International Water Management Institute

Policy and Institutional Study on the Strategic Role of Water Storage in Nepal

Built Water Storage in South Asia Project

Radheeka Jirasinha, Sanjiv de Silva, Matthew McCartney, Anil Aryal and Jibesh Kumar K.C.

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Acronyms and Abbreviations

BWWSA	Built Water Storage in South Asia Project
DWRI	Department of Water Resources and Irrigation
GESI	Gender Equality and Social Inclusion
GLOF	Glacial Lake Outburst Flood
GWP	Global Water Partnership
IBT	Inter-Basin Transfer
ICIMOD	International Centre for Integrated Mountain Development
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
IWT	Inland Water Transportation
KIIs	Key Informant Interviews
MOEWRI	Ministry of Energy, Water Resources and Irrigation
NWP	National Water Plan
RBM	River Basin Management
RBO	River Basin Offices
SDG	Sustainable Development Goal
US	United States
WECS	Water and Energy Commission Secretariat
WUAs	Water User Associations

Key Messages

- Nepal's rich water resources are not available and accessible to all for year-round use, mainly due to temporal and spatial variability. The variability of climate, terrain, and other geographical features necessitates different types of water storage systems for effective and sustainable water management.

- Water storage needs in Nepal also vary by sector. Interbasin transfer (IBT) as a solution—which is more diversion than storage—has gained prominence in the *agriculture and irrigation sectors*, in discussions as well as policy, and storage systems such as small-scale pond/spring systems and large-scale multipurpose reservoirs are being considered. In the *domestic sector*, small-scale water storage—including pond/spring systems, rainwater harvesting, dug wells, and tube wells—has been promoted in policy but implementation remains scattered. In the *hydropower sector*—the primary energy source for everyday life in Nepal and a major revenue earner through energy exports—water storage includes mini and micro hydropower systems as well as large-storage hydropower and multipurpose reservoirs. In the *environment sector*, the importance of natural storage is recognized in policies and plans (e.g., rehabilitation and restoration of ponds and lakes and conservation of wetlands) but there has been insufficient incorporation in practice. The environment is still primarily viewed as a supplier of water rather than a legitimate user.

- In the Water Resources Act of 1992, the government prioritizes the use of water as follows: (1) drinking water; (2) irrigation and agricultural needs; (3) hydropower; and (4) industrial use, followed by other uses (GoN 1992). Nevertheless, the present study found that in practice the government's emphasis on water storage is primarily in relation to hydropower and energy security. Further, the Water Resources Act of 1992 adopts a sectoral approach aimed at maximizing use for economic growth. There is an urgent need to revise this law to align it with the National Water Resources Policy (2020) and Nepal's federal governance system (GoN 2015).

- As part of the decentralization process in Nepal, an expanded mandate was delegated to local governments, including management of water, irrigation, and natural resources (GoN 2015; Poudel 2019). However, there is a lack of clarity about the roles and functions of each tier of government and between agencies within these tiers. There is also a lack of coordination in the planning, development, and management of water storage systems. Current natural resource management decision-making fails to empower local communities. While policies related to water resources management do include provisions for local community participation, traditional knowledge, and gender equality and social inclusion (GESI) considerations, the directives are not always followed in practice.

- Geographically, landlocked Nepal lies downstream of China—and therefore is affected by that country's water resource management decisions—and upstream of India and Bangladesh. It is dependent on its neighbors for access to global markets. Nepal's transboundary agreements relating to water management have been bilateral agreements; to date, there are no multilateral agreements in the region. As a result, many water storage projects have stalled due to interdependencies, ongoing negotiations, and political complications, leading to hesitancy by donors and international organizations to invest.

1. Overview

1.1 Built Water Storage in South Asia Project

The Built Water Storage in South Asia (BWSSA) project, funded by the US Department of State and implemented by the International Water Management Institute (IWMI) and the Global Water Partnership (GWP), runs for three years from 2023 to 2026 and seeks to address water insecurity in the region. It will contribute to a transformation in the way water storage is perceived, planned, and managed in Bangladesh, Bhutan, India, Nepal, and Pakistan. Water storage here refers to all built (gray) and natural (green) infrastructure, across varying scales ranging from a small pond to a large reservoir or wetland. The overall objectives of the project are to:

- Strengthen national capacities for integrated water storage planning and management;
- Enable relevant ministries and line agencies to make better use of data in understanding water storage gaps and the options available to fill them;
- Facilitate cross-border and regional dialogue to address water storage gaps; and
- Address historical inequalities, especially in terms of who benefits from water storage, and in the technical and management aspects of planning and implementing water storage.

Working in close collaboration with relevant government ministries and other stakeholders, the project contains three interlinked work streams. The first work stream, ***understanding water storage gaps and the options to fill them***, is developing tools and approaches to map and investigate the seasonal dynamics and trends in different types of water storage. It will identify critical water services provided by different water storage options and determine future water demand across sectors.

The second work stream, ***capacity development for sustainable, integrated water storage***, is working with a cohort of 30 technical staff (at least 40% women) from different government ministries on raising awareness and building technical skills. Regular workshops are co-designed with the cohort to share knowledge and experience on issues that they prioritize, including topics such as data collection, storage mapping and modeling, water resource implications of climate change, and optimizing water use and infrastructure management.

The third work stream, ***transboundary water storage cooperation***, is promoting the benefits of international cooperation in water storage planning and management. Working with relevant national stakeholders, this work stream is identifying opportunities as well as constraints to international cooperation and convening technical dialogues on specific topics to build trust and enhance cooperation.

The BWSSA project completed inception workshops in each country in January 2023, identified cohort groups (six members from each country), and conducted six cohort workshops in 2023 and 2024.

1.2 Policy and Institutional Study on the Strategic Role of Water Storage

While seeking to find water storage solutions to current water-related challenges and to prepare for future scenarios in each of the target countries, the BWSSA project is identifying how more effective water storage in all its forms can best support the development needs of the focal countries. Toward this end, this Policy and Institutional Study addresses the following questions:

1. What types of water storage are possible within the various topographic contexts, and what are the current storage types and their uses?
2. What strategic roles do different water storage types play across sectors, and how do they contribute to achieving sector goals, including climate and other risk mitigation? What current and future investments are planned?
3. What is the institutional and decision-making landscape specifically in relation to water management and storage, including the roles of decentralized administrative levels?

4. How coherent are sectoral storage plans with broader integrated water resources management (IWRM) and river basin management (RBM) planning processes? How are potential trade-offs between different water storage types (current and planned) addressed?
5. What knowledge gaps hinder informed and integrated planning?
6. What opportunities exist for community involvement in planning, implementing, and managing different storage types, and how can women's roles be strengthened?

The findings of this Policy and Institutional Study support Outcome 1 of the BWSSA project by identifying factors that shape decisions on storage (type, scale, location, purpose), and by highlighting how water storage decisions impact different stakeholders and the broader national development goals. The study contributes to Outcome 2 by expanding the framework within which storage needs to be assessed, specifically as a sociotechnical intervention with multisector and multistakeholder implications, including possible synergies and trade-offs between development goals. The study also touches upon upstream-downstream issues and hence transboundary cooperation (Outcome 3), though this is highlighted more in some countries than in others. Particular attention was given to highlighting how the diversity of storage types can improve the response to needs and risks in specific biogeographic contexts and sectors, to reinforce the importance of targeting investments beyond large-scale schemes.

In each project country, the Policy and Institutional Study was implemented in phases (Figure 1). The first phase analyzed the content of national policies and strategies to understand the positioning of water storage in various sectors and its contribution to overall national development goals, the cross-sector synergies and trade-offs, and the space available for socially inclusive and stakeholder-responsive planning, design, and management of storage. Significant findings from Phase 1 were further explored in Phase 2 through face-to-face interviews with key stakeholders from various agencies and sectors, including government, NGOs, academia, and the private sector, to capture diversity in information and perspectives. These interviews explored themes in greater detail, including important gaps between stated policy and actual practice and the subtexts underlying such gaps. The key informant interviews (KIIs) also helped identify the existing institutional mechanisms for water resources management, the status quo on how sector storage needs are aggregated into water-sector/basin-scale plans, and the extent to which storage investments respond to the needs of diverse water users. While river systems in South Asia are distinctly transboundary, this aspect was not explicitly covered during the KIIs due to country sensitivities. However, information and perspectives on transboundary issues volunteered by respondents were recorded and they do inform this report. A draft country report was generated after an analysis of data from Phases 1 and 2 and a review of published literature. The draft report was shared with all key informants with a request to verify the details and narratives, filling in any gaps (Phase 3). The results of this consultative process were used to finalize the report and contributed to building stakeholder consensus and credibility.

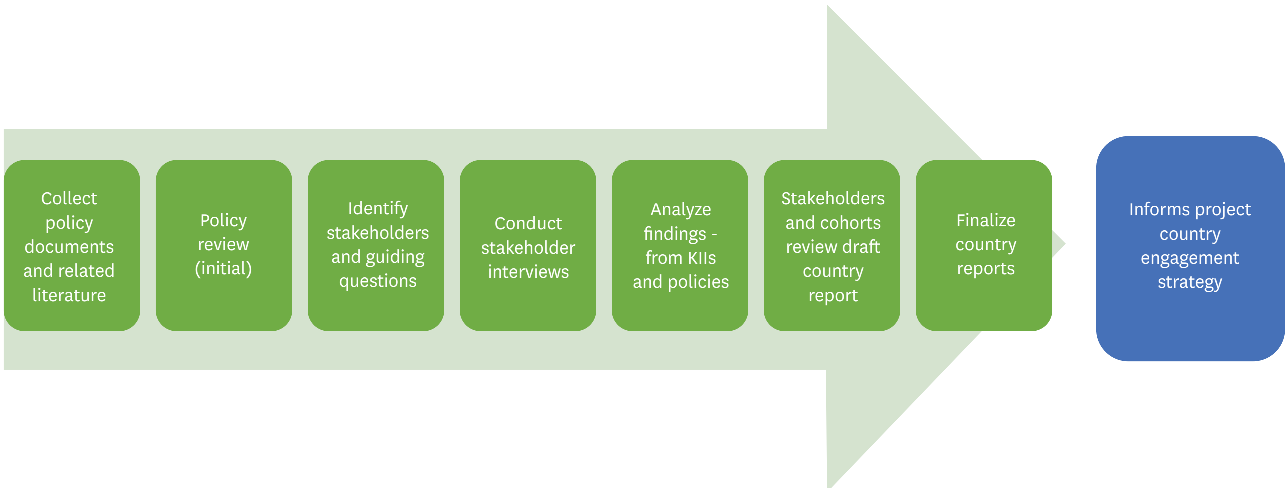

Figure 1. The approach adopted for the Policy and Institutional Studies conducted in Bangladesh, Bhutan, India, Nepal, and Pakistan.

