally, the EWS is detection-based and lacks forecasting capabilities, which limits proactive GLOF risk management.

Without adequate technologies and equipment, the NHCM faces challenges in achieving its core objective of providing reliable and timely GLOF warnings to safeguard life and property downstream.

3.9.4 Response capability

Setting up an early warning system alone doesn't automatically benefit at-risk communities; its value lies in ensuring that people are aware of its existence and understand how it can help them reduce the impact of GLOFs and rainstorm-induced floods. To achieve this, it's crucial to sensitise communities about the SoP, first, to raise awareness, and second, to teach them how to effectively communicate and respond during events like GLOFs or rainstorm floods.¹¹

While DLGDM is mandated to develop and implement public education, awareness, and capacity building programmes on disaster management, the NCHM, as outlined in the SoP, is also responsible for conducting public/stakeholders' education and awareness on the GLOF EWS regularly in coordination with the DLGDM.

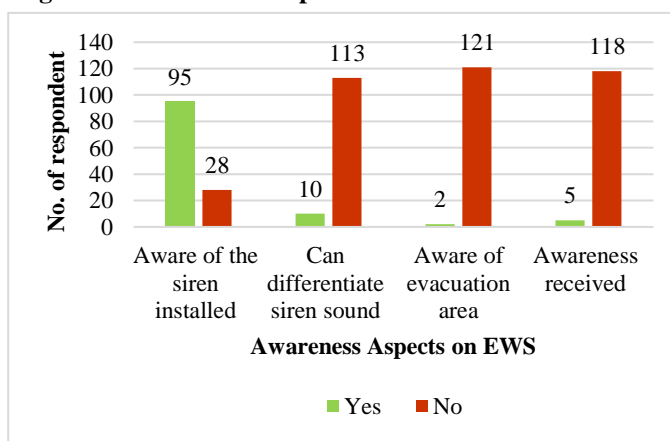
The RAA during the visit to Punatsangchu basin EWS and interviews with vulnerable communities residing in the red zones near the three installed sirens located at Khuruthang, Samthang, and Punakha Higher Secondary School, noted the following:

- i. The RAA interviewed 123 individuals who have been residing in the red zones, ranging from one year to as long as 50 years.

Figure 16 illustrates the level of awareness across different aspects of the EWS.

It indicates that a number of respondents (95) are aware of the sirens installed in their area. However, a large percentage of respondents (91.86%) are unable to differentiate the siren sound from other emergency sounds. Awareness

Figure 16: Awareness Aspects on EWS



Source: RAA's representation based on the interview

are unable to differentiate the siren sound from other emergency sounds. Awareness

¹¹ Report on Awareness on GLOF Rainstorm Flood EWS conducted for Punatsangchhu and Chamkhar-Mangde chhu Basin From June 17 to June 21, 2021

of evacuation areas is extremely low, with only 2 out of 123 respondents knowing the designated safe zones.

Above all, a significant portion of respondents (95.93%) did not receive any awareness or training related to the EWS.

- ii. In addition, communities are unclear about the specific purpose of the EWS, which is installed to warn them of GLOF risks. The GLOF EWS is specifically designed to monitor conditions at glacial lakes and rivers upstream, near glacier-fed lakes, to detect potential GLOF events. However, many residents believe that the EWS should also trigger during general floods caused by heavy monsoon rains or rising river levels.
- iii. *For instance*, several residents recounted that during the 2023 monsoon, the water level of the Phochu River rose close to their homes. When the EWS sirens did not activate, the residents assumed that the system was malfunctioning. This misinterpretation indicates a communication gap and a lack of public awareness efforts by the responsible authorities.
- iv. The NCHM also informed that there has been little to no awareness provided to the communities in recent years. As per the records, the last awareness programme on the GLOF and Rainstorm Flood EWS for the Punatsangchhu basin was conducted in 2021.

During this programme, the staff from Punakha Dzongkhag and disaster focal points, Punatsangchu Hydro Power Authority, and schools emphasised the urgent need for regular mock drills to educate communities on emergency response protocols. However, no mock drills have been conducted in the past three years. The last recorded drill was in 2019.

The lack of awareness and mock drills among the vulnerable communities is due to a lack of strategy to conduct awareness, and a lack of collaboration between DLGDM and NCHM in coordinating the awareness of GLOF and the EWS.

Without adequate public awareness and training, the effectiveness of EWS is undermined. During an emergency, residents may not be prepared to respond appropriately, leading to potential risk to loss of life and property damage.

NCHM informed that Center has conducted awareness programmes in 2024 and 2025 for the Punatsangchhu GLOF Early Warning System, including a recent mock drill in 2025. However, such activities are limited due to a lack of funding, as no annual budget is allocated for them.

The DLGDM stated that under a World Bank project on risk information for disaster resilience in Bhutan, a nationwide social vulnerability assessment has been conducted. During the current project period, specific areas at the Chiwog level are being covered, with NCHM and DLGDM serving as the implementing agencies, thereby ensuring collaboration.

In addition, the NCHM stated that they have updated all hazard maps, particularly for floods (does not differentiate between GLOF and other floods), noting that such maps become irrelevant when there are changes in the area due to reasons like constant flooding. Further, NCHM informed that they do not have the mandate to conduct a vulnerability assessment.

While RAA appreciates the initiatives undertaken by NCHM and DLGDM, such as awareness programs, mock drills, and hazard mapping to strengthen disaster preparedness, it reiterates that these efforts remain limited and fragmented, thereby increasing the risk associated with GLOF and flood preparedness.

3.10 Data Foundations for Climate Adaptation Actions and Resilience

Maintaining a comprehensive inventory of climate information and adaptation actions is essential to effectively address climate change. According to UNFCCC and World Bank, such an inventory facilitates tracking progress, identifying gaps, fostering collaboration, and securing funding, which are critical elements for building resilience.

3.10.1 Climate data

For effective climate action, the NCHM is required to maintain comprehensive information on climate change and its impacts. As highlighted in the *Analysis of Historical Climate and Climate Change projection*, accurate and timely hydro-meteorological information is essential for understanding climate patterns and their impacts.