This report on Nepal presents the study methodology (section 2), a brief overview of water resources and water storage in the landlocked country (section 3), water storage in policy and practice (section 4), the institutional architecture for water storage governance (section 5), and cross-border considerations (section 6). It concludes with an outline of potential areas for intervention (section 7).

2. Methodology

2.1 Phase 1: Policy Review

The Policy and Institutional Study was initiated as a pilot in Nepal and thereafter conducted in the other project countries. The policies and strategies reviewed for the study included those relevant to national development as well as those relating to various sectors such as water resources, agriculture and irrigation, environment, forestry, domestic water supply, energy, and climate change (Annex 1). The documents and literature for the review were sourced from databases such as FAOLEX, Google, Google Scholar, the IWMI library database, Scopus, and ProQuest. The list of policies was shared with the IWMI and GWP country offices in Nepal to review and add other applicable policies.

Information extracted from these documents—on development priorities; types of water storage, plans, targets, challenges, and risks; links to integrated water resources management (IWRM), river basin management (RBM), and other aspects of governance; and opportunities for local stakeholder involvement—was entered into an Excel database according to pre-identified sectors and thematic areas (Annex 1). These thematic areas were identified by the project team based on previous policy and institutional studies but tailored to the overall scope and focus of the BWSSA project. However, the information extracted from the documents was not limited to these thematic areas; any area that enabled an understanding of the situation of water storage within a project country was included.

For the Nepal review, 18 documents representing the most relevant policies and strategies were reviewed (Table 1). Entering relevant extracts from these documents into an Excel database enabled an analysis of thematic aspects and targets across two or more documents and aided in the detection of synergies and gaps across sectors. This information helped in identifying focal topics and framing questions for the KIIs conducted in Phase 2.

2.2 Phase 2: Key Informant Interviews

The KIIs conducted in Phase 2, featuring in-person and in-depth discussions, built on the analysis done in Phase 1. Interviewees for the KIIs were selected to provide diverse and reliable information drawing on their position and experience within the government structure, or to offer perspectives from outside the public sector. This allowed a degree of triangulation with respect to what the priorities were and how policies and plans responded to them, the planning and implementation processes, and the institutional structures and their strengths and weaknesses. Based on the policy review and aided by the guidance provided by the country focal points (IWMI and GWP), a list of key stakeholders across sectors and expertise was created (Annex 2), and semi-structured interview questionnaires were developed encompassing a combination of common and key informant- or sector-specific topics (Annex 3). Selection of the key informants was informed by the need to strike a balance among the government sector, NGOs, and academia. The approach to the discussions was expansive, leaving room for deviations if an important supplemental topic emerged. A total of 15 KIIs, lasting approximately one hour each, were conducted from the 21st to 24th August 2023 in Kathmandu. The resulting qualitative data were sorted in Excel.

The overall aim and approach of the Policy and Institutional Study was explained to the cohort in Nepal, which assisted in the coordination and planning of the study.

Table 1. Policies[a], plans, and strategies reviewed for the Policy and Institutional Study on water storage in Nepal.

Year of publication/ timeframe	Policy document	Citation
2021-2050	National Adaptation Plan: Summary for Policymakers 2021-2050	GoN 2021
2020	National Water Resources Policy	MoEWRI 2020
2020	Second Nationally Determined Contribution	GoN 2020
2019	National Climate Change Policy, 2076	GoN 2019
2019	National Energy Efficiency Strategy, 2075	MoEWRI 2019
2019	Irrigation Master Plan	DWRI 2019
2018-2022	Multi-Sector Nutrition Plan	NPC 2017a
2018	Towards Zero Hunger in Nepal: A Strategic Review of Food Security and Nutrition	NPC 2018
2016-2030	Sustainable Development Goals: Status and Roadmap	NPC 2017b
2016	Nationally Determined Contributions	MoPE 2016
2016-2025	Forestry Sector Strategy	MoFSC 2016
2016-2025	Nepal Zero Hunger Challenge: National Action Plan	MoAD 2016
2015-2035	Agriculture Development Strategy	MoAD 2015
2015	Land Use Policy	MoLRM 2015
2009	National Urban Water Supply and Sanitation Sector Policy	MoPPW 2009
2006	Rural Energy Policy	MoE 2006
2004	Irrigation Policy, 2060	MoI 2004
2002-2027	National Water Plan	WECS 2005
2001	Hydropower Development Policy, 2058	DoED 2001

Note:

[a] Only policies published before 2024 and are available in English were reviewed for this study.

2.3 Phase 3: Country Report on the Strategic Role of Water Storage

The analysis and report writing process included a verification step by which the draft report was initially shared with the country focal points for inputs and thereafter with the key informants for accuracy and any further insights. The findings are presented below according to the national development goals and priorities around water storage, the sectoral plans, the institutional structure, decision-makers on water storage, the cross-border aspects, and areas for further development of water storage planning and implementation.

3. Water Storage in Nepal

Nepal has a population of approximately 29 million with an annual growth rate of 0.92% (MoFA 2024). The average GDP per capita is USD 1,399 (CEIC Data 2023). Agriculture is the main source of livelihood for 60% of the population (Sharma et al. 2023a). Based on the Multidimensional Poverty Index[1] (OPHI 2023), 17.4% of Nepalese (ca. 5 million people) were multidimensionally poor in 2019. Indicators show most individuals are deprived in terms of housing materials, cooking fuel, years of schooling, assets, and nutrition (NPC 2021).

Nepal is landlocked, situated between India to the south and China to the north, with a total area of 147,516 km² (Sharma

[1] The Multidimensional Poverty Index is a measure of deprivation that includes indicators from health, education, and standard of living. It goes beyond the sole focus of income as a measure of poverty. It reveals who is poor and how they are poor, and creates a comprehensive picture of poverty in a country. Source: Multidimensional Poverty Peer Network (2024) https://www.mppn.org/multidimensional-poverty/what-is-multidimensional-poverty/

and Khadka 2020). The topography ranges from 70 m above sea level in the southeastern lowlands to 8,848 m above sea level in the northeastern Himalayas (Nepal Outlook 2020). Approximately 77% of the country comprises hills and mountains (Nepal Outlook 2020). Forests cover 44.7% (DFRS 2018) while agriculture accounts for 24% (Sharma et al. 2023a). There are different physical or ecological zones: the Terai (low, flat land, rich soil, marshes), the Inner Terai (Churia foothills, broad basins), the hills and mid-mountain region (the Mahabharat range), and the Great Himalayas, which contain the world's highest peaks. Most of the country's population resides in the Terai and Inner Terai (Nepal Outlook 2020; Proud et al. 2025). The climate is highly variable: the Terai and Inner Terai have a subtropical climate with an average rainfall of 2,000-2,500 mm; the hills and mid-mountain range has a temperate climate with an average rainfall of 1,500 mm; and the Great Himalayas have a dry, alpine climate with an average rainfall of 500 mm (MoWS 2022).

There are four main river basins (Figure 2): the Koshi; the Gandaki (also known as the Narayani); the Karnali, originating from the Tibetan plateau in China; and the Mahakali, originating in the Milam glacier in India and the Lipulekh area of Nepal (Nepal River Portal 2019). The rivers ultimately flow into the Ganges River which traverses India and Bangladesh. The major parts of the Karnali and Gandaki/Narayani basins are located within Nepal (USAID 2021).

While Nepal is rich in water resources, the temporal and spatial variability is such that water is not available and accessible to all for year-round use (USAID 2021). Various forms of water storage are therefore needed because much of the precipitation received during the monsoon season (approximately four months, June to September) is not stored for the dry season (approximately eight months, October to May). The need for water management in the different geographic physical or ecological zones of Nepal is broadly as follows:

The Terai and Inner Terai region in southern Nepal is a flat lowland river plain with high population density. There is high agricultural demand for water (USAID 2021) and therefore a need for water storage (e.g., reservoirs) for irrigation. Residents of this region depend on groundwater for drinking and agriculture. Local water markets exist in the Terai, where water is not priced, but people pay for electricity to extract groundwater. Only 22% of the available groundwater recharge is currently being used (Shrestha et al. 2018). Aquifers in this region may be transboundary and therefore affected by groundwater pumping in India (USAID 2021).

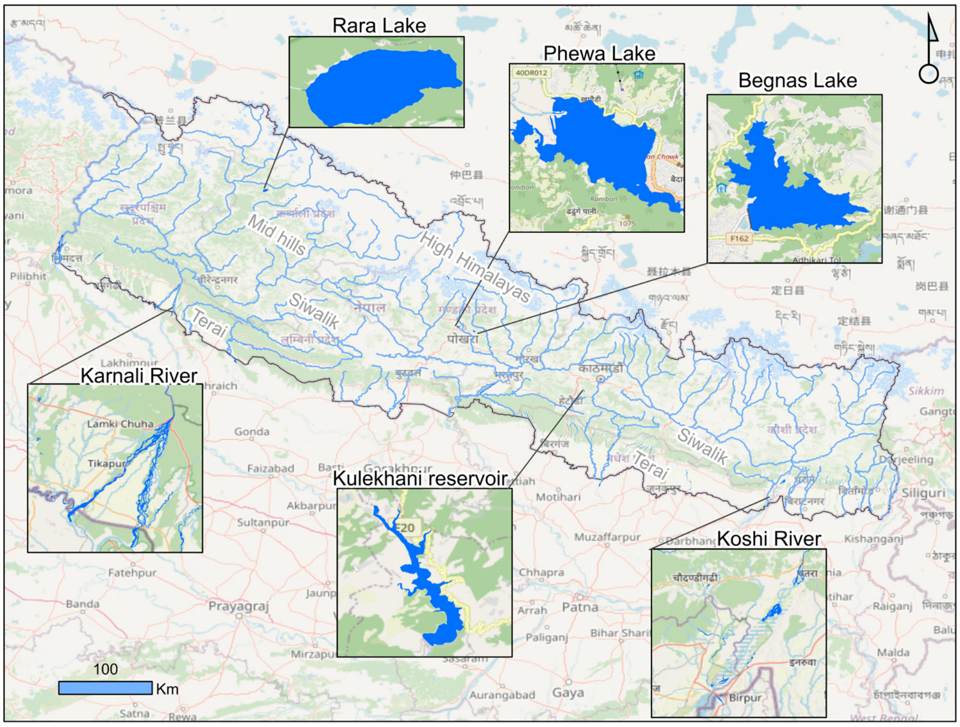

Figure 2. Water resources of Nepal.