The RAA, while reviewing the climate data, noted the following:

- i. World Meteorological Organisation (WMO) recommends a minimum of 30 years of data for assessing climate shifts or planning climate-resilient policies. For the formulation of Bhutan's National Adaptation Plan (NAP), this translates to a baseline climate period from 1960 to 1990. However, Bhutan's climate records only date back to 1996, limiting the ability to establish long-term climate trends.
- ii. In the recent 2024 climate change projections, it specifies that datasets spanning 50 to 100 years are required to ensure robust and reliable future climate projections, as they capture long-term trends and variability. However, Bhutan has only 27 years of station data. As a result, global climate datasets have been used, which may fail to capture local climate variations, reducing the accuracy of projections.
- iii. The NCHM also reported that the northern part of the country lacks climate data due to a limited number of hydromet stations. The difficult mountainous terrain restricts accessibility, resulting in inadequate monitoring of essential climate variables in these regions.
- iv. The NIMP outlines that Bhutan experiences the greatest variety of climates due to its wide altitudinal variations across short distances. As a result, the impact of climate change on irrigation and drinking water resources varies by location. However, the Irrigation Division informed the RAA that the hydro-meteorological stations, operated by NCHM, are located only at the Dzongkhag level. This limits the availability of localised data needed for effective water resource planning and adaptation measures.

- v. Additionally, officials from Wangdue Phodrang Dzongkhag shared that the current climate data did not fully meet their planning needs, as they require more localised data for effective planning of irrigation and drinking water resources. They also suggested specific location information for new weather stations to enhance data accuracy and relevance for these purposes.¹²
- vi. Similarly, officials from other Dzongkhags, including Samtse, Samdrup Jongkhar, and Pemagatshel, reported facing the same climate data challenges.

These issues stem from inadequate scientific and technical infrastructure, as well as limited skilled personnel within the NCHM, and there is a lack of collaboration between the NCHM, water agencies, and Dzongkhags in generating localised climate data.

Without sufficient historical and localised data, it becomes challenging to accurately assess climate impacts and develop targeted adaptation strategies to respond effectively to climate change issues. Ultimately, it impedes the efforts to build climate resilience and sustainability, particularly for vulnerable communities relying on climate-sensitive resources.

The NCHM explained that the national hydro-meteorological network operated by NCHM includes a hydrological network covering the main river basins and a Meteorological Network covering 20 Dzongkhag levels. Class C climate stations and Automatic Weather Stations (AWS) are installed and operated to fill data gaps in other areas. Due to mountain terrain, the density of the station network is limited. This limits the availability of detailed, localised climate and water data needed to address specific irrigation and drinking water needs across different regions.

The NCHM stated that they are currently working on generating area-specific gridded data from the existing data and plan to make it readily available on the climate data portal.

The DoID added that weather stations should be established for critical watersheds and in areas with higher user demand.

While NCHM's efforts to expand the hydro-meteorological network and generate area-specific gridded data are appreciated, the limited density of monitoring stations continues to constrain the availability of localised climate and water data essential for planning and managing irrigation and drinking water supply. The RAA notes that the absence of sufficient ground-based observation data, especially in critical watersheds and areas, limits data-driven adaptation strategies to respond effectively to climate change issues.

3.10.2 Inventory of climate change adaptation actions

The Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report (AR6), emphasises that effective adaptation efforts are essential for managing the climate-related risks, particularly in vulnerable regions such as Bhutan. To effectively formulate adaptation strategies, Bhutan's Second National Communication highlights the importance of maintaining

¹² Report on Awareness on GLOF Rainstorm Flood EWS conducted for Punatsangchhu and Chamkhar-Mangde chhu Basin From June 17 to June 21, 2021

an improved environmental and climate database and enhancing resilience against climate change.

Moreover, Technical Guidelines for the NAP process highlight the importance of compiling information on climate adaptation actions. It provides essential insights into the benefits of specific measures and lessons learned, offering guidance for future adaptation planning. Such documentation not only supports decision-making but also ensures the sustainability of adaptation efforts.

Upon the review of the adaptation actions implementation, the RAA noted the following:

- ✓ As part of its reporting requirements under the UNFCCC, DECC has submitted various reports and communications till 2022 as detailed in Table 6.

Table 6: Report/communication submitted by DECC to UNFCCC

Report/Communication	Report Date
1 st National Communication	2004
2 nd National Communication	2011
3 rd National Communication	2020
Biennial Update Report (BUR)	2022
1 st Nationally Determined Contribution	2015
2 nd Nationally Determined Contribution	2021

Source: UNFCCC

The report/communication documents identified the key adaptation actions as stated below:

- The 1st NDC identified 10 priority areas for adaptation.
 - The 2nd NDC and BUR indicate that climate change has been integrated into development planning with "Climate Neutrality, Climate, and Disaster Resilience" as an NKRA in the 12th FYP.
 - The 3rd NAPA project, funded by the LDCF, aimed at enhancing resilience in forest and agricultural landscapes (2017-2023), building on the 2nd NAPA, which focused on addressing climate-induced disaster risks (2014-2019).
 - The Local Climate Adaptive Living Facility (LoCAL) programme, piloted and expanded to cover 100 Gewogs, is planned to scale up to all 205 Gewogs.
 - The formulation of a NAP, with GCF support, was completed in 2023.
 - The 2nd NC identifies key vulnerabilities and adaptation needs across multiple sectors, including water resources, forests and biodiversity, agriculture, energy, human health, and glaciers.
- ✓ As required in the CCP and other environmental laws, the Bhutan State of the Environment Report 2022 highlights the implementation of NAPA and the formulation of NAP.

Despite the progress in adaptation planning and reporting, the RAA identified shortcomings in maintaining a comprehensive inventory of climate adaptation actions:

- i. There is an absence of a centralised system for recording and tracking adaptation efforts across different sectors and levels of governance. Currently, reporting mechanisms focus on program- or project-specific actions, with no unified approach tailored to Bhutan’s context for systematically recording and reporting all adaptation actions.
- ii. For instance, while the NAP document provides a structured format for documenting adaptation actions, strategic action, short-term activities, medium-term activities, KPIs, lead agency, collaborating partners, and estimated costs, this approach has not been uniformly adopted across all adaptation initiatives. Consequently, many adaptation measures remain undocumented, particularly those implemented by LGs and agencies outside Bhutan’s official climate commitments.
- iii. *For instance*, the Strategic Programme for Climate Resilience (SPCR) under the PPCR, implemented to address climate risks and institutional adaptation gaps, with the support of the Climate Investment Fund, lacks a centrally maintained inventory. Information on activities under projects like “Building Climate Resilience through the Enhancement of Hydro-Meteorological and Cryosphere Information” and “Strengthening Climate-Resilient Management of Targeted Watersheds and Water Sources” is fragmented across project management units and implementing agencies instead of being consolidated at a national level.
- iv. Although the 12th FYP integrated climate change considerations into the NKRA for "Climate Neutrality, Climate, and Disaster Resilience," specific adaptation measures implemented under this framework are not documented. There is no central inventory of climate-related initiatives under NKRA with the DECC.
- v. During discussions with the Chief Engineers of selected Dzongkhags, the RAA learned that there is no established system for recording and reporting climate risk adaptation actions related to the development of drinking and irrigation schemes. The engineers were, therefore, unaware of any reporting requirements for such actions.
- vi. Additionally, Dzongkhag Environment Officers do not collect data on climate action initiatives since there is no proper direction from the Department on this matter.

The absence of a central repository for climate adaptation actions can be attributed to a lack of established mechanisms to enforce CCP requirements, which resulted in agencies not reporting their climate actions. This is compounded by the lack of effective tracking and limited oversight by the DECC and the relevant committees. Further, there is the absence of coordinated and collaborative efforts from DECC as the focal agency for climate change.

Without a central repository for climate adaptation actions, Bhutan will face difficulties in tracking progress, evaluating climate resilience efforts effectively, and making informed decisions.

3.10.3 Data repository of losses and damages caused by climate impacts

Loss and damage of climate impacts can be categorised into economic losses, which include the loss of resources, goods, and services commonly traded in markets, and non-economic

losses, which refer to intangible impacts such as cultural heritage, health, and biodiversity that are not typically valued in market transactions (Assessment Report 6, IPCC).

At COP27 in 2022, countries agreed to establish a Loss and Damage Fund to provide financial assistance to nations most affected by climate change, addressing the concerns of climate-vulnerable countries. This initiative aims to combat the losses and damages that threaten the poorest populations, potentially leading to poverty traps.

This is particularly relevant for countries like Bhutan, which are highly vulnerable to climate-related risks but have contributed minimally to global greenhouse gas emissions. This concept ties into the broader idea of climate justice, recognising that those least responsible for climate change often suffer its most severe consequences. The fund was operationalised at COP28 in November 2023, marking a historic agreement to deliver financial resources to assist developing nations.

The eligibility criteria to get financial assistance for addressing loss and damage resulting from climate change impacts include:

- Establishment of a robust and universally endorsed system for recording loss and damage to accurately quantify countries' climate-related losses and present their needs for financial support transparently.
- According to a report by the UNDP, many countries already maintain disaster loss and damage data systems, which track hazardous events and their consequences. These systems can be leveraged for estimating future risks and losses.

The RAA learned from the DECC that Bhutan currently does not have a framework to capture losses and damages, which is essential for accessing the fund. While the DECC plans to collaborate with international and relevant agencies to develop it, the activity is not prioritised in the 13th FYP.

The RAA, on further review, noted that DLGDM maintains disaster-related information in the Disaster Management Information System (DMIS), and DLGDM indicated that the system has the potential to extract information related to loss and damage. However, no actions have been taken to develop a climate-specific loss and damage database utilising the DMIS data.

Without efforts to establish loss and damage data, Bhutan may lose the opportunity to have access to the Loss and Damage Fund, as financial support is contingent upon countries demonstrating their needs through robust and comprehensive data.

The DLGDM stated that the old Disaster Management Information System is tabular and not user-friendly, and as a result, the system is becoming obsolete. However, under the same project, a multi-hazard risk decision support system is being developed to serve as a repository and platform for data sharing.

CHAPTER 4: RECOMMENDATIONS

Based on the audit findings, the RAA has developed the following recommendations to address gaps and challenges identified during the review. The relevant agencies may review the relevancy and appropriateness of these recommendations for implementation and also note that there may be better alternatives to address the shortcomings. As such, the recommendations are not intended to restrict the ability of policy and decision-makers in their decision-making or to select better alternatives to address the issues reflected in this report.

The recommendations are as discussed below:

4.1 The DECC should coordinate and support NCCC to strengthen the implementation of the Climate Change Policy (CCP).

While the institutional framework for climate change coordination through the NCCC, C4, and DECC is well-established under the CCP, its implementation remains limited due to the absence of a CCP Action Plan and the non-functioning of the C4. The lack of monitoring and reporting mechanisms has resulted in fragmented actions and limited accountability among implementing agencies. To address these gaps, the DECC, in collaboration with the NCCC, should strengthen the implementation of CCP. Particularly, the following actions are recommended:

- i. Assess the current status of the CCP Action Plan's development, including the reasons for any delays or halts, and determine whether the development of the CCP Action Plan is still necessary;
- ii. The functionality of C4 should be reinforced, as intended in the CCP, to ensure effective coordination, regular monitoring, and timely reporting of progress by all relevant agencies; and
- iii. Establish a systematic reporting and follow-up mechanism to ensure coherent and timely reporting, and accountability among agencies, with DECC and C4 playing the central roles in this process.

These measures will help streamline efforts, ensure better coordination, and facilitate a more effective national approach to climate change mitigation and adaptation.

4.2 The DoW and DoID should strengthen institutional linkages with water-related agencies to improve coordination in planning and implementation of drinking and irrigation activities.

Despite efforts to consolidate water-related functions under the Department of Water (DoW), water resources management remains fragmented, with ministries and local governments (LGs) operating in silos.

The RAA noted that LGs implement water projects without routing proposals through DoW, and water source assessments are often carried out by the Department of Infrastructure Development (DoID) or Dzongkhag engineers without DoW's technical input, leading to overlapping roles. DoW also lacks sufficient staff and resources to conduct nationwide water

source assessments or manage watershed and springshed activities at the local level. Additionally, the adoption of innovative and climate-resilient water technologies remains limited, with most infrastructure relying on conventional systems.