Source: Authors' creation

The hills and the mid-mountain region (including the Siwalik region and Mahabharat range) is characterized by deep valleys, steep slopes, mountain springs, terraced agriculture, and livestock farming (USAID 2021). Groundwater availability in this region is variable. Kathmandu Valley has a highly productive alluvial aquifer (USAID 2021) which, however, is overexploited and polluted (Shrestha et al. 2018). Large-scale surface water storage in this region is not feasible due to the terrain; so, pond/spring systems and small-scale water storage (e.g., rainwater harvesting tanks) are used for drinking water and agricultural purposes. There needs to be further development of small-scale water storage options due to pressures such as land-use change and degradation, increased demand, and climate change. In Western Nepal, spring outflows have declined by more than 70%; in Kavrepalanchok District (Koshi Basin) one-third of the springs have dried up (USAID 2021).

The Great Himalaya region (the northern border; the Hindu Kush Himalayan region) is characterized by rangelands and glaciers and low population density. The region's frozen water bodies play a crucial role in maintaining dry-season flows (USAID 2021). There are 3,252 glaciers covering 5,323 km², with length ranging from 1 km to 24 km and ice-depth varying from 20 m to 190 m (Sijapati et al. 2023). These glaciers sustain lakes and rivers and provide approximately 480 million cubic meters (MCM) in natural water storage in the Karnali, Gandaki, and Koshi basins (USAID 2021). The high Himalaya region is also known for its high risk of glacial lake outburst floods (GLOF), which in the past have caused significant loss of life and infrastructure damage (Shrestha 2023a). Currently, 21 glacial lakes in Nepal are at risk of bursting with six of them considered critical GLOF hotspots (Sijapati et al. 2023). The risk varies depending on downstream factors; there may be smaller lakes where outbursts are more likely, but downstream population densities are lower. GLOFs result in a sudden and massive release of water; so provision of storage downstream might mitigate impacts. However, this is a highly uncertain scenario where information and data are minimal. In reality, solutions will vary from one lake to another. Experts also highlight another emerging risk in the Hindu Kush Himalaya region: Changes in snow melt are already affecting the water flow of major river basins and exacerbating water scarcity (ICIMOD 2024).

In terms of overall water resources availability and use (Table 2), Nepal has one of the lowest per capita reservoir capacities in South Asia. This coupled with high interseasonal variability contributes to increased flood and drought risk (USAID 2021). Climate change, water pollution, and land-use changes, among other factors, affect the availability of natural water storage. To meet the demand of various water users and prepare for climate-related risk, there is a need to couple natural water storage with built water storage solutions. The Government of Nepal prioritizes the use of water in the Water Resources Act of 1992 as follows: 1) drinking water, 2) irrigation and agricultural needs, 3) hydropower, and 4) industrial use, followed by other uses such as navigation and recreation (GoN 1992). Sijapati et al. (2023) found that the demand for water storage is largely driven by the irrigated agriculture sector. However, this study found that in practice the government's emphasis on water storage relates primarily to hydropower and energy security. Based on discussions with key informants, Table 3 provides a summary of the water storage types and purposes currently available and/or being implemented in Nepal.

To gain a deeper understanding of Nepal's strategies and plans for water storage as well as opportunities for further development and investment, this study examined the relevant policies, what occurs in practice, and the institutional aspects, including decentralization and sectoral structures related to water storage.

Table 2. Water resources availability and usage in five South Asian countries, 2020.

	Unit	Nepal	Bangladesh	Bhutan	India	Pakistan
Long-term average annual precipitation	mm/year	1,500	2,666	2,200	1,083	494
Interannual variability (WRI)[a]		1.00	0.7	0.6	1.7	2.40
Dam capacity per capita	m^3/inhabitant	2.93	39.33	-	179.32	125.89
Total dam capacity	km^3	0.09	6.48	-	247.46	27.81
Environmental flow requirements	10^9 m^3/year	95.94	600.3	54.10	937.10	83.79
Total internal renewable water resources	10^9 m^3/year	198.20	105.0	78.0	1,446.0	55.0
Total renewable groundwater	10^9 m^3/year	20.0	21.12	8.10	432.0	55.0
Groundwater produced internally	10^9 m^3/year	20.0	21.09	8.10	432.0	55.0
Groundwater entering the country (total)		-	0.03	-	-	-
Total renewable surface water	10^9 m^3/year	210.2	1,205.9	78.0	1,868.9	239.2
Surface water produced internally	10^9 m^3/year	198.20	83.91	78.0	1404.0	47.4
Surface water entering the country (total)	10^9 m^3/year	12.00	1122.0	-	635.2	265.1
Surface water leaving the country to other countries (total)	10^9 m^3/year	210.20	0.06	78.0	1,385.0	10.72
SDG 6.4.2 Water Stress	%	8.31	5.72	1.41	66.49	116.3
Total water withdrawal	10^9 m^3/year	9.50	35.87	0.34	761.0	183.4
Agricultural water withdrawal	10^9 m^3/year	9.32	31.50	0.32	688.0	172.4
Irrigation water requirement	10^9 m^3/year	5.43	24.56	0.10	370.8	126.9
Industrial water withdrawal	10^9 m^3/year	0.03	0.77	0.0	17.00	1.4
Municipal water withdrawal	10^9 m^3/year	0.15	3.60	0.02	56.0	9.65

Source: FAO AQUASTAT

Note: [a]WRI = World Resources Institute.

Table 3. Summary of storage types currently implemented/promoted in Nepal.

Sector	Storage type
Drinking water and household use	• Pond/spring systems for multiple use, including household purposes • Rainwater harvesting • Pump storage systems • Dug wells/tube wells
Agriculture	• Interbasin transfer for irrigation (see Box 1) • Pond/spring systems for multiple use, including agriculture and livestock • Multipurpose storage reservoirs
Energy	• Mini and micro hydropower • Large storage type hydropower • Multipurpose reservoirs
Environment	• Rehabilitation of ponds and lakes • Wetlands conservation • Small water storage infrastructure for biodiversity

4. Policies and Realities of Water Storage in Nepal

4.1 National Development Policies and Water Storage

This section considers the strategic role of water storage in development policies and plans across water-user sectors in Nepal. In general, there is only a limited reflection of water storage in the overall targets, objectives, and aims of national policies (Table 4). However, the activities identified in the policy and strategy documents do indicate the importance of a range of water storage types in meeting diverse development goals. Access to water for all citizens, better nutrition, higher average income, and increased irrigated land and energy supply are some of the key overarching goals that drive water storage plans and development in Nepal.

Key national policies related to water resources management, such as the Sustainable Development Goals (SDGs), the National Water Resources Policy, and the National Water Plan, contain explicit references to water storage (Table 4). The findings of a recent rapid assessment of water storage by the Department of Water Resources and Irrigation (DWRI) (Sijapati et al. 2023) were similar to this Policy and Institutional Study regarding national development policies. They indicate that provisions related to water storage gained prominence in policy documents only in the last two decades. The key sectoral policies that promote water storage are discussed in section 4.2.

Although policies and plans for various forms of water storage exist, implementation remains limited (Regmi and Shrestha 2018; Sharma et al. 2023a). Water storage is not prioritized in practice, and despite numerous plans—some key experts cited 50 plans—most have not been implemented. Experts identified the absence of enabling conditions, particularly financial constraints, as a primary reason for slow or non-implementation of water storage infrastructure plans. These enabling conditions refer to factors that facilitate changes in approach, strategy, or management regimes. The presence of these enabling conditions can drive action in relation to a specific policy, while their absence will be a barrier (Huber-Stearns et al. 2017). While enabling conditions differ across sectors, they typically encompass factors such as policy, governance structure, regulatory framework, investment programs, and social, cultural, and economic factors that influence actors and systems (IFPRI et al. 2019). In Nepal, the lack of cohesive policies, an institutional structure, capacities, and finance undermine the enabling environment for water storage.

The Water Resources Act of 1992 adopted a sectoral approach, followed by development of policies and strategies aimed at economic development through maximization, management, and conservation of water resources. However, policymakers realized that the goals of maximum use and conservation could not both be effectively achieved within this framework, leading to the conclusion that integrated water resources management (IWRM) was necessary. IWRM was subsequently incorporated into the National Water Plan (2002) and the more recent National Water Resources Policy (2020) (Table 4).

The latter is a comprehensive policy that gives prominence to water storage through large-scale multipurpose projects, small-scale household or community-based water storage solutions, and measures to support disaster risk management and groundwater recharge. However, through the KIIs conducted for this study it became clear that there is a gap between the policy intentions and what has occurred to date on the ground. According to one key informant, this reflects a *de facto* vs *de jure* gap: Nepal excels in developing *de jure* policies but struggles to translate them into effective action (Gyawali 1989).

The need for water storage remains significant, and most of the key informants interviewed for this study indicated that the benefits of implementing IWRM are yet to be realized. This is partly due to the disconnect between legislation and policy. There is a clear need to revise the Water Resources Act of 1992 to make it a comprehensive water law that incorporates IWRM and aligns with Nepal's federal governance system and unites all sectors within a single framework.

The disconnect between legislation and policy is evident in the regulation of groundwater use. The Water Resources Act (1992) grants people user rights, meaning that individuals do not require a permit to access groundwater on their own land. As a result, many households have tube wells or dug wells to extract water for domestic and agricultural use. However, the National Water Resources Policy (2020) calls for the formulation of rules to control groundwater extraction, and limits construction and expansion of infrastructure in areas of natural groundwater recharge. This creates a conflict between the policy's intent to manage groundwater resources sustainably and the existing legal framework that allows unrestricted access.

Table 4. A review[a] of the role of water storage in national policies on water resources management, land-use, and related sectors.

Policy/strategy/plan	Overall goals and objectives	Role of water storage
National Adaptation Plan: Summary for Policymakers 2021-2050	Building adaptive capacity and resilience in natural, social, and economic sectors; integrating climate change into policies and plans in all sectors at all institutional levels; distribution of resources for climate change adaptation.	• Considers water storage solutions and early-warning systems for GLOF risk reduction in glaciated river basins. • Recommends check dams, rainwater harvesting, and storage solutions for climate resilience (under the water resources and energy program). • Supports local governments in conservation of water sources, water recharge and retention activities for improving water supply for drinking water and sanitation.
Second Nationally Determined Contribution, 2020	The focus is on reducing greenhouse gas emissions through mitigation with an overall goal of achieving net zero by 2050. The adaptation priorities cover eight thematic areas including water resources and energy.	• Mitigation: Expand clean energy generation from 1,400 MW to 15,000 MW by 2030 with 5-10% coming from mini and micro hydropower, solar, wind, and bioenergy. • Create an inventory of wetlands and sustainably manage them by 2030. • Adaptation: Increase water supply and incorporate climate risk assessment into WASH (water, sanitation, and hygiene) planning.
National Climate Change Policy, 2076 (2019)	Climate change adaptation of people; resilience of ecosystems; green economy; climate finance; technology research and development; integrating climate change into policies; and integrating GESI considerations into climate change plans.	• Storage combined with multiple and efficient use in risk-prone areas and settlements. • Rainwater harvesting ponds for multiple uses including drinking and groundwater recharge. Section 8.3 also alludes to infrastructure for irrigation. • Sustainable groundwater management in urban areas, reflecting its key role in urban water supply.
Sustainable Development Goals: Status and Roadmap 2016-2030	Shows Nepal's progress on each goal, target, and indicator. SDG 6 contains information on indicators for supply of (piped) drinking water, access to sanitation, treatment of wastewater, degree of IWRM implementation, and water-use efficiency.	• Installed capacity of hydropower to increase from 782 MW (2015) to 15,000 MW by 2030 under SDG 7, Target 7.2. In 2015, total electricity demand was approximately 1,300 MW (Trace 2019). • Increase the number of conserved lakes, wetlands, and ponds from 1,727 (2015) to 5,000 by 2030 under SDG15, Target 15.1.

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Table 4. A review[a] of the role of water storage in national policies on water resources management, land-use, and related sectors. (Continued)

Policy/strategy/plan	Overall goals and objectives	Role of water storage
National Water Resources Policy 2020	Contribute to economic prosperity and social transformation by conserving, promoting, and developing multiple uses of available water resources. The overall objectives include: to institutionalize the system of protection, development, management, and regulation of the water resources sector based on	• Development of multipurpose projects including reservoirs and inter-watershed transfers that will provide irrigation facilities and drinking water, mitigate flood disasters, and provide for other uses. • Development of small-scale rainwater harvesting (ponds, tanks, clay pots, etc.) for supply of water in the dry plains and areas where water resources are scarce; use of technologies such as water lifting. • Storage of rainwater by constructing reservoirs to maintain water levels in the rivers.
	study, research, facts, and evidence; and to plan for the protection, development, and use of water resources in coordination with federal, provincial, and local administration.	• Designating areas vulnerable to water scarcity as protected areas. • Identifying areas for natural groundwater recharge and limiting infrastructure development there. • Formulating and implementing regulations to control exploitation of groundwater resources. • Construction of dams, embankments, and reservoirs in river systems to effectively control and reduce water-related disasters such as floods, landslides, etc.
National Water Plan (2002-2027)	IWRM principles are the main theme of the NWP with each river basin managed holistically. The overall aim is to improve the quality of life. The objectives include reducing poverty, increasing agricultural productivity, protecting the environment, and health security. Key water-sector objectives are to generate hydropower to meet national energy needs and export the surplus; facilitate water transport, particularly connecting to a seaport; and prevent and mitigate water-induced disasters.	• Structural measures such as building river dikes, spurs, check dams, and embankments, and carrying out trail improvement with the help of community groups to mitigate water-induced disasters. • Digging shallow and deep tube wells in new areas for irrigation needs; monitoring groundwater for water-level fluctuations and water quality. • Hydropower: Multipurpose irrigation projects with a hydroelectric generation component. • Isolated micro and small projects to expand electrification of hill and mountain areas. • Natural storage: Environment protection and management in all priority watershed and aquatic ecosystems. • Navigation: Developing inland water transportation for trade and industrial development. • Feasibility assessment of a dedicated navigation canal from Kosi High Dam to Kursela in India in the Ganges River system to open a navigational route for large barges from Sunsari in Nepal to Haldia port in India.

Continued >>

Table 4. A review[a] of the role of water storage in national policies on water resources management, land-use, and related sectors. (Continued)

Policy/strategy/plan	Overall goals and objectives	Role of water storage
Land Use Policy 2015	This policy considers natural disaster risk in developing physical infrastructure in the context of the earthquake of April 2015. The document is mainly related to limits and protection of land and land resources, optimum use, and effective management.	• Includes promotion of conservation of natural and built water storage systems – lakes, reservoirs, ponds, rivers, and wetlands, among others.

Note:

[a] Only policies published before 2024 and available in English were reviewed for this study.

4.2 Sectoral Policies and Water Storage

The key sectoral policies influencing water storage development and management in Nepal include the Agriculture Development Strategy, the National Urban Water Supply and Sanitation Sector Policy, the Irrigation Master Plan, and the Hydropower Development Policy. A summary of the policies and practices related to water storage development across sectors—agriculture and irrigation, drinking water and domestic use, energy (hydropower), and environment—is presented in Table 5.

While the value of multiple-use systems (or multipurpose reservoirs) is recognized in various sector policies (Table 5), it has not been fully embraced in practice. Hydropower development plans, for instance, are typically created only with a hydropower lens and do not factor in multiple uses. Planning water storage for flood control and fire prevention and natural forms of storage is even less emphasized.

There is a clear need for a more holistic approach encompassing both conventional and nonconventional, large and small, built and natural types of storage (e.g., as outlined in the National Water Plan 2002-2027 and the Forestry Sector Strategy 2016-2025; Table 5). Multiple-use systems can be a successful form of storage in certain places, in rural areas for example, as they provide water for agriculture, livestock, domestic purposes, and more, thus offering a sustainable, multifunctional approach to water storage.

Table 5. The role of water storage in sectoral policies[a] and implementation of water storage plans/activities.

Sector	Policies and plans reviewed	Water storage type, programs, targets
Drinking water and household use	Key policies: • National Adaptation Plan: Summary for Policymakers 2021-2050 • National Urban Water Supply and Sanitation Sector Policy 2009 • National Climate Change Policy 2076 (2019) • National Water Resources Policy 2020	• Conservation of water sources; watershed management; water retention and recharge activities. • Solar water pumps and hydroelectricity for water pumping for drinking and irrigation. • Drinking water supply connection for urban populations or at least communal water points not more than 100 m from each household. • Rainwater harvesting at household and community level. • Providing financial assistance to local user groups for the protection of traditional water sources like stone spouts and dug wells.
Agriculture and irrigation	Key policies: • Agriculture Development Strategy 2015-2035 • National Water Plan 2002-2027 (NWP 2005) • Irrigation Policy, 2060 (2003) • Irrigation Master Plan 2019 Other relevant policies: • Towards Zero Hunger in Nepal: A Strategic Review of Food Security and Nutrition (2018) • Nepal Zero Hunger Challenge: National Action Plan 2016-2025 (2016) • National Adaptation Plan: Summary for Policymakers 2021-2050	• Interbasin transfers (see Box 1) to move water from permanent to seasonal rivers to augment supply in water-short irrigation systems if economically justified by generation of hydropower. • Multipurpose irrigation projects with a hydroelectric power generation component (e.g., Bheri-Babai diversion, Sunkoshi/Kamala diversion, West Rapti storage). The Irrigation Master Plan 2019 includes 9 such projects with a combined installed capacity of approximately 730 MW. • Prioritizing irrigation projects with storage dams: The combination of two transfer schemes, Sunkoshi Marin and Kamala, with storage dam Sunkoshi 3 enhances dry-season irrigable area to 352,300 ha. Similarly, the Tamor-Morang transfer serves only 45,500 ha of irrigable land with run-of-river hydropower; adding the storage dam Tamor 3 increases the dry-season irrigable area to 113,700 ha. • Small local water sources and water harvesting—rainwater harvesting, farm ponds, etc. • Construction of new shallow tube wells and deep tube wells, water courses and field canals, and reservoirs for year-round irrigation. • Repairing of tube wells, main canals, and damaged surface schemes. • Groundwater monitoring, exploration, and promotion. • Natural storage—managing and using existing water bodies (lakes, rivers, etc.) for industries, tourism, fisheries, and navigation. • Institutional coordination: Department of Irrigation with the Water and Energy Commission Secretariat (WECS) to develop and manage water reservoirs for irrigation, with the possibility of using them for electricity generation as well.

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Table 5. The role of water storage in sectoral policies[a] and implementation of water storage plans/activities.(Continued)

Sector	Policies and plans reviewed	Water storage type, programs, targets
Energy (hydropower)	Key policies: • Hydropower Development Policy 2058 • Sustainable Development Goals: Status and Roadmap 2016-2030 • Second Nationally Determined Contribution (NDC) 2020 • Rural Energy Policy 2006 • National Water Plan 2002-2027 Other relevant policies: • National Adaptation Plan: Summary for Policymakers 2021-2050 • National Climate Change Policy 2076 (2019)	• Large-storage hydropower projects and multipurpose projects. • Increasing the share of renewable energy and installed capacity of hydropower. In 2015 hydropower was 782 MW, projected to increase to 15,000 MW by 2030. In 2015, total electricity demand was approximately 1300 MW (Trace 2019). • By 2030, expand clean energy generation from approximately 1,400 MW to 15,000 MW, of which 5-10% will be generated by mini and micro hydropower plants, and solar, wind, and bioenergy sources. • Mini and micro hydro projects to be integrated with irrigation, education, health, drinking water, and small-scale industry. Technical assistance will be provided, and locally available skills will be used.
Environment	Key policies: • National Adaptation Plan: Summary for Policymakers 2021-2050 • National Climate Change Policy 2076 (2019) • National Environment Policy 2076 (2019) • Sustainable Development Goals: Status and Roadmap 2016-2030 • Land Use Policy 2015 • Forestry Sector Strategy 2016-2025 Other relevant policies: • National Water Resources Policy 2020 • National Water Plan 2002-2027	• Ponds and lakes in community forests—development and rehabilitation for biodiversity and groundwater recharge. • Wetlands conservation and management in the foothills of Chure—build small earthen dams, connect water bodies, and restore forests for healthy wetlands. Retaining streams, gorges, estuaries, waterholes, ponds, and lakes to sustain groundwater. • Karnali watershed management programme—reduce climate risks and vulnerabilities and promote downstream irrigation facilities. • Engaging local communities and indigenous groups in watershed conservation. • Conserving freshwater ecosystems (lakes, ponds, wetlands)¬—from 1,727 in 2015 to a target of 5,000 by 2030. • Prohibiting activities that affect the natural flow of rivers, boundaries (e.g. encroachment), and prescribed land-use regulations.