Therefore, the DoW and DoID should strengthen the coordination mechanism to improve climate change adaptation in the planning and implementation of drinking and irrigation activities. Specifically, in the following areas:

- i. The DoW and DoID should establish a clear coordination mechanism to implement their respective mandates and align with the IWRM principle, ensuring coordinated efforts, avoiding duplication, and preventing any gaps in implementation.
- ii. The DoW should collaborate with DoID and LGs in water source assessments and management.
- iii. The DoW should formalise collaboration arrangements with DoFPS and/or LGs for the O&M of watershed and springshed management activities to ensure sustainability.
- iv. The DoW should update and enhance the existing Water Roadmap by incorporating emerging water technologies to strengthen climate resilience and promote sustainable water management at all levels of implementation.

4.3 The DECC should ensure coordinated actions for adapting to the impacts of climate change.

The DECC, as the focal agency for climate change, is responsible for coordinating actions to adapt to climate change impacts. Although DECC has successfully developed Bhutan's first NAP and fulfilled the national and international reporting obligations, there remain gaps in its coordinating and monitoring efforts. DECC lacks awareness of whether or to what extent central agencies and LGs have integrated adaptation actions into their development plans, and the Dzongkhag Environment Officers have limited involvement in climate-related functions of the CCD. There is little cross-sectoral coordination, inadequate technical and capacity support, and no systematic monitoring or reporting of adaptation progress. The current awareness efforts are sporadic, and they lack comprehensive records or data tracking for their awareness activities.

To ensure the coordinated and effective implementation of climate adaptation actions, the DECC should strengthen its role as the central coordinating agency for climate change by:

- i. *Enhancing technical support*: Providing specialised guidance and capacity-building initiatives to DoW, DoID, and LGs for implementing adaptation measures;
- ii. *Fostering cross-sectoral collaboration*: Promoting collaboration among government departments, the private sector, and civil society to align efforts and ensure comprehensive climate action. Specifically, for water agencies such as the DoW, DoID, and LGs;

- iii. *Strengthening the role of Dzongkhag Environment Officers:* Equipping Dzongkhag Environment Officers to support climate change functions at the district level, expanding their role beyond waste management and clearances;
- iv. *Improving monitoring and reporting:* Establishing robust reporting and monitoring systems for tracking progress, evaluating outcomes, and ensuring transparent reporting of climate change actions at all levels, and report to C4/NCCC;
- v. *Developing a clear strategy for awareness programs:* Designing and implementing a comprehensive strategy for climate change awareness and outreach that effectively engages the public, key stakeholders, and decision-makers.

The DECC should further coordinate and collaborate with DoW and DoID to enhance the reach and impact of awareness programs, ensuring effective implementation at all levels.

4.4 The DECC should establish mechanisms to ensure that the intent and priorities of policies and legislations on climate adaptations are mainstreamed into national and sectoral policies and plans.

The review of relevant Acts, policies, and plans related to water found that while most documents acknowledge the impacts of climate change and the need for adaptation strategies, their practical integration and enforcement remain weak. Additionally, key legislative instruments recognise climate risks and incorporate strategies such as integrated water resource management, watershed protection, and environmentally sustainable water infrastructure. However, most of these frameworks were developed over a decade ago and do not reflect recent climate challenges or emerging needs such as springshed revival, multi-purpose water use, digitisation, and nature-based solutions. The dissolution of the Mainstreaming Reference Group and the limited role of Environment Officers in integrating climate concerns into local plans further constrain effective mainstreaming. This is further exacerbated by the lack of clear reporting requirements on implementation status to the reporting authority.

Despite recognition of the importance of mainstreaming climate change in various Acts, rules, policies, and plans, there remain gaps in translating this priority into concrete plans and programmes by implementing agencies. This gap increases the risk of greenwashing, where climate-related commitments remain largely rhetorical.

Therefore, DECC should establish mechanisms to mainstream climate change actions into sectoral policies, plans and programmes to ensure that climate actions translate from policy commitments into measurable outcomes, thereby reducing the risk of greenwashing.

4.5 Agencies should strengthen institutional capacity for effective implementation of climate actions.

The RAA noted challenges and gaps in the institutional capacities of agencies involved in water-related functions, which hinder the effective implementation of climate actions. Agencies lack adequate human resources, technical expertise, and technological tools necessary to plan, coordinate, and execute adaptation measures. To effectively plan and implement climate actions, agencies need to strengthen their institutional capacities by

ensuring adequate human resources, skills, knowledge, and appropriate technology to address climate risks. To this, the RAA recommends initiating the following actions:

4.5.1 NCHM

NCHM should conduct a comprehensive training needs assessment to identify skill gaps and develop strategies to address these skill gaps. Additionally, the NCHM should prioritise efforts to address the ongoing challenges related to the lack of technical infrastructure and the timely upgradation of the existing technologies.

4.5.2 DECC

In order to enhance monitoring and coordination, reporting, and implementation of integrated climate actions, DECC should:

- i. Develop strategies to enhance skills and knowledge;
- ii. Identify human resource gaps and devise strategies to address these gaps;
- iii. Develop knowledge transfer processes such as documentation and regular knowledge-sharing sessions;

4.5.3 DoW

To carry out the mandates effectively, the DoW should develop HR strategies focusing on the recruitment of professionals with a water engineering and hydrological background and targeted capacity-building programmes for the development of sustainable water management practices.

4.5.4 DoID

To address the HR capacity issues, DoID should:

- i. Formulate strategies focusing on developing specialisations in climate-resilient infrastructure and enhancing skills & knowledge;
- ii. Devise strategies to address HR shortages.

4.5.5 All agencies (DECC, DoW, DoID)

Agencies should exchange knowledge and expertise among themselves and collaborate with relevant institutions when needed, while tapping into the specialised skills and resources of colleges and academic institutions to strengthen institutional capacity for the effective implementation of climate actions.

4.6 The DECC, in collaboration with DMDF, should collaborate to explore and implement innovative financing options that enhance funding for climate initiatives.

The RAA noted that Bhutan faces significant challenges in securing adequate and sustained financing for climate change adaptation initiatives. While international climate finance has been a major funding source, domestic financial resources remain limited, and private sector contributions are notably absent. Furthermore, Bhutan's recent graduation from Least

Developed Country (LDC) status has reduced its access to concessional climate funds, compounding the financial gap.

This funding gap poses a major barrier to effective climate action and achievement of the NAP targets, as the estimated adaptation costs exceed available resources.

To bridge the funding gap and enhance the effectiveness of climate action, the following actions are proposed:

- i. Expedite the completion of the resource mobilisation strategy to attract additional climate finance beyond traditional donors and development partners.
- ii. Engage with accredited National Implementing Agencies, international donors and partners, as well as domestic and private sectors, to diversify and secure funding for climate initiatives.

4.7 The DECC, in collaboration with RUB, should review and operationalise the Roadmap and Strategy for Strengthening Climate Change Research in Bhutan.

A Roadmap and Strategy for Strengthening Climate Change Research was developed in November 2020 to address the fragmented and inconsistent nature of climate research in the country. However, its activities and milestones have not been implemented. While the RUB has conducted research in collaboration with certain government agencies, these efforts were not part of the roadmap's initiatives. As a result, the research roadmap remains unimplemented.

Therefore, the DECC should take the lead in operationalising the climate research roadmap to foster a more coordinated and systematic approach to climate research. This will enhance institutional capacity, promote collaboration, and provide actionable data to support evidence-based climate action.

4.8 The DoID, in collaboration with the Dzongkhag Engineering Sector, should ensure the prioritisation and effective implementation of adaptation actions for drinking water and irrigation at the local level.

The RAA noted that although the DoID is responsible for promoting capacity development in innovative planning, design, and construction, Dzongkhag engineers and technicians have limited formal training and technical expertise in water infrastructure planning and climate-resilient design.

Further, adaptation actions for drinking water and irrigation infrastructure remain reactive and project-specific, driven by immediate developmental needs rather than long-term climate resilience. The common response has been to use alternative sources (springs, streams), which are also vulnerable to drying up, without systematic seasonal yield assessments or springshed management.

Pump systems, though adopted in some cases, face challenges of frequent breakdowns, high electricity costs, and underutilisation. Moreover, existing infrastructure often lacks climate-resilient design, with frequent damage from floods and landslides, while outdated design manuals fail to incorporate climate risks.

To ensure prioritisation and effective implementation of adaptation actions for drinking water and irrigation at the local level, the following actions are recommended:

- i. DoID should ensure that the planning and prioritisation of drinking water and irrigation projects at the local level are guided by climate risk and vulnerability assessments carried out by the DoW;
- ii. Establish a coordination with the Dzongkhag Engineering Sector to ensure and monitor compliance with the guidelines for climate-resilient infrastructure in the planning and design of drinking water and irrigation projects at the local government level;
- iii. Revise and update the Design Manual for Rural Water Supply (1998) to incorporate climate change projections, risks of extreme events, and the use of durable materials suited for changing climate conditions; and
- iv. Build technical skills of the Dzongkhag engineers and technicians in terms of climate-resilient infrastructure and water management technologies.

4.9 The DoW and DoID should strengthen the O&M of drinking water and irrigation systems.

The RAA noted issues related to O&M of drinking water and irrigation schemes, including unregistered or inactive WUAs, inconsistent and reactive maintenance of infrastructure, and absence of a standardised O&M manual.

Additionally, there is minimal technology integration, with tools like IoT systems often being non-functional. Capacity building is also lacking, with no regular training for WUAs and insufficient technical support.

In order to build sustainable, climate-resilient water infrastructure through regular maintenance, the following actions are recommended:

- i. The DoID, in collaboration with DoW and LGs, should develop an O&M manual, especially for large and complex drinking water and irrigation projects, to ensure consistent, systematic maintenance and operational procedures;
- ii. The DoW, in collaboration with the DoID and LGs, should facilitate the adoption of water-friendly and efficient technologies for water use and conservation, such as IoT systems for real-time monitoring and efficient drinking water and irrigation systems; and
- iii. The DoW, in collaboration with DoID and LGs, should provide regular user training and technical support to WUAs to carry out O&M efficiently.

4.10 The DECC should implement a comprehensive risk management and Monitoring & Evaluation process for the National Adaptation Plan of Bhutan.

Currently, the National Adaptation Plan (NAP) lacks a formal risk management framework. In the absence of a structured process to identify, assess, and mitigate risks, the NAP is exposed to potential challenges such as implementation delays, resource misallocation. These issues could hinder the plan's effectiveness and compromise the country's ability to adapt to climate

change. Moreover, although an M&E system has been established, no related activities have been initiated.

Therefore, the DECC should establish a structured risk management process to identify, assess, and mitigate potential risks while ensuring timely implementation of M&E activities, including stock-takes, progress surveys, and mid-term reviews, to enhance the effectiveness and resilience of the NAP.

4.11 The NCHM and DLGDM should strengthen the GLOF EWS.

The GLOF Early Warning System in Bhutan faces significant challenges, including outdated hazard zonation and vulnerability maps, ineffective communication systems, and ageing technology that hinders reliable monitoring and forecasting. The sirens used in alerting communities are not clearly distinguishable from other emergency sounds, and many residents lack awareness of how to respond. Additionally, the absence of updated public awareness programs and mock drills leaves communities unprepared for potential GLOF events, diminishing the effectiveness of the system.

These issues, including poor risk knowledge, communication breakdowns, and inadequate community training, reduce the EWS's ability to protect lives and property during emergencies.

Therefore, to strengthen the GLOF EWS, the following actions should be undertaken:

- i. NCHM and DLGDM should establish a coordinated mechanism for developing and regularly updating hazard and vulnerability maps in order to enhance the ability to address disaster risks effectively and support the planning and implementation of targeted adaptation measures;
- ii. NCHM should focus on addressing the gaps in technical infrastructure and ensure the timely upgrade of existing technologies to enhance the effectiveness and reliability of the GLOF EWS;
- iii. DLGDM, in collaboration with NCHM, should conduct regular awareness programs and mock drills for vulnerable communities to ensure they are well-prepared to respond not only to GLOF threats but also other floods and landslides, ultimately enhancing the EWS's ability to protect lives and livelihoods.