Note:
[a] Only policies published before 2024 and available in English were reviewed for this study.

4.2.1 Key takeaways on the practicalities of implementing water storage

Agriculture and irrigation sector. Interbasin transfers (IBTs) have gained prominence in policy (e.g., Water Resources Policy 2020 and irrigation policies of 2013 and 2023) to provide water for irrigation in the Terai areas (Box 1). However, not all users (e.g., local communities, biodiversity sectors, riparian countries) are included in the planning and implementation of IBTs. This may lead to conflict and delay in projects. For the agriculture and irrigation sector, water storage is mainly being considered through a diversion lens, and there is a lack of effort on natural water storage systems.

Box 1. Interbasin transfers

Interbasin transfer is the movement of water from a surplus watershed to a watershed with shortage for the purposes of agriculture, hydropower generation, and navigation expansion. The implementation of IBT involves pipelines, canals, and other diversion and storage structures. IBTs can have high socioeconomic and environmental impact and are therefore strictly regulated in some areas and prohibited in others.
(*Source:* CTCN 2024)

Water supply sector (drinking water and household use). Despite the promotion of small-scale water storage and recognition of the role of local communities in sector policies, only scattered efforts have been made to include communities in the assessment, management, and rehabilitation of small-scale storage systems. Key informants for this study indicated that this is due to the lack of technical capacity, human resources, and awareness of the significance of these systems. For example, pond and spring systems used to be an integral part of communities in the past, providing a wide range of benefits (Box 2). However, the decrease in ponds and the resulting impacts have not been fully assessed and pond systems are not well-connected to policy.

Water supply sources vary across Nepal, and in the Terai, groundwater is mainly used for drinking water, household purposes, and irrigation. However, there is a need for updated information on the availability and use of groundwater to ensure sustainable management.

Box 2. Pond and spring systems in Nepal.

Historically, ponds and springs have been integral to the lives of farmers and communities in Nepal, with traditional knowledge guiding the construction and management of these water systems. Privately or communally owned ponds provide water for humans, livestock, and irrigation, and for flood control and groundwater recharge. They also contribute to spring flows, and hold cultural and religious significance. However, several factors have led to the degradation and decline of pond and spring systems, including population growth and increased use, changing rainfall patterns exacerbated by climate change, pollution, and infrastructure development. Some key informants stated that due to water shortages and technological innovations (such as piped and pump systems) and migration of people from rural communities to urban areas, ponds are being abandoned and/or built over.

A few decades ago, the Government of Nepal handed over forest areas to be managed by local communities. The local traditional knowledge inherent to these communities recognizes the critical link between water availability and forest conservation. Pond systems were constructed and managed by local community groups, which highlights the interconnectedness of communal wellbeing and the sustainability of pond systems. There are currently 22,000 community forest groups and around 2.3 million households associated with community forestry as part of the Federation of Community Forestry Users Nepal (FECOFUN). However, according to some key informants, the role of communities in managing pond systems and their contribution to water resource management is not fully captured in policy.

Hydropower sector. Hydropower is the primary energy source driving everyday life and economic activities in Nepal. It is a major revenue earner in Nepal through exports to neighboring countries. In a landlocked and predominantly hilly country such as Nepal, the economic importance of hydropower remains significant both as a direct enabler of economic growth and as a foreign revenue earner. As a result, it is no surprise that there are plans for energy storage related projects. However, few of these have moved beyond the planning stage. This may be due to the poor investment environment for hydropower development (Sharma et al. 2023b) and the lack of coordination and cooperation among sectors.

Key informants interviewed for this study noted that despite policy requirements—such as the involvement of local communities and the mandatory provision of 10% environmental flows (e-flows) (DoED 2001)—hydropower developers often fail to adhere to them in practice. Furthermore, there is a lack of systematic monitoring to ensure compliance (K.C. et al. 2024).

Hydropower decision-making in Nepal is further complicated by the country's relations with India, particularly regarding India's access to hydro-electricity generated in Nepal. This dynamic creates challenges in balancing hydropower development with the needs of other sectors. Hydropower storage is a crucial driver of Nepal's development and is also viewed by India as essential for ensuring its energy and water supply. This shared interest adds a layer of complexity to the management of water resources and development of storage solutions within Nepal.

Environment sector. The importance of various types of natural storage is recognized in Nepal's policies and plans. However, natural storage does not receive sufficient prominence in practice or in discussions. Despite the arbitrary fixed e-flow percentage (DoED 2001), the environment is still primarily viewed as a supplier of water rather than as a legitimate user. The arbitrary fixed percentage for e-flows has been criticized by the environment sector and other stakeholders (Shrestha and Dixit 2020). From an environmental perspective, the current e-flow percentage does not adequately reflect the specific conditions and needs of ecosystems and key species, such as the endangered Ganges river dolphin. Therefore, investing in research to determine specific river-system e-flows is crucial for facilitating more informed dialogue and decisions between the environmental and energy sectors (K.C. et al. 2024).

A diversified storage strategy, supported by clear policy, is important for Nepal to meet the needs of multiple sectors. Large-scale storage, often driven by the shared hydropower needs of Nepal and India, as well as India's and the Nepal Terai's dry-season needs, may not address the full range of requirements. This broader understanding is reflected at the policy level by the varied types of storage promoted across sectors (Table 4).

5. Institutional Landscape of Water Storage Planning and Management

5.1 Decentralization and Governance of Water Resources

In 2015, a new constitution was adopted in Nepal, and the government was restructured into a three-tier system that includes the federal government, seven provincial government agencies, and 753 local governments; these local governments include metropolises, submetropolises, municipalities, and rural municipalities (GoN 2015). Through this decentralization process, an expanded mandate over the management of water, irrigation, and natural resources was conferred upon local governments, in line with constitutional and statutory reforms (GoN 2015; Poudel 2019). Depending on the scale of investment and, for irrigation, the size of the command area, decisions related to water management and storage are handled by all three tiers (GoN 2015). For example, licenses for hydropower projects up to 1 MW are in principle issued by the local government, and for larger projects by the central government. Another example is when an irrigation project is spread across several provinces (or is large-scale), it is handled by the central government, while smaller irrigation schemes within a province come under the government of that province (Sharma et al. 2023b). Currently, planning of projects, especially hydropower, continues to occur at the central government level because decentralization is relatively recent, and the implementation of the new system is yet to be fully realized. While some key informants in this study believed that the roles and responsibilities of each agency under the new structure have been clearly mapped out, most stated that they are still unclear. There is a lack of clarity on the functions of different government agencies, specifically among local leaders regarding water resources management (Poudel 2019). Some key informants cited a lack of clarity on and understanding of relevant laws and regulations; some aspects are inclusive of various stakeholders, and some are exclusive to a specific agency.

Across scales, the federal government is mandated to conserve water resources and develop policy for multiple-use reservoirs; the provincial governments are mandated to manage water resources within their jurisdiction; and local governments are mandated to provide domestic/drinking water and ensure watershed management (GoN 2015). The concurrent rights of the federal, provincial, and local governments also include water resources management (Acharya et al. 2020; Regmi and Shrestha 2018), which introduces considerable uncertainty over division of authority over water resources (Sharma et al. 2023b). However, one key informant stated that the new proposed water act will operationalize the constitutional power of the local, provincial, and federal governments on water management, and enable the local and provincial levels to prepare laws and policies on water management within their jurisdiction. Nevertheless, the current lack of clarity in responsibilities across the tiers and between sectors, as well as the shortage of technical capacity and financial resources, is impeding the holistic development and management of water storage systems.

Poudel (2019) found that, in principle, projects follow a comprehensive seven-step process led by the local government, with engineers appointed to guide the process. However, despite this structured approach, road development is typically prioritized over water storage systems by both local and provincial governments (Poudel 2019). Key informants also highlighted that the recently formed local governments have become increasingly politicized with decisions frequently driven by individual agendas rather than informed and objective assessment. Moreover, monitoring by federal and provincial governments has become challenging as the new system grants local government greater authority over planning and decision-making (Poudel 2019), leading to a lack of coordination between the different layers of governance. However, a more recent assessment by Sijapati et al. (2023) argues that planning processes can become more accountable to end users if decentralization leads to closer collaboration between local governments and beneficiaries and if information becomes more accessible (see section 5.2).

In practice, due to the fragmented nature of water storage investments, there remains a significant need for better coordination in water storage planning. Despite the promotion of multiple-use storage systems and the acceptance of IWRM and RBM as planning principles, lack of coordination exists both vertically across the three tiers of government and horizontally within each tier, between sectors (section 5.3). This raises an important question regarding how the newly decentralized administration will integrate IWRM and basin-scale management, which both focus on hydrological rather than politically defined units. Water-use areas are often not the same as water-recharge areas (as is the case for many springs), and upstream-downstream dynamics typically lie across different administrative boundaries (Poudel 2019).

"We have 761 governments working independently — people feel that one is under the other, but this is not true. Earlier, the central government used to plan development activities, now 761 governments are doing so and there are many people involved."

Dr. Vishnu Pandey, Professor, Water Resources, Institute of Engineering, Tribhuvan University, Nepal

5.2 Community Empowerment, Gender Equality and Social Inclusion

Key informants highlighted that current natural resource management decision-making fails to empower local communities. In developing various forms of water storage, the involvement of local communities and incorporation of traditional knowledge are considered crucial (Table 6). Raising awareness of the diverse benefits of storage and ensuring their equitable distribution requires the active inclusion of local community groups. However, in large-scale diversion projects, such as the Bheri-Babai Diversion and Sunkoshi Marin Diversion, the process of ensuring benefits are equitably shared among local stakeholders is not clear (Poudel 2019). The absence of community inclusion in larger project design, planning, and implementation processes can impact water security for different water users. In contrast, in the example of the Kamala River Basin (or Kamala Valley), the recent decentralization process enabled local government to respond to local needs and engage with the community in developing small-scale water storage infrastructure (CSIRO and WECS 2021; Sijapati et al. 2023).