4.12 The NCHM and DoW should collaborate in generating local-level climate data based on areas of critical importance.

Currently, the hydro-meteorological stations operated by NCHM are located only at the Dzongkhag level, limiting the availability of detailed, localised climate and water data needed to address specific irrigation and drinking water needs across different regions. Stakeholders indicated that the current climate data is insufficient to meet their planning needs, as more localised information is required for effective water resource management.

Since the DoW is responsible for assessing hydrological trends, impacts, and associated risks due to climate change, the NCHM should collaborate with DoW to generate localised climate data based on areas of critical importance. Such data would enhance the accuracy and relevance

of data, thereby strengthening climate risk and vulnerability assessments and improving the planning and management of irrigation and drinking water resources at the local level.

4.13 The DECC should maintain a central repository for climate adaptation actions.

As part of its reporting requirements under the UNFCCC, DECC has submitted various reports and communications up to 2022. However, the reporting at both national and international levels primarily focuses on program or project-level actions. Adaptation actions implemented at both the national and local levels by various agencies, based on their mandates and requirements, as well as donor-funded projects that are not part of official commitments, are not systematically reported or collected by DECC. The RAA also observed that there is no established system for recording and reporting climate risk adaptation actions related to the development of drinking and irrigation schemes at the dzongkhag level.

To effectively formulate adaptation strategies and enhance resilience against climate change, the DECC should establish and maintain a central repository for climate adaptation actions. This will ensure comprehensive tracking and reporting of all adaptation initiatives across different levels and sectors.

4.14 The DLGDM, in collaboration with the DECC, should develop a Loss and Damage Data Repository.

The Loss and Damage Fund provides financial support to climate-vulnerable nations, like Bhutan, which face significant climate risks despite contributing minimally to global emissions. To access assistance for addressing climate-related losses, Bhutan needs a Loss and Damage Data Repository.

Although the DLGDM maintains disaster data in the Disaster Management Information System (DMIS), no climate-specific loss and damage database has been developed.

Therefore, DLGDM, in collaboration with DECC, should expedite the development of a Loss and Damage Data Repository to better track and report climate-related losses and damages. This will enable more effective access to financial support and enhance resilience against climate impacts.

CHAPTER 5: CONCLUSION

Climate change is already underway, and urgent adaptation actions are needed to reduce its impacts. In Bhutan, where fragile ecosystems are highly vulnerable, climate change contributes to 36.5% of the drying up of water sources. Recognising this, the RAA conducted a performance audit on the effectiveness of climate change adaptation actions in water resources management, focusing on drinking and irrigation water, including the GLOF EWS.

The audit findings reveal that Bhutan has made some progress in addressing climate change impacts on water resources management, particularly through the development of the National Adaptation Plan (NAP) and upholding its international commitments. However, significant gaps remain in both governance and implementation of adaptation actions. The current governance framework is marked by fragmented responsibilities, limited technical capacity, and inadequate institutional coordination, which hinders effective oversight and comprehensive climate adaptation. The absence of functional coordination mechanisms, such as the C4, along with unclear reporting and monitoring processes, further impedes the implementation of coordinated and comprehensive adaptation actions. Additionally, gaps in resource mobilisation, institutional capacity, and the integration of climate change considerations into policies and legislation exacerbate these challenges.

In terms of effective implementation of adaptation actions, particularly in the areas of drinking and irrigation water, it has been driven more by immediate developmental needs than by systematic climate risk assessments and vulnerability assessments. Additionally, the adoption of innovative water technologies at the local level remains limited. This reactive approach, coupled with outdated infrastructure, high repair costs, and inadequate O&M practices, undermines the long-term resilience of water systems. Regarding GLOF EWS, outdated hazard maps, and inadequate community preparedness were noted.

At the national level, the lack of risk management efforts and the absence of monitoring and evaluation activities for the National Adaptation Plan undermine the country's ability to ensure adaptive and resilient water resources management.

In conclusion, the audit findings underscore the need for enhanced climate change adaptation efforts in Bhutan's water resources management. The RAA provided 14 recommendations in an effort to address these challenges. Implementing these recommendations is expected to foster more coordinated, effective, and sustainable climate adaptation strategies, ensuring that water resources management aligns with national development goals and contributes to a stronger, more resilient future in the face of climate change impacts.

Appendices

Appendix-I: List of drinking water and irrigation schemes assessed by the RAA

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
1	Khasadrapchu HS water Source	Drinking	Khasadrapchu	Maedwang	Thimphu	Source drying up	i. No proper weir structures ii. No proper filtration at the intake point	Fencing around the water source
2	Wakila water source	Integrated	Sisina	Maedwang	Thimphu	Source drying up		i. Opted for an alternative source ii. Additional FCR Tank constructed iii. Water release is time- based
3	Wolona water source	Integrated	Namseling	Maedwang	Thimphu	Source drying up	i. No proper weir structures ii. No proper filtration at the intake point iii. Water seepage at the source	i. Reservoir tank constructed (200,000-litre) to manage water for irrigation (not in use due to water shortage)
4	Debsi water project	Drinking	Debsi	Chang	Thimphu	No issues		Use of weir, intake, sand trap, stream crossing, river crossing, non-return valve, reservoir tanks and BPT
5	Tshoshing Tsawa RWSS	Drinking	Jukar	Doteng	Paro	Source drying up		i. Opted for an alternative source ii. Fencing around the water source