While policies related to water resources management do provide for local community participation, traditional knowledge, and GESI considerations (Table 6), some key informants claimed these principles are not always followed in practice. Large water storage has generally been the domain of the State, with differing degrees of local stakeholder involvement in the design, construction, and operation. As several key informants noted, water storage projects are typically implemented by engineers and supported by economists without sufficient involvement of local stakeholders. This top-down approach reflects a long-standing state culture that predates current policy content on community inclusion and contributes to the gap between government and donor requirements. The missed opportunity here lies in not fully leveraging communities as empowered managers of appropriately scaled water storage infrastructure, which might have ensured these systems are effectively and systematically managed.

Further, the policies do not fully incorporate local knowledge or adequately address GESI. For example, while the regulations for irrigation water users' associations (WUAs) include provisions for gender equality, they may not fully address equity because the social dynamic and structure varies from one community to another. The policy mandates that 33% of WUA participants must be women and minority group representatives (MoI 2004). Non-compliance with this requirement is a disqualification for registration. However, as one key informant noted, in some villages this requirement does not necessarily result in empowering women in the management of water resources. For example, while having a female community leader within a WUA/group may facilitate women's access to water, the decision-making for the management of water often remains dominated by men in informal settings.

Table 6. Inclusion of local community, traditional knowledge, and GESI aspects in policies on water storage.[a]

National and sectoral policies	GESI, local community, and traditional knowledge in the design and management of water storage systems
Water policies • National Urban Water Supply and Sanitation Sector Policy 2009 • National Water Resources Policy 2020 • National Water Plan 2002-2027 • Agriculture Development Strategy 2015-2035	• Participation of women and men in water supply and sanitation planning, implementation, management, and operations and maintenance will be encouraged and emphasized. • Participation to be encouraged through education and awareness programs for effective water management. • Build capacity of women farmers to build, manage, and maintain irrigated agriculture and water resources systems. • Promotion of community participation in the management of watersheds and aquatic ecosystems, including provision of legal arrangements for the management of such ecosystems. • Establishing and strengthening community-based institutions. • Promoting community-based research and demonstration. • Incorporating traditional knowledge, skills, and technologies for the control and mitigation of water-related disasters such as soil erosion and landslides. • Involving all stakeholders, including consumers/beneficiaries and local community in the research, use, management, and conservation of water resources.

Continued >>

Table 6. Inclusion of local community, traditional knowledge, and GESI aspects in policies on water storage.[a] (Continued)

National and sectoral policies	GESI, local community, and traditional knowledge in the design and management of water storage systems
Climate change policies • National Adaptation Plan: Summary for Policymakers 2021-2050 • National Climate Change Policy, 2076 (2019)	• Transparency, accountability, and active participation of women and men and local communities will be encouraged for climate change adaptation and disaster risk reduction programs. • Concerns of women, Dalit, indigenous people, Madheshi, Tharu, Muslim, minorities, marginalized groups, farmers, laborers, youth, children, senior citizens, persons with all forms of disability, pregnant women, incapacitated, underprivileged and disadvantaged persons or groups will be addressed in matters related to climate change. • Adaptation measures will be adopted in line with local and indigenous knowledge, skills, and technologies by identifying climate-change-affected households, communities, and risk zones. • Increase in research on GESI and climate change impacts, risks, and adaptation for evidence-based planning and implementation.

Note: [a]Only policies published before 2024 and available in English were reviewed for this study.

5.3 Sectoral Structure and Governance of Water Resources

A summary of the institutions that have a direct role or function related to water storage in Nepal is provided in Table 7. This includes roles as defined in the policies and legislation as well as those emphasized by key stakeholders. The Water and Energy Commission Secretariat (WECS) was envisioned as the apex body for water sector planning and monitoring but is regarded by experts as lacking authority in practice. Despite its designated role, WECS suffers from inadequate human and financial resources, leading it to rely on other agencies for project approvals (Regmi and Shrestha 2018; Sijapati et al. 2023).

At the national level, the Department of Water Resources and Irrigation is the primary agency responsible for water storage investments, implementing IWRM and supporting local governments on irrigation-related projects (Sijapati et al. 2023). While this department is recognized as the executing agency for water resources projects, there is overlap between it, the WECS, and other agencies regarding their national-level responsibilities, particularly those related to water resources management (Table 7). For example, while WECS is responsible for developing the River Basin Master Plan, and DWRI is responsible for the implementation of IWRM, the Department of Forests and Soil Conservation has also been proposed as the agency for river basin management plans (RBMP) at the federal level.

Prior to 2015, the energy, environment, irrigation, and drinking water sectors were managed by different ministries, leading to gaps and lack of cohesion in the management of water resources. Although WECS was tasked with overseeing planning and management in these sectors, its role did not fully address these challenges (Regmi and Shrestha 2018). As a response, the current institutional structure integrated key agencies under the Ministry of Energy, Water Resources and Irrigation (MoEWRI) including the Department of Electricity Development, DWRI, the Department of Hydrology and Meteorology, and the Hydroelectricity Investment and Development Company (Annex 4). This restructuring aims to enhance coordination in planning and implementation. However, the Ministry of Water Supply and the Ministry of Forests and Environment remain separate entities. The former is responsible for national and interprovincial water supply and sanitation while the latter oversees watershed conservation, groundwater protection, and the management of river and natural storage water quality (Table 7; Annex 4).

Table 7. Key government institutions involved in water storage.

Institution	Role in water storage/water management
Ministry of Energy, Water Resources and Irrigation	Main functions include sustainable development, protection, use and distribution of water resources, and research and technology development related to water resources, energy, irrigation, and underground water resources as well as alternative energy promotion, and water- and meteorology-related work.
➔ Department of Water Resources and Irrigation	Responsible for formulating national-level irrigation and related policies, master plans, and technical guidelines, and executing and monitoring national-level projects. Planning, developing, maintaining, operating, managing, and monitoring different types of irrigation systems (large-scale). DWRI also manages the larger reservoirs; medium and smaller-sized projects are under provincial and local government jurisdiction. IWRM is implemented under DWRI. More recently (2023/24), the implementation of groundwater development and conservation (previously under the Groundwater Resources Development Board) was brought under DWRI.
➔ Department of Electricity Development	Established to develop and promote the electricity sector. Major functions include assisting MoEWRI with electricity policies, ensuring transparency of the regulatory framework, and accommodating, promoting, and facilitating private sector investment and participation in the sector.
➔ Department of Hydrology and Meteorology	Collects and monitors hydro-met data and disseminates to water resource planners, developers, researchers, and users. Role includes delivering agrometeorological, forecasting, and early-warning information.
Ministry of Forests and Environment	Functions include development of policies, laws, standards, and regulations related to protection, promotion, and management of interprovincial forests, mountains, conservation areas, biological diversity, and groundwater areas; environmental protection and cleanliness of natural river channels, lake beds, ponds, borders and watershed areas; and water pollution control.
➔ Department of Environment	Main goals involve strengthening policy and regulatory mechanisms, raising awareness, preventing pollution, effective monitoring, protecting biodiversity, and avoiding risks of climate change through mitigation and adaptation. Involves functions of planning and implementing activities related to the above at all levels.
➔ Department of Forests and Soil Conservation	Mandated with conservation of soil, water, and forest resources for the environment and to supply forest products.
Ministry of Water Supply	Its scope is to formulate policies, laws, and standards related to water supply and sanitation; implement national-level large water supply projects; interprovincial water supply projects; and identify, develop and regulate, national-level projects on water quality (specifically sewage treatment).

Continued >>

Table 7. Key government institutions involved in water storage.(Continued)

Institution	Role in water storage/water management
➔ Department of Water Supply and Sewerage Management	Responsibilities involve planning, implementing, repairing, and maintaining large-scale water supply and sanitation systems. The provincial and local governments manage medium and smaller-sized water supply and sanitation projects respectively.
Department of Agriculture (under Ministry of Agriculture)	This central government agency focuses on large-scale agriculture development projects, with some support to local and provincial governments with small-scale storage projects.
Water user associations (WUAs)/groups	Groups/committees formed to manage and operate irrigation and drinking water projects (under the Water Resources Act and Irrigation Policy) (Poudel 2019). For example, the National Federation of Irrigation Water Users' Associations, Nepal (NFIWUAN) was registered in 1999 and has over 3,000 water user groups and committees registered (Poudel 2019). The federation functions as an umbrella agency in assisting groups to build capacity and awareness and develop leadership and advocacy. There is also a membership fee from groups. Most irrigation projects are funded by donors. There are two types of irrigation systems: 1) Entities jointly managed with government agencies, WUAs and/or farmer groups; construction and management contributions are made by farmers and local communities; and 2) farmer-led irrigation systems, which are entirely managed by farmers.

Despite the consolidation of water-related agencies under two ministries, key experts continue to highlight the lack of coordination among different departments (across and within ministries). An example is the Karnali River system, where plans were developed for a major irrigation area without considering drinking water needs. As a result, the water supply sector is now looking at lifting water for drinking purposes after the irrigation development has been completed. This could have been avoided with more coordinated planning from the outset. Coordination could also be stronger between the Department of Forestry and DWRI, for example, by sharing data held by the former agency on conservation of water sources.

The lack of coordination across agencies contributes to the lack of implementation of IWRM (Box 3) and in the planning and development of water storage systems.

Box 3. Factors affecting implementation of IWRM.

Key experts identified several gaps in the implementation of IWRM due to a lack of (1) understanding of and capacity on the approach, especially at the local government/subnational levels; (2) enabling tools and guidelines for implementation; (3) coordination and information sharing across government agencies; and (4) financial resources/investment support. The experts also noted that donors tend to invest in the "software" of IWRM at a micro scale, but when it comes to "hardware", investment is focused primarily on hydropower and the energy sector.

To address the lack of coordination between sectors, RBMPs based on the IWRM approach are being developed by WECS (WECS 2022) (Box 4). Stakeholders generally agree that effective integration and coordination of activities regarding water management, especially storage, must occur at the river basin level. However, river basin management in Nepal is inherently complex because of the need to involve the different levels of government (USAID 2021) and neighboring countries in the case of shared river basins. Suhardiman et al. (2018) argue that river-based planning will not solve the existing overlapping responsibilities, fragmented decision-making, and competition between agencies in water resource management. The extent to which planning and development of water storage systems are incorporated into the RBMPs remains to be seen.

Box 4. River-based management plans

River basin management plans are being developed by WECS, the apex agency responsible for policy and planning. There are plans to establish four river basin organizations (RBOs) for the four main rivers in Nepal. It is proposed that the Department of Forests and Soil Conservation under the Ministry of Forests and Environment be the agency for IWRM and RBMP implementation at the federal level with WECS as the organizational entity, two separate ministries for the provincial-level implementer and organizer, and local government entities for implementation at the local level (WECS 2022). Further understanding is needed on how the RBOs and local governments will operate in practice. As noted by key informants, the Department of Forests will consider water conservation in the implementation of RBMPs, in line with its mandate. Some of the key experts mentioned that the RBMPs will include biodiversity, environment conservation, water flow, interbasin transfers, and small-scale water storage.

In the discussions around IWRM, RBMPs, and water storage, key stakeholders identified the need for more capacity building. Although this need was highlighted in general from planning to implementation stages, there was specific emphasis regarding technical capacity development on design standards and guidelines in the hydropower sector, and decision support tools for water allocation and management (section 7). In addition, a review and revision of the process of transferring personnel from one government agency to another was requested, because currently this undermines the effectiveness of technical training.

6. Cross-border Considerations Relating to Water Storage in Nepal

The geographical location of Nepal is such that it is downstream of China—and is thus affected by that country's water resource management decisions—and upstream of India and Bangladesh. In total, the four main river basins in Nepal contribute 70% of the wet-season flows and 40% of the dry-season flows of the Ganges River in India. Issues such as flooding, drought, aquifer depletion, and potential water storage solutions go beyond the borders of the countries in the South Asian region (USAID 2021). On the other hand, geopolitical issues extend far beyond water resources. Nepal is only partially integrated with regional and global markets (Basnett and Pandey 2014). It sits strategically between two of the world's fastest growing economies, India and China. But because it is landlocked, it is dependent on its regional neighbors for access to global markets. This, in conjunction with insufficient infrastructure, greatly hinders the development of Nepal's national economy.

Due to regional geopolitics and their geographical proximity, India and Nepal depend on each other for the development of water storage schemes on rivers in Nepal. The transboundary agreements around water resources management in Nepal are bilateral agreements. To date there are no multilateral agreements in the South Asian region. The first Indo-

Nepal transboundary agreement was signed in 1929, and since then, there have been three treaties, the 1954 Koshi treaty (amended in 1966); the 1959 Gandaki treaty; and the 1996 Mahakali treaty. According to some of the experts interviewed, all treaties were signed during political turmoil and instability of some sort in Nepal, when the country struggled to fully protect its own interests. As a result, India wields significant influence in three of the main river basins in Nepal through these bilateral agreements.

The Sapta Koshi Dam (Box 5) serves as an example of transboundary deliberations and highlights the complex nature of benefit sharing between the two countries. There are other instances of benefit sharing challenges where India needs water for irrigation and Nepal requires storage (Box 6). While Bangladesh has expressed interest in investing in water storage in Nepal, progress has been hindered due to geopolitical constraints and Bangladesh's reliance on India for regional trade. Many water storage projects have stalled due to these interdependencies, ongoing negotiations, and political complications, leading to hesitancy from international organizations and donors in their investment and involvement. Additionally, internal political instability within Nepal coupled with relatively weak capacity contribute to ineffective regional negotiations because there is no unified consensus-based national position on transboundary water management among Nepal's political parties.

Another example of transboundary challenges is the management of glacial lakes. In addition to data needs for GLOFs, there is also a significant need for discussion and agreements with neighboring countries on managing risk. In 2016, there was a small lake that burst in Tibet and caused significant damage to a hydropower plant in Nepal. In the 1960s and 1980s transboundary GLOF events originated in Tibet Autonomous Region/China and caused damage to roads, bridges, hydropower stations, livestock, and farmland (ICIMOD 2011). Risk perceptions may vary between countries, with China viewing GLOFs as primarily a matter of research while Nepal considers it a significant hazard. Nevertheless, as one key informant mentioned, the process to share data and information on GLOFs needs to be improved. While some data-sharing occurs with India, it is non-existent with China, underscoring the need for enhanced collaboration and transparency in managing shared risks.

Box 5. The Sapta Koshi High Dam Multipurpose Project.

Nepal and India are engaged in negotiations to build this multipurpose project offering the benefits of hydropower generation, irrigation, flood control, and inland waterway transport. The project with a 269 m high dam will have an installed hydropower generation capacity of 3,000 MW at 50% load factor, offering annual power generation of 15,732 million units and the optionality of peaking power. The other benefits include irrigation to 546,000 ha (and stabilization of a further 167,750 ha) in the Terai region of Nepal, and 1,053,000 ha in Bihar state in India. A flood cushion of three meters has been proposed to enable flood control in the Terai and Bihar. For navigation, a sea route is proposed through a Koshi inland waterway from Chatara to Kursela (India), where the Koshi meets the Ganges.

Recent developments in the project include an agreement by India and Nepal to reduce the height of the proposed dam (Shrestha 2023b) as a response to protests by local communities and residents who are apprehensive that the reservoir could inundate a large area of land upstream and lead to displacement of people.

Source: MoEWRI 2025.

Box 6. Benefit sharing agreements

A benefit-sharing mechanism is a series of agreements between watershed stakeholders, including water users, local groups, industries, government, and NGOs. Typically, such agreements are focused on ensuring (1) the environment is protected; and (2) financial and other benefits accrue to water beneficiaries as well as those caring for the basins that provide the resource.

Source: CONDESAN 2014.

7. Conclusions and Potential Areas for Intervention

Water storage needs and potential solutions in Nepal are diverse and vary significantly by terrain. While the agriculture sector is the largest water user in the country, large-scale hydro-storage for energy is prioritized over irrigation and small-scale storage. However, the latter plays a significant role in advancing national development goals and priorities which place drinking water at the top, followed by agriculture and irrigation, and thereafter hydropower. Nepal's national policies recognize that variation in water availability across the landscape, coupled with growing water demand, means there is need for more water storage and the adoption of an IWRM approach (Sharma et al. 2023a). However, for effective water storage development, some policies and legislation must be revised or updated to ensure better alignment and cohesion across sectors. Further, the institutional landscape in Nepal and the transboundary challenges the country faces may limit the feasibility of certain water storage solutions. Currently, the lack of coordination among local, provincial, and federal tiers of government and between and within various sectors results in fragmented water storage efforts.

Given this study's dependence on secondary data regarding community involvement in water storage systems, further research is needed to fully assess the extent to which plans and policies have been realized on the ground. A deeper understanding of the dynamics between local communities, the three tiers of government and the various stakeholders involved in the design, development, and management of water storage systems will enable the formulation of more effective solutions than the current *ad hoc* process allows. The geopolitical nature of transboundary issues further complicates large-scale storage, limiting external (international) and regional multilateral investment. However, there are opportunities for some bilateral (India-Nepal) investment in water storage systems (e.g., the Sapta Koshi Dam). Based on the findings of this study, the following areas of intervention are suggested to advance water storage development and implementation in Nepal.

- Revise the 1992 Water Resources Act to align it with the constitutional provisions for shared roles and responsibilities among the three levels of government and to integrate the holistic approach outlined in the Water Resources Policy (2020).
- Create an enabling environment by developing implementation guidelines, toolkits, and decision-support tools for water storage and water resources management.
- Clarify roles in water storage (especially between WECS, DWRI, and the Department of Forests and Soil Conservation, and across the three tiers of government) and establish mechanisms to improve interagency coordination and collaboration.
- Enhance capacity-building for institutions and address data needs related to water storage development. Specific areas for further assessment include:
    - ◊ Data on GLOF triggers, and the nature of each, such as the travel speed, volume, and mix of water and debris to develop effective solutions. While water storage may be one option, other strategies such as early-warning systems and structural interventions in the lake itself (e.g., lowering water, excavations, bank

protection) may be necessary. Integrated approaches, combining multiple options, should be considered based on local contexts.

    - ◊ Additional technical and financial support for the development of RBMPs. While the Gandaki RBMP is funded by the Green Climate Fund and the Kamala RBMP is being developed with Australian government funding, further technical support is required for socioeconomic assessments.
    - ◊ Updated information and data on water demand and availability, especially groundwater availability and use in both the Terai and mid-mountain regions.
    - ◊ Developing a classification and water storage inventory to enhance policy formulation and decision-making.

- Leverage existing capacity-building programs to avoid replication and ensure tailored, effective training. For example, the Asian Disaster Preparedness Center's Climate Adaptation and Resilience for South Asia project aimed to develop a capacity-building program for water harvesting (Sharma et al. 2023a). Further capacity-building activities can be built on the work done by this project.
- Develop a unified national policy on transboundary water management to guide future bilateral and multilateral discussions and inform large-scale water storage planning and investment.
- Systematically integrate local communities and GESI considerations into policy on, and management of water storage. Documenting local knowledge and case studies of small- to medium-scale community water storage systems will support the planning, restoration, and implementation of water storage projects (Sijapati et al. 2023).
- Strengthen the capacity of local governments in managing small-scale water storage systems, including policies, planning, monitoring, and evaluation. Given their constitutional mandate over water supply, irrigation, biodiversity conservation, and watershed management, enhancing the adaptive capacities of local communities and climate-vulnerable groups is crucial.

By addressing these areas, Nepal can build a more cohesive, inclusive, and effective approach to water storage development that aligns with its national priorities and enhances the resilience of local communities.

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Annexes

Annex 1. Thematic Areas for Water Storage Policy Review

Sectors and themes included in the review of water storage policies and strategies for this Policy and Institutional Study. Broader topics are in bold with subtopics/areas listed under them.

List of sectors and themes	
Key goals/outcomes	**Fisheries**
Country context	Contribution to development
Water sources	Water security
Scarcity/abundance	Storage as new opportunity; storage as risk
Patterns shaping temporal and spatial water availability	**Climate resilience/adaptation**
Explicit reference to storage	Water security
Agriculture	Storage for resilience
Contribution to development	**Governance**
Supply-side requirements	Integrated water resources management
Demand-side management	Transboundary water management
Water storage/harvesting	Cross-sector planning
Soil moisture	Participatory solution identification, design and implementation
Flood management	Focus on vulnerable groups including women
Desalination	Local knowledge in resource management and adaptation
Energy Environment	**Other**

Annex 2. Questions for Key Informant Interviews

Political economy of built water storage – Nepal
Key stakeholder interviews – Guiding questions

Please note: Not all questions will be asked to every individual respondent. A different combination of the following questions were asked based on the sector/expertise of the individual; for example, agriculture-related questions are meant for the respondent from the Department of Agriculture. There are approximately 8 questions and 45 minutes per interview. This is a semi-structured interview, and the questions are meant to guide the discussion. Further follow-up questions may arise during the discussion.