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
6	Jagar Chasho Irrigation scheme	Irrigation	Jabi Lochoe, Jib Duezhim, Changchu Karp	Doteng	Paro	No issues	Water leakage	
7	Hoshpang RWSS	Drinking	Khuduphu	Dop Shari	Paro	Source drying up	Continuous blockage of pipes due to lack of filtration	i. Opted for an alternative source ii. Private water pumps
8	Richulum water scheme	Integrated	Jukar, Kempa, Shari rinchendhing	Dop Shari	Paro	Source drying up		Water usage is based on a rotational schedule
9	Chumina water source	Drinking	Bara	Shaba	Paro	Source drying up		i. Opted for an alternative sourceii. Zinc alum tank (14000 L)
10	Tenchikha RWSS (Khariphu water source)	Drinking	Tenchikha	Dogar	Paro	Source drying up	water seepage at the source	Groundwater (currently dried up)
11	Tsiphu RWSS (Nebu water source)	Drinking	Tsiphu	Dogar	Paro	Source drying up	water leakage	
12	Tshomen Tsawa water source	Drinking	Tsenjo	Tsento	Paro	Source drying up		i. Constructed reservoir tank ii. Fencing around the water source
13	Domdihoka water source	Drinking	Tsendona	Tsento	Paro	Source drying up	No proper filtration at the intake point	
14	Begulu water source	Drinking	Jangteyna and Nakha	Wangchang	Paro	Source drying up		Fencing around the water source
15	Shingkhana Irrigation	Irrigation	Shingkhana	Wangchang	Paro	No issues	Pump system failed	Use of Pump System

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwoq/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
16	Geptey water source	Drinking	Geptey	Wangchang	Paro	Source drying up		i. Constructed reservoir tank ii. Fencing around the water source
17	Biru Sipsoo irrigation channel	Integrated	Sipsoo	Trashicholing	Samtse	No issues	i. Water seepage at the source ii. Frequent blockages and landslide-induced washouts in the irrigation channel	i. water weir and intake relocated ii. Replaced HDPE pipes (buried underground) from the open channel.
18	RSPN RWSS	Drinking	Dungkar and Sonakha	Yoesel-tse	Samtse		i. Water seepage at the source ii. Frequent pipe bursts due to water pressure	
19	Lamitar irrigation scheme	Irrigation	Jidhigang and Jimithang	Yoesel-tse	Samtse	Source drying up		
20	Kuchi Diana Irrigation scheme	Irrigation		Yoesel-tse	Samtse	Source drying up		Water diversion towards the channel (High water levels once flowed into the channel, but now they no longer reach it due to the decrease)
21	Gola RWSS scheme	Drinking	Gola town	Trashicholing	Samtse	No issues	Pipes washed away due to landslides	infrastructures were restored
22	Chunpatang irrigation scheme	Irrigation	Dechengang	Ogyentse	Samtse	Located below the cultivation area	The pump system has been repaired 4-5 times but is currently non-functional	Construction of Irrigation pump system
23	Thraykhola Irrigation scheme	Irrigation		Norbugang	Samtse	No issues	i. Water source damaged due to landslide ii. Pipe burst	A pressure-free flow system is used

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
24	Singyegang Irrigation Scheme	Irrigation	Singyegang	Trashicholing	Samtse	No gravity source (source located below the cultivation area)	Breakdown of pump system	Maintenance improved functionality and significantly reduced the electricity bill.
25	Chukarpo water source	Integrated		Langchenphu	Samdrup Jongkhar	No issues	i. Previously, due to frequent landslides, the community did not have adequate structure and water for drinking and irrigation. ii. The current structure built at the water source is filled with debris and sand indicating design failure. Due to this, there is little or no flow of water towards the intake point.	Weir and intake built
26	Namchazor irrigation scheme	Irrigation	Namchazor and Jangsa	Langchenphu	Samdrup Jongkhar	No issues	Pipeline washed away by flood	dependent on rainwater
27	Jangpani Source	Integrated	Jangpani	Langchenphu	Samdrup Jongkhar	Source drying up		
28	Rongchuthang chhu	Integrated	Rongchuthang	Langchenphu	Samdrup Jongkhar	No issues	frequent landslide at the source	clearing slips whenever required using JCB
29	Omshari Landmark irrigation project	Irrigation	Raling, Pemathang, Chirtosha, Metothang	Pemathang	Samdrup Jongkhar	No issues	main pipeline from the water source has been washed away by erosion	the same pipeline restored
30	Wooling RWSS	Drinking	Wooling	Orong	Samdrup Jongkhar	Source drying up		Opted for an alternative source

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
31	Kulung integrated irrigation scheme	Irrigation	Nang, Raling, Kulung, Yangri	Kulung	PemaGatshel	Source drying up	Pipes damaged due to farm road construction	i. Opted for an alternative source ii. New FCR Tank build
32	Pump system for Shumar Gewog	Integrated	Gongphu, Sharli, Gamung	Shumar	PemaGatshel	Source drying up	i. The pump system, although functional, has not been operationalised due to internal conflicts within the community. ii. Rainwater collection	Use of Pump System
33	Khonmaree pump system	Integrated	Gonpa singma, Ngangmalang, Zobel	Zobel	PemaGatshel	Source drying up	Reluctant to use water pump due to high electricity charges	i. Use of Pump System ii. Rainwater collection
34	Pump system for Yongla Goenpa	Drinking	Yongla	Zobel	PemaGatshel	No gravity sources (Located above the water source)		Use of Pump System
35	Laring RWSS	Drinking	Gakidling	Gakidling	Sarpang	No issues	Pipes washed away due to landslides	Pipes restored
36	Landmark water project	Drinking	Gelephu and Samtenling	Gelephu	Sarpang	No issues		Consideration of landslide-prone areas, mainline re-routed and buried 5 ft deep, structure development blended with nature
37	Construction of Gaden Irrigation Channel	Irrigation	Gaden and Rijug	Umling	Sarpang	No issues	A portion of irrigation channel washed away	Switched to RCC canal from earthen

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
38	Gaden and Rjug RWSS	Drinking	Gaden and Rjug	Umling	Sarpang	Source drying up		i. Opted for an alternative source ii. Using multiple source (both old and new)
39	Semjong Drinking water and dry land irrigation	Integrated	Dangrigang	Semjong	Tsirang	Source drying up	Smart irrigation is non-functional	i. Opted for an alternative source ii. GI pipes, RCC tank, sand or silt trap, gravel trap, reservoir tanks, BPT ii. Smart irrigation using sensor for water control
40	Jhatey irrigation scheme	Irrigation	Sergithang	Sergithang	Tsirang	Source drying up	i. Exposed pipes are damaged.ii. No water controller at water source leaving no provisions for cleaning the tank.iii. No filtration at source leading to frequent blockage of reservoir tank.	Opted for an alternative source
41	Tashithang RWSS	Drinking	Tashithang	Gesarling	Dagana	Source drying up	faces acute shortage during dry season.	i. Water release is time based ii. Maintenance of intake, FCR, and distribution of pipes