1. Different sectors may need different types of storage at different spatial scales with their own management regimes. At what scales and in what types of storage is Nepal investing, and what development goals drive these investments?
2. Which government agencies plan/regulate/implement water storage investments? Given different sectors may focus on different storage types, is there a mechanism to coordinate these investments across sectors?
3. The Agriculture Development Strategy (ADS) calls for small local water sources or water harvesting. Will these investments form part of a wider irrigation investment plan along with larger schemes? Will these use government-community management models? Who will finance these?
4. The ADS states that the transboundary river agreements with India do not adequately protect Nepal's interests. How does this inform the selection of storage types and allocation of water among sectors?
5. The SDG Roadmap and other policies view hydropower as a renewable energy and promote a substantial increase in production capacity. How do planning mechanisms account for externalities such as loss of e-flows and downstream ecosystems services that are important for food and livelihood security? Is there an EIA process and is this used for all water storage related projects?
6. The Irrigation Master Plan, the National Adaptation Plan and other policies stress the need to expand irrigation. What kinds of storage are needed given the characteristics of Nepal's topography and the needs of different food producers? Do these match with the current storage types being invested in?
7. The National Adaptation Plan and other plans highlight the role of water pumping and exploring groundwater as a source for irrigation. How is this managed across sectors and scales?
8. The National Adaptation Plan also highlights the risks of GLOF. Is storage a factor in Nepal's risk management strategies?
9. The National Adaptation Plan highlights the Karnali Watershed Management Programme (KWMP) as an example of more locally based water resources management for adaptation. How important are approaches like the KWMP in other parts of Nepal? How are local knowledge, diverse stakeholders, accountability, and inclusion principles incorporated?
10. The National Adaptation Plan requires adaptation to be GESI informed for adaptation and resilience investment to be socially equitable (s.6.9). How do you think GESI principles can be applied to the planning, design, and implementation of different types of storage?
11. How does the recent decentralization of state functions influence who makes decisions on storage? Would it help to increase the range of stakeholders in these decisions, or will planning and design remain centralized?
12. What impact (if any) do you think the adoption of IWRM (as per the National Water Plan and the National Climate Change Policy) could have in how the government and donors perceive different types of storage and its role in many development objectives?

Annex 3. List of Key Informants Interviewed

No.	Name	Gender	Position	Organization
1	Bharati Pathak	Female	Chairperson	Federation of Community Forestry Users Nepal (FECOFUN)
2	Mukesh Raj Kafle	Male	Former Managing Director	Nepal Electricity Authority
3	Prachanda Pradhan	Male	Chair, Founder, and farmer-led irrigation expert	Farmer Managed Irrigation Systems Promotion Trust (FMIST)
4	Ganesh Paudel	Male	Deputy Director General	Department of Forests and Soil Conservation
5	Sanjeeb Baral	Male	Director General	DWRI
6	Divas B. Basnyat	Male	Coordinator, Water and Climate Program	Nepal Development Research Institute
7	Rubika Shrestha	Female	Water Resources Specialist	World Bank
8	Manju Sharma	Female	Joint Secretary/Senior Sociologist	DWRI
9	Vishnu Prasad Pandey	Male	Professor, Water Resources	Institute of Engineering, Tribhuvan University
10	Rajesh Sada	Male	Head of Freshwater Programs	World Wide Fund for Nature, Nepal
11	Dhrub Raj Pant	Male	Former head of IWMI Nepal	Independent
12	Arun Bhakta Shrestha	Male	Strategic Program Lead, ICIMOD	ICIMOD
13	Shailesh Mishra	Male	Chief Executive Officer	Independent Power Producers Association, Nepal
14	Dwarika Nath Dhungel	Male	Academician, writer	Former secretary, Government of Nepal
15	Dipak Gyawali	Male	Former minister for water resources	Nepal Academy of Science and Technology

Note: The designations of the key informants were noted at the time of interviews.

Annex 4. Key Government Agencies Involved in Water Resources Management

Figures A4.1 to A4.4 depict the structure of key government agencies involved in water resources management and development of water storage in Nepal. The sectors covered are energy, water, agriculture, water supply, and environment.

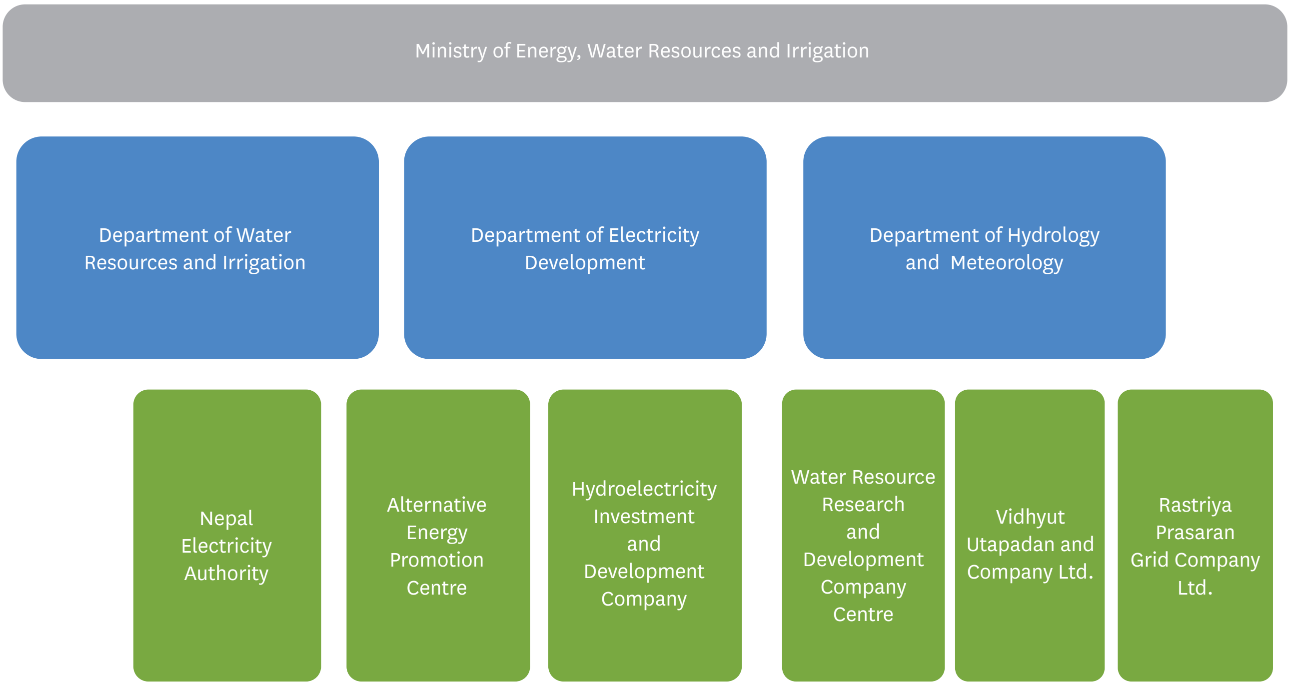

Figure A4.1. Agencies working under Nepal's Ministry of Energy, Water Resources and Irrigation. The blue row shows different departments, and the green row depicts organizations/authorities. The organizations do not necessarily come under the departments; all entities work closely in collaboration with the Ministry.

Figure A4.2. Agencies working under Nepal's Ministry of Agriculture and Livestock Development. The blue row shows the departments, and the green row depicts the councils. The councils do not necessarily come under the departments; all entities work in collaboration with the Ministry.

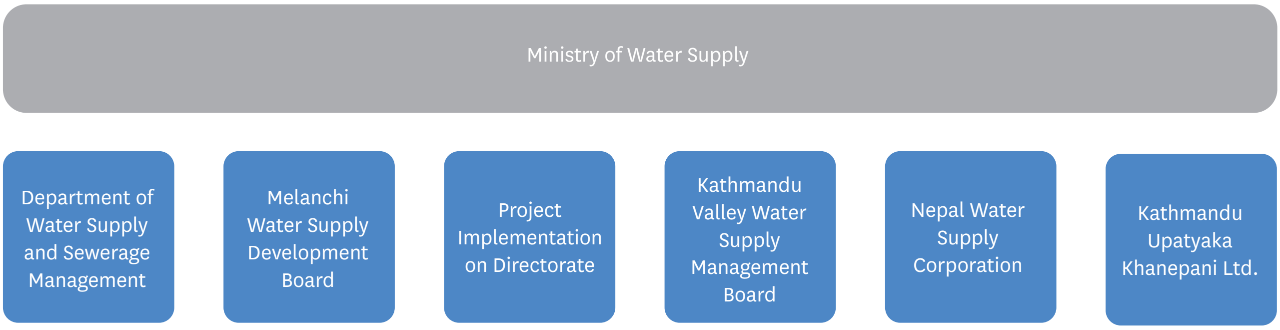

Figure A4.3. Agencies working under the Ministry of Water Supply of the Government of Nepal.

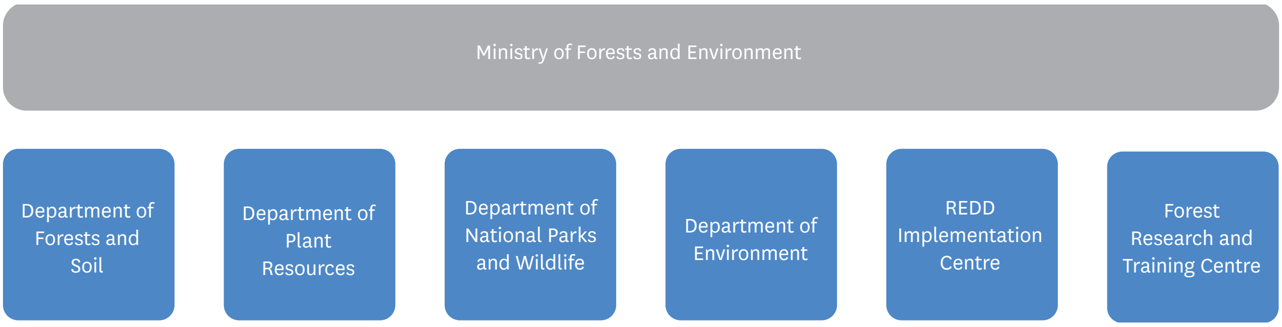

Figure A4.4. Agencies working under the Ministry of Forests and Environment of the Government of Nepal.

International Water Management Institute

The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 15 countries and a global network of scientists operating in more than 55 countries.

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