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
42	Garamala RWSS	Drinking	Gozhi toed	Gozhi	Dagana	Source drying up		i. Water release is time based ii. DFO's 43 and WHO's 130 check dams have improved winter water yield and availability.
43	Gangzor RWSS	Drinking	Gangzor	Tsendagang	Dagana	No issues	landslide damaging the pipes	
44	Phangyuel Irrigation scheme	Irrigation		Kazhi and Phangyuel	Wangdue Phodrang	Source dried up		Opted for an alternative source
45	Bechhu Irrigation channel	Irrigation	Woanjokha, Thango, Matalungchu	Theedtsho	Wangdue Phodrang	No issues	Used Ductile Iron (DI) pipes which are frequently damaged by the landslide/road construction and requires recurring maintenance.	
46	Nyisho RWSS	Drinking	Pangkha, Jaybakha, Gangjab, Phastokha, Dako, Samtengang	Nyisho	Wangdue Phodrang	Source drying up		i. Awareness provided on water source protection and management ii. Exploring alternative sources (using multiple sources)
47	Phendey Irrigation scheme	Irrigation	Beygona	Toeb	Punakha	No issues	In the past, there were issues of insufficient water and water seepage, the area was marshy.	Replaced HDPE pipes from the open channel.

SI No	Channel/ Scheme Name	Type (Drinking/ Integrated)	Chiwog/ village	Gewog	Dzongkhag	Issues related to the water source	Other issues	Adaptation Actions Noted
48	Tagulum RWSS	Drinking		Talo	Punakha	Source drying up		i. Water release is time-based ii. Individual spring protection (groundwater) iii. Awaiting approval for an alternative source
49	Solar water pump	Irrigation	Jara	Toedwang	Punakha	No issues	Pump system damaged	i. Pump operated through solar and electricity
50	Khuruthang town borewell	Drinking	Khuruthang town		Punakha	No issues		i. Use of borewells ii. Water release is time-based ii. Individuals own storage tanks to store the water

Source: RAA

Appendix-II: Drinking and irrigation water schemes having maintenance-related issues

Sl. No.	Channel/Scheme Name	Issues related to maintenance	Remarks
1	Khasadrapchu HS water Source	No proper filtration at intake point	No maintenance work carried out
2	Jagar Chasho Irrigation scheme	Water leakage	No maintenance work carried out
3	Hoshpang RWSS	Continuous blockage of pipes due to lack of filtration	No maintenance work carried out
4	Tsiphu RWSS (Nebu water source)	Water leakage	No maintenance work carried out
5	Domdihoka water source	No proper filtration at intake point	No maintenance work carried out
6	Shingkhana Irrigation	Pump system failed	No maintenance work carried out
7	Biru Sipsoo irrigation channel	Frequent blockages in the irrigation channel	No maintenance work carried out
8	RSPN RWSS	Frequent pipe bursts due to water pressure	No maintenance work carried out
9	Gola RWSS scheme	Pipes washed away due to landslides	Maintenance carried out
10	Singyegang Irrigation Scheme	Breakdown of pump system	Maintenance carried out
11	Omshari Landmark irrigation project	main pipeline from the water source has been washed away by erosion	Maintenance carried out
12	Kulung integrated irrigation sheme	Pipes damaged due to farm road construction	No maintenance work carried out
13	Laring RWSS	Pipes washed away due to landslides	Maintenance carried out
14	Construction of Gaden Irrigation Channel	A portion of irrigation channel washed away	No maintenance work carried out
15	Jhatey irrigation scheme	i. Exposed pipes are damaged. ii. No water controller at the water source leaving no provisions for cleaning the tank. iii. No filtration at source leading to frequent blockage of reservoir tank.	No maintenance work carried out
16	Bechhu Irrigation channel	Used DI pipes which are frequently damaged by the landslide/road construction and requires recurring maintenance.	No maintenance work carried out
17	Solar water pump	Pump system damaged	No maintenance work carried out

Source: RAA's compilation from field visit

Appendix-III: MANAGEMENT ACTION PLAN TEMPLATE

Reco m. No.	Recommendation in brief	Action Plans: action taken or to be taken <i>(a recommendation may have one or several action plans. The actions mentioned as taken should be supported by evidence)</i>	Estimated implementation or start date <i>(the implementation date for each action plan may be different)</i>	Estimated completion or end date <i>(the completion date for each action plan may be different)</i>
4.1	The DECC should coordinate and support NCCC to strengthen the implementation of the Climate Change Policy (CCP).			
4.2	The DoW and DoID should strengthen institutional linkages with water-related agencies to improve coordination in planning and implementation of drinking and irrigation activities.			
4.3	The DECC should ensure coordinated actions for adapting to the impacts of climate change.			
4.4	The DECC should establish mechanisms to ensure that the intent and priorities of policies and legislations on climate adaptations are mainstreamed into national and sectoral policies and plans.			
4.5	Agencies should strengthen institutional capacity for effective implementation of climate actions.			
4.6	The DECC, in collaboration with DMDF, should collaborate to explore and implement innovative financing options that enhance funding for climate initiatives.			
4.7	The DECC, in collaboration with RUB, should review and operationalise the Roadmap and Strategy for Strengthening Climate Change Research in Bhutan.			
4.8	The DoID, in collaboration with the Dzongkhag Engineering Sector, should ensure the prioritisation and effective implementation of adaptation actions for drinking water and irrigation at the local level.			
4.9	The DoW and DoID should strengthen the O&M of drinking water and irrigation systems.			

4.10	The DECC should implement a comprehensive risk management and Monitoring & Evaluation process for the National Adaptation Plan of Bhutan.			
4.11	The NCHM and DLGDM should strengthen the GLOF EWS.			
4.12	The NCHM and DoW should collaborate in generating local-level climate data based on areas of critical importance.			
4.13	The DECC should maintain a central repository for climate adaptation actions.			
4.14	The DLGDM, in collaboration with the DECC, should develop a Loss and Damage Data Repository.			



